

# **Relevancy of Data Entered into Riskmaster**

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*NCDOT Research Project 2009-10*

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## Table of Contents

<b>ABSTRACT .....</b>	<b>1</b>
<b>INTRODUCTION .....</b>	<b>1</b>
<b>OBJECTIVE .....</b>	<b>1</b>
<b>ACCIDENT INVESTIGATION AND CAUSATION THEORIES .....</b>	<b>1</b>
<b>GIBB-HASLAM MODEL .....</b>	<b>3</b>
UNDERSTANDING THE GIBB-HASLAM MODEL.....	3
USING THE GIBB-HASLAM MODEL .....	4
METHOD FOR USING THE GIBB-HASLAM MODEL .....	5
GIBB-HASLAM MODEL TERMINOLOGY .....	7
REACTIVE AND PROACTIVE USES.....	10
NC DOT OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT SYSTEMS .....	10
<b>METHODS .....</b>	<b>10</b>
CASE SELECTION.....	10
INCIDENT INVESTIGATION MEETINGS.....	15
INTERVIEWS .....	15
MODEL VERIFICATION .....	15
<b>FINDINGS.....</b>	<b>15</b>
INCIDENT VIGNETTES.....	30
INCIDENT VIGNETTE SUMMARY TABLES .....	92
MODEL VERIFICATION SUMMARIES.....	95
<b>DISCUSSION .....</b>	<b>103</b>
RECOMMENDED CHANGES TO RISKMASTER .....	103
RECOMMENDED CHANGES TO FORMS .....	103
POTENTIAL RECOMMENDED FORMS.....	104
NC DOT FEEDBACK.....	107
<b>CONCLUSIONS.....</b>	<b>107</b>
<b>REFERENCES.....</b>	<b>108</b>

## **ABSTRACT**

This research project was undertaken to attempt to make a positive impact on the manner in which NC DOT collects data during accident investigations. Twenty-seven accidents were analyzed using a diagnostic investigation technique designed to allow the investigator to identify multiple causes and influences that will impact the individual accident under investigation as well as the organizational safety management in general. The model was used on two additional accident investigations to further validate its utilization. Recommendations are made to change the forms utilized during incident investigations. The Riskmaster system, a descriptive technology, was evaluated for possible changes to impact accident diagnostics.

## **INTRODUCTION**

Injuries, illnesses, and accidents impact the morale of the NCDOT workforce, the productivity of operations, and the cost of doing business. It is important to identify and analyze injury, illness, and accident trends to develop action plans to use limited resources in the most efficient manner. Investigations are made to identify the causal factors and to recommend corrective actions that will reduce the probability of similar incidents occurring. When investigations are inconsistent and inaccurate, resources are wasted or not invested properly in appropriate and effective countermeasures.

Modern accident causation models recognize that there are multiple root causal factors for each single hazards-related accident. Yet, there seems to be a desire to retain the longstanding practice of simplicity by accident investigators who frequently assign accident root causes to one significant causal factor. Often this single root cause is classified as “carelessness” and is focused on a “person-failure”, stemming from Heinrich’s misused axiom that asserts unsafe acts as the primary cause of accidents. Where accident investigation is performed optimally, multiple causes of hazard events are identified and countermeasures are developed which focus on the hierarchy of controls placing responsibility on management to eliminate or substitute for hazards with a focus on engineering controls as the primary measure to reduce risk to acceptable levels.

## **OBJECTIVE**

The research objectives of this project were to: 1) improve the data gathering process during incident investigations to fully utilize the Riskmaster system, and 2) create an investigation process that assures the investigators identify true root causal factors. The research objective was reinforced in an email from Robert Andrews dated September 18, 2008. “As a follow-up, we are to focus on the data we collect that will go into Riskmaster. This data will be used to identify trends with injuries and incidents so we can plan awareness, training, and other programs and initiatives to prevent future injuries and incidents. The key component is the data pieces we collect from our investigations.”

## **ACCIDENT INVESTIGATION AND CAUSATION THEORIES**

There are numerous approaches and theories to accident causality. If you ask 10 safety professionals the best way to investigate accidents, you might very well receive ten different responses. The inconsistency in accident investigation techniques are best described by Lundberg et al (2009) where they find that the causes of the accident found during an investigation reflect the assumptions of the accident model. They coined the acronym “WYLFIFY”, meaning What You Look For Is What You Find. Accordingly, What You Find

Is What You Fix, “WYFIWYF”. Neither the purpose here, nor of this research project, is to provide a detailed literature review or summary on accident causation. That exercise would be a research project in and of itself. The extremes of the accident causation theories can be summarized by the person approach and the systems approach. The person approach focuses on the errors of individuals, blaming them for forgetfulness, inattention, or moral weakness. The system approach concentrates on the conditions under which individuals work and tries to build defenses to avert errors or mitigate their effects. For accident causation, like most issues, we believe the truth lies somewhere in the middle. In this case a sensible balance of the person approach and the systems approach was proposed. For the purposes of this research the Gibb-Haslam model was chosen (Figure 1). This model allows the user to find their own solutions which are in a combination of the person approach and systems approach. Each identified deficiency is viewed as an opportunity for organizational safety improvement. The researchers are familiar with this approach, have used this approach before, and this was recommended and suggested in the project proposal.

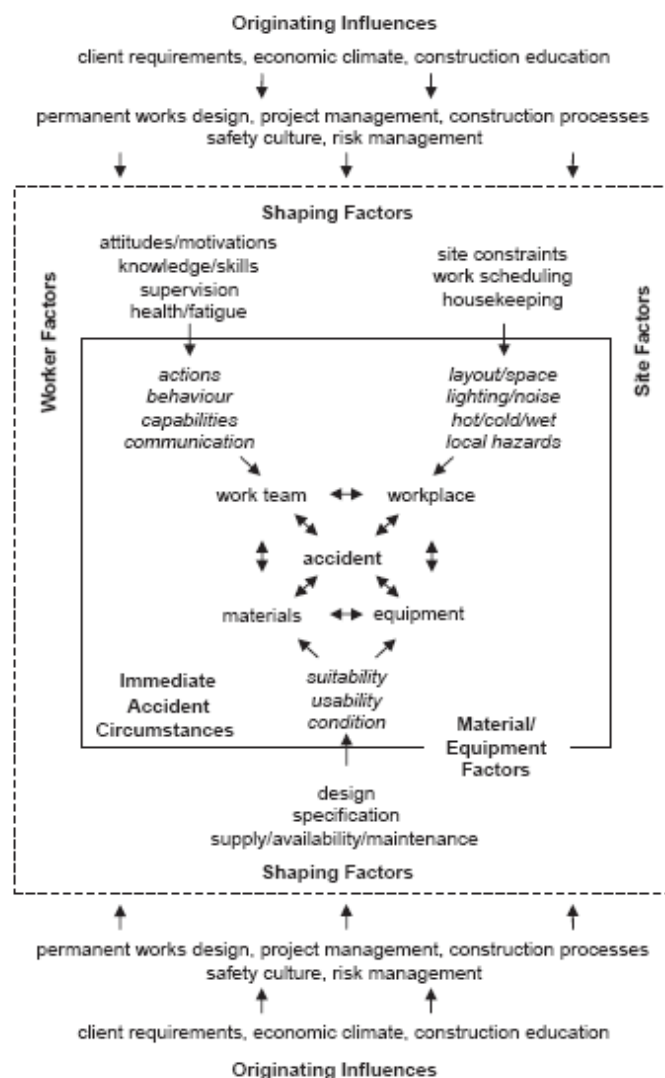


Figure 1. Gibb-Haslam model of causal influences in accidents

## **GIBB-HASLAM MODEL**

### Understanding the Gibb-Haslam model

The Gibb-Haslam model is not a checklist style incident investigation model. It is based on Reason's Swiss Cheeses model, which seeks to span the entire accident sequence from organizational to individual levels. Accident causation models that focus on individual level factors (i.e. immediate factors in the Gibb-Haslam model) lose a great deal of diagnostic information especially if the goal is organizational safety improvement. Consider a model that focuses on solely employee acts and/or unsafe conditions. Specifically consider Incident #2, EV2008046326, in this report. In this incident a focus on the employees would certainly reveal that they got too close to the overhead wires and this is in violation of work rules that they understand. If we stop at this point the organization we can reprimand the employees and the employees become frustrated with the safety effort because there was more to the incident than a simple focus on the employees' acts. Through the investigation it was revealed that management did not scope and plan the job properly keeping safety in mind. In relation to the overhead wires, employees stated they were told to "be careful". Any incident investigation is only as good as what is revealed by the people involved and the information revealed must be factual. In many investigations, we will never be 100% certain that the reported information is absolutely truthful and accurate. However, the Gibb-Haslam model allows the investigator to critically think about influences that affected the particular incident under investigation but also to think about factors that might influence the organizational aspects. In this particular example, there was clearly a lack of communication between employees and supervisors. Knowing this should prompt the investigator to consider other aspects where poor communication increase risk; the organization should consider ways to improve safety communication between employees and management. One way is to improve safety culture. We noted safety culture as an originating influence in this incident because clearly there is a culture of disagreement when it comes to safety planning and communication. An organization interested in improving employee safety would investigate further as to whether this is an isolated clash or if there is more animosity at the group or organizational level. A focus on the employees' acts would certainly prevent this group from doing the same type of unsafe in the future in the short term. It might also affect work groups within the division to not perform unsafe acts within overhead power lines. It might not if the other groups thought that this particular workgroup just got unlucky that day or they were not communicated the conditions surrounding the incident. However, what about the long term and what about learning from this across the other 13 Divisions? We were informed through discussion with other Divisional Safety Engineers and the Incident Investigation meetings we attended that two other incidents of hitting overhead power lines have occurred. We question whether this is a work rule violation that needs to be corrected at the employee level through training and enforcement or whether this is an organization issue where risk could be minimized through better planning of the work, proactive communication, a building of trust between employees and management, and potentially other originating influences identified. We believe the latter will enhance organizational safety in working with and around overhead power lines safely. We further believe that identifying these originating influences will ultimately affect other work issues (outside of power line safety). Consider if the organization decides to focus on better work planning. This would potentially include a large gamut of DOT activities not just working on or around overhead power line.



It is believed that by using an incident investigation model that tries to explain the complexity of the interaction between the various factors and encourages people to look beyond the immediate circumstances of the accident that an organization can make better decisions that will positively affect the safety of their employees.

#### Using the Gibb-Haslam model

The Gibb-Haslam model is based on the thinking put forth by James Reason in that there are more to accidents than the immediate causes, or active failures as dubbed by Reason. The immediate causes can be traced back to organizational level analysis which takes into account the input of management and decision makers. Reason calls these latent failures. Gibb and Haslam name these shaping factors and originating influences. These shaping factors and originating influences are decision or actions which may lay dormant for a period of time and only become evident when they combine with the local triggering factors. Their defining feature is that they were present within the system well before the onset of the recognizable accident sequence. Research in the UK found that the preconditions of unsafe behavior originate in poor management decisions or an organizational culture in which health and safety goals are subordinate to production goals. Moreover, these unsafe acts are known to occur more frequently in situations where responsibilities are ambiguous or ill-defined and times pressures are high – very typical of DOT conditions. It is clear that unsafe acts by employees and unsafe conditions (immediate causes) are the last step before the accident occurs and are extremely important to their prevention. It is also clear that these unsafe acts and conditions are not occurring only when the accident actually occurs. They occur multiple times but yet are acknowledged as acceptable risk until the accident occurs.

In using the Gibb-Haslam model, the user should think of each immediate cause (work team, workplace, equipment, materials) as the end point for the accident and the starting point of tracing the causes back through the Swiss Cheese. There could very well be multiple starting points and then each immediate factor may have multiple shaping factors and originating influences associated with it. The Swiss Cheese can turn into a web of causation in very complex accidents and when numerous causes are identified. Figure 2 shows the Swiss Cheese model and Figure 3 shows the model with the Gibb-Haslam terminology utilized as an example.

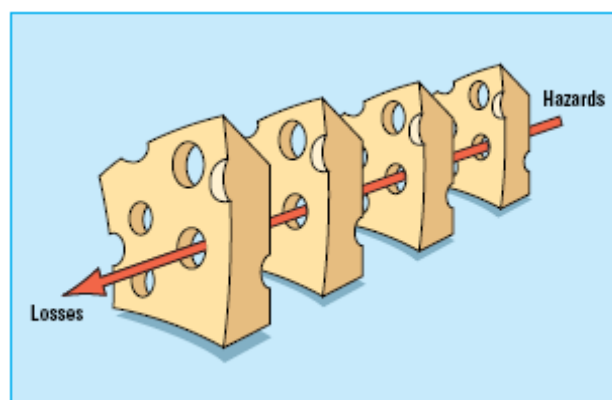


Figure 2. Swiss Cheese model of system accidents (adapted from Reason)

### Method for using the Gibb-Haslam model

1. Throughout the analysis, always remember the principle of multiple causes: problems and loss-producing events are seldom, if ever, the result of a single cause. The purpose of an incident investigation is to find ALL the relevant causes of the incident under analysis. In doing so, you reveal more options and avenues to correct system deficiencies.
2. Treat the phrases in the model, Immediate Cause, Shaping Factors, and Originating Influences as questions. For example, if worker actions and behaviors are identified as an immediate cause follow through the model to the shaping factors associated with the work team. Ask the following questions:
  - 2.1. Did the worker(s) attitudes or motivations influence the worker(s) actions and behaviors? If so, how?
  - 2.2. Did inadequate supervision contribute the worker(s) actions and behaviors? If so, how?
  - 2.3. Did the employee(s) knowledge or skill contribute to their actions and behaviors? If so, how?
  - 2.4. Did the employee(s) health or fatigue contribute to their actions and behaviors? If so, how?
3. When any yeses are identified to these questions, then each must be followed back to the potential originating influences and similar questions asked. Think about a piece of swiss cheese. For example, if inadequate supervision were detected, then the investigator would ask does the safety culture of the organization encourage this type of inadequate supervision, and was the project managed successfully. The investigator must think critically about each influence and try to locate organization issues that have affected the incident. This can be difficult, but will be worth the effort. Moreover, this type of questioning will help during the divisional incident investigation meetings where multiple viewpoints brainstorming can develop practical solutions to reduce organizational risk.
4. When causes and influences are identified, they should be highlighted on the model and written down. Then the search to find methods to reduce risk can proceed.
5. Causes and influences may appear more than once in a single incident if there are multiple deficiencies or improvement areas found. For example, an originating influence such as project management may affect the manner in which equipment is scheduled and may also affect supervision and the work team.

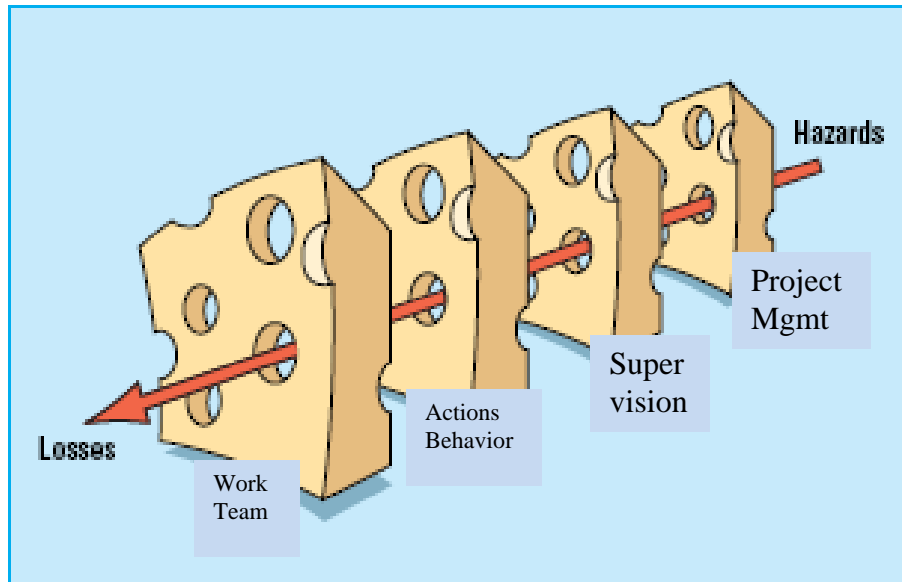


Figure 3. Example of Swiss Cheese model with Haslam-Gibb terminology

## Gibb-Haslam Model Terminology

### WORKER AND WORK TEAM

#### 1. Worker actions and behaviors (including attitudes and motivation)

In general, workers do not want to be injured themselves or be responsible for injuring others. However, the actions and behaviors of workers are usually the last link, and the last spot to control risk, before an incident occurs.

#### 2. Worker capabilities (including knowledge/skills)

Do the worker and/or work team know how to do the job, use the equipment, identify hazard and risks associated with the work, etc? A distinction should be made between education and training. Education imparts a higher level of knowledge and skills, which is transferable to different situations. Training is more context specific, dealing with procedures or rules for undertaking particular tasks or activities. Both are included in this operational definition. Effective education equips individuals with the ability to analyze a situation and respond accordingly. Training, however, provides more directive instruction as to how an act should be performed. A combination of both is desirable.

#### 3. Communication

Problems with communications can occur at the work group level, supervisory level, or the organizational level. Communication issues can include poor command of the English language, not wanting to communicate for a multitude of reasons, supervisors not wanting to communicate safety, etc. Communication includes the written as well as the spoken word.

#### 4. Immediate supervision

Previous research has identified the important influence front line supervisors have on safety. It has long been argued that the supervisor is a key individual in accident prevention, having daily contact with staff and the opportunity to control unsafe conditions and acts likely to cause accidents and plan the work in a manner to reduce risk and identifiable hazards.

#### 5. Worker health/fatigue

Construction workers work long hours as a result of paid overtime for workers or, in the case of managerial or professional staff, regarded as necessary due to a high work load. Some accident-involved individuals have been shown to have worked very long periods without a break, or several long days without a day off. The consequences of tiredness and fatigue are reduced concentration, poor decision making and compromised safety. This phenomenon does not appear to be widely recognized in the construction industry.

### WORKPLACE

#### 6. Site conditions (excluding equipment, materials, weather)

This includes the ground and area where the work is performed, and the immediate adjacent area if contributing to the accident, and the relationship to the hazards and risks of the tasks.

7. Site constraints, site layout/space

This is the space in which the work is performed, and includes the relationship of equipment and the work team to identifiable hazards.

8. Local hazards

Hazards and risks that are specific to the site which typically should have been identified or somehow managed or planned to avoid or minimize.

9. Working environment (lighting/noise/hot/cold/ wet)

The work environment includes wet conditions, thermal stressors, lights, noise, and other physical, climatic factors involved in influencing the factors involved in the incident.

10. Work scheduling

This includes the required pace of the work, work sequencing, scheduling pressures, and other factors affecting the safety health of workers in relation to work preparation and arrangement.

11. Housekeeping

A safe job site is a clean and orderly worksite. The disorderly condition of trucks, equipment, job sites, and all working areas negatively affects worker safety.

### MATERIALS

12. Suitability of materials

Were the materials utilized suitable for the job and task to be performed? Were materials used for something other than what they are supposed to be used for?

13. Usability of materials

This includes a lack of functionality of the materials or a lack of materials themselves.

14. Condition of materials

Was the condition of materials safe and acceptable?

### EQUIPMENT

15. Suitability of equipment

Was the equipment utilized suitable for the job and task to be performed? Were the equipment used for something other than what they are supposed to be used for?

16. Usability of equipment

This includes a lack of functionality of the equipment or a lack of equipment. While usability is typically linked with suitability or condition, that does not always have to be the case. For example, in a case where an employee fell because no handrail existed, usability was marked as the sole aspect for the equipment because the handrail was not there and one should have been there to make the back of the truck usable.

17. Condition of equipment

Was the condition of the equipment safe and acceptable?

ORIGINATING INFLUENCES

18. Permanent (and temporary) works design

Includes permanent features of the equipment and buildings that influences the incident. It also includes temporary structures (temporary works) built for the tasks and projects. Includes information about underground and overhead utilities in the planning of projects/tasks.

19. Project management

Project management includes the safety oversight of the intricacies of the project and tasks to be performed. Also includes contractor arrangements, sub-contracting, labor supply, work scheduling, time management, time pressures, and individuals taking it upon themselves to do jobs/tasks.

20. Construction processes

Improper methods statements or absence of method statement if there should have been one developed and communicated. Inadequate or lack of verbal instructions when they should have been given or more thoroughly planned. Includes improper tools for the job or using tools not suitable for the job.

21. Safety culture

Safety culture is the way things are done around the organization and can be an organizational level, divisional, and group (work team) level phenomenon. Safety culture affects communication, supervision, scheduling, and work team behavior regarding safety. It influences how projects and tasks are planned. When employees take short-cuts it can be rooted in the safety culture of the organization or group in that they are encouraged either directly or indirectly to take those shortcuts to get the job done.

22. Risk management

Includes improper risk assessments, improper incident investigation, which includes not learning from past mistakes and/or failures, poor identification of proper remedial actions, lack of or poor employee consultation and participation in identification of hazard and risks, and includes conditions where recognizable hazards were not identified and recognizable risks were not properly anticipated and identified.

23. Outer Originating Influences

Economic climate, client requirements, and construction knowledge are indicated within the model as outer originating influences. These are rarely able to be identified in incident investigations, but they are worth noting and keeping them within the model to provide the user with more information and better understanding of the complexity of incidents.

### Reactive and Proactive Use of the Gibb-Haslam Model

Accident investigations are by their very nature a reactive process. However, effective safety management cannot be based on hindsight. To effectively manage safety in any organization there must be a balance of the reactive and proactive. By using a model, such as the Gibb-Haslam model, in reactive investigations an organization could easily shift the thinking behind the model into proactive safety management. Because the model acts as a primer to help stretch investigators' minds as to what aspects might be involved in a particular event, it is possible to use the same process in thinking about planning a particular task, writing a new safe procedure, or other proactive decision about worker safety.

### NC DOT Safety and Health Management Systems

We also categorized occupational safety and health management system deficiencies using the NC DOT Safety and Health Management Systems (SHMS). Figure 3 shows the NC DOT SHMS. We broke down the causes of the accident by the 'prevention' part of the system and included leadership, policies and procedures, training, awareness, and audits for each incident investigated.



Figure 3: NC DOT Safety and Health Management System graphic

## **METHODS**

### Case Selection

Cases were selected to represent DOT accidents by nature of injury and cause code. Divisions 1 through 6 (eastern NC) were the focus of the research. We used the cause code variable as the original sorting variable. Through Riskmaster we found 537 cases between 1/1/08 and 10/1/08. Eighty-one cases were selected from reading through the operation code. We tried to maintain the same original spread of cause codes for the list of 537 and also evaluate the nature of injury category. From to discussion with the steering committee, we were asked to ensure we evaluated a sufficient number of sprains and strains (nature of injury code) in the investigations. We

originally selected 29 cases to be selected in the research. Due to retirements, layoffs, and either the employee or supervisor not being available we were missing about 10 data points. We tried to include cases where only the supervisor or employee were available but those interviews did not yield the type of varying views and rich information compared to interviewing both the employee and supervisor. These were not included in the final analysis. We also did not have sufficient number of cases in Division 1 which was noted by the Steering Committee. We went back to the cases and selected additional ones for analysis. Table 1 shows the cause code information for all cases considered and those in the final twenty-seven selected. Table 2 shows the breakdown of the nature of injury codes in the final analysis. Table 3 shows the cases selected distributed by Division. Table 4 shows the distribution of the cases selected by day of the week. There was a decent distribution across both Divisions and day of week. The complete list of accidents selected with greater detail is provided as Table 5 on pages 11 – 13.

Table 1: Total cases and cases selected by cause code

<b>Cause Code</b>	<b>Total</b>	<b>Selected</b>	<b>Cause Code</b>	<b>Total</b>	<b>Selected</b>
Contact with Bloodborne	1	-	Burns	4	-
Contact with chemical	1	1	Collision with fixed	4	-
Continual Noise	1	-	Overtaken	4	-
Fall from ladder or scaffolding	1	-	Repetitive Motion	4	-
Fatality	1	-	Shoveling, Scraping	4	-
Foreign body in ear	1	-	Struck by other vehicle	4	-
Heating apparatus	1	-	Dizzy, fainted, passed out	5	-
Holding & Carrying	1	-	Heat Exhaustion	5	-
Ice or Snow	1	-	Moving parts of machinery	5	-
Machine or Machinery	1	1	Slipped, did not fall	7	-
Not Applicable	1	-	Hand tool or machine	10	1
Other external factor	1	-	Hand Tool, utensil	10	1
Ran off road	1	-	Hit stationary object	10	2
Reaching	1	-	Other Injury	10	-
Skin Abscess	1	-	Fall from different level	13	1
Struck by lightning	1	-	Climbing or stepping	16	2
Struck other object	1	-	Pushing or Pulling	16	1
Struck other vehicle	1	-	Rear end collision	16	-
Vehicle upset (overturned)	1	-	Falling, rolling or flying obj	17	1
Broken Mirrors	2	-	Misstep, Slip, Trip	19	-
Fall into opening	2	-	Foreign body in eye	21	1
Lay/Pour/Spray/Cleaning	2	-	Collision with another vehicle	22	1
Motor Vehicle (hit by)	2	-	Contact with Poison	24	-
Overturned or Thrown	2	-	Object Being lifted	24	1
Physical Activity and	2	-	Lifting	26	1
Puncture Wound	2	-	Cut, puncture, scrape	27	2
Allergic Reaction	3	1	Struck by object	27	2
Bending	3	-	Caught in, under, or between	38	3
Broken Glass	3	-	Animal or Insect	46	1
Jumping	3	1	Fall, slip, trip	47	2
Walking	3	-	TOTALS	537	27
Backing	4	-			



Table 2: Cases selected by Riskmaster Nature of the Injury

	Frequency	Percent
Strain	11	40.7
None Listed	5	11.1
Contusion	5	11.1
Laceration	2	7.4
Foreign Object	2	7.4
Fracture	1	3.7
Puncture	1	3.7
Total	27	100.0

Table 3: Cases selected By Division

	Frequency	Percent
Div 1	5	18.5
Div 2	4	14.8
Div 3	3	11.1
Div 4	4	14.8
Div 5	6	22.2
Div 6	2	7.4
DMV	2	7.4
Ferry	1	3.7
Total	27	100.0

Table 4: Cases selected by Day of Week

	Frequency	Percent
Monday	5	18.5
Tuesday	5	18.5
Wednesday	5	18.5
Thursday	8	29.6
Friday	3	11.1
Weekend	1	3.7
Total	27	100.0

Table 5: Detailed information form Riskmaster of the 27 selected incidents

<b>ID#</b>	<b>Event No.</b>	<b>County</b>	<b>Date</b>	<b>Body Part</b>	<b>Operation</b>	<b>Cause</b>	<b>Nature</b>
1	EV2008045071	Pitt	8/20/2008	Near Miss	EMPLOYEE HOOKED UP THE CHAIN TO PULL ANOTHER TRACTOR OUT BECAUSE HE WAS STUCK. WHILE PULLING THE TRACTOR OUT THE CHAIN BROKE. A PIECE OF THE CHAIN WENT THROUGH THE REAR WINDOW OF THE TRACTOR.	Struck by object	None listed
2	EV2008045326	Beaufort	10/8/2008	Near Miss	EMPLOYEE WAS INSTALLING DRIVEWAY PIPE ON SR 1722 (S. SAVANNAH ROAD). EMPLOYEE WAS LEVELING STONE ON DRIVEWAY WHEN THE BOOM OF THE RUBBER TIRE EXCAVATOR HIT A SERVICE LINE CAUSING THE SLING THAT APPLIES TENSION TO THE SERVICE POLE TO BREAK. THIS CAUSED THE SERVICE LINE TO DROP APPROX. 2-3' LOWER THAN ORIGINAL HEIGHT.	Hit stationary object	None listed
3	EV2008044843	WAKE	7/8/2008	EYE(S)	EMPLOYEE WAS SECURING CONES ON THE TRAILER WITH THE ROPE THAT IS USED TO TIE THEM OFF. AS HE PULLED THE ROPE TIGHT, IT SLIPPED OFF THE STACK OF CONES STRIKING HIMSELF IN THE RIGHT EYE.	Falling, Rolling or Flying Object	Foreign Object
4	EV2008044013	WAKE	2/7/2008	Chest (Ribs, Sternum, Soft Tissue)	EMPLOYEE TURNED AROUND TO START WALKING AND WALKED INTO A METAL POST FILLED WITH CONCRETE. EMPLOYEE FELT PAIN IN HIS CHEST AREA.	Hit Stationary Object	Contusion
5	EV2008043797	WAKE	1/14/2008	Facial Soft Tissue	EMPLOYEE WAS CHIPPING UP BRANCHES FROM TREES. EMPLOYEE WAS EXPOSED TO SOMETHING THAT CAUSED A RASH ON FACE.	ALLERGIC REACTION/RASH	None listed
6	EV2008045498	Pitt	11/6/2008	Wrist	EMPLOYEE WAS USING DRILL TO MIX CONCRETE WHEN HE WENT TO REPOSITION HAND TOWARD BOTTOM OF DRILL CHUCK AND PULLED HIS ARM AND HAND. THE MACHINE RIPPED THE GLOVE OFF HIS HAND AND TWISTED HIS LEFT ARM/WRIST	Caught in under, or between	Strain
7	EV2008045545	Jones	11/6/2008	Back	EMPLOYEE WAS UNLOADING SIGNS AND CONES OUT OF THE BACK OF THE BACK OF A CREW CAB TRUCK. AFTER THE SIGNS WERE UNLOADED HE WENT TO CLIMB DOWN FROM THE BED AND STEPPED ON TIRE WHEN THE WOOD RAILING BROKE CAUSING HIM TO LAND HARD ON BOTH FEET.	Climbing or stepping	Strain
8	EV2008044859	DUPLIN	7/24/2008	Chest (Ribs, Sternum, Soft Tissue)	EMPLOYEE WAS REMOVING CROWN STRIP FROM CAP ON BRIDGE 111 IN DUPLIN COUNTY. EMPLOYEE WAS ON PONTOON WITH ANOTHER EMPLOYEE WHEN, THE WEIGHT OF THE CROWN STRIP CAUSED THE PONTOON TO SIFT AND THEY BOTH LOST THEIR FOOTING. EMP	CAUGHT IN, UNDER OR BETWEEN	Contusion
9	EV2008043985	GRANVILLE	2/11/2008	FINGER(S) (excluding thumb)	EMPLOYEE WAS ATTEMPTING TO ADJUST FORKS ON LOADER TO FIT LIFT POINTS ON SALT TANKS WHEN, HE MASHED HIS RIGHT CENTER FINGER BETWEEN THE RODS ON THE FORK.	CAUGHT IN, UNDER OR BETWEEN	Fracture

<b>ID#</b>	<b>Event No.</b>	<b>County</b>	<b>Date</b>	<b>Body Part</b>	<b>Operation</b>	<b>Cause</b>	<b>Nature</b>
10	EV2008044220	JOHNSTON	3/25/2008	Back-Lower (Lumbar, Lumbosacral)	EMPLOYEE WAS STEPPING DOWN OUT OF A CAB OF A TEN WHEELER TRUCK FOR THE PLATE AGENCY. HE WAS HOLDING ONTO THE CAB BAR AND STEPPED TO THE GROUND AND TWISTED HIS BACK. HIS BACK POPPED.	CLIMBING OR STEPPING UP/DOWN	Strain
11	EV2008044253	WAKE	4/2/2008	Back-Lower (Lumbar, Lumbosacral)	EMPLOYEE SATES WHILE TRAVELING DOWN I-40 A PRIVATE VEHICLE HIT US FROM THE SIDE MERGING INTO OUR TRAFFIC LANE.	Collision with Another Vehicle	Strain
12	EV2008045001	WILSON	8/11/2008	Back-Upper (Cervical, Thoracic area)	EMPLOYEE WAS OPERATING EXCAVATOR. AS HE WAS PULLING ON THE THROTTLE, HE FELT A PAIN IN HIS BACK.	Pushing or Pulling	Strain
13	EV2008044699	BRUNSWICK	6/21/2008	Internal Organs (other than heart, lungs)	EMPLOYEE PUT OUT FIRE WITH FIRE EXTINGUISHED WHEN HE CAME INTO CONTACT WITH CARBON MONOXIDE.	Contact with chemicals	None listed
14	EV2008044099	JOHNSTON	3/4/2008	THUMB	EMPLOYEE STATES THE CHUTE ON THE CHIPPER WAS STOPPED UP AND EMPLOYEE WAS USING A PIPE BAR TO CLEAN OUT AND THE EMPLOYEES FOOT SLIPPED AND HIS LEFT HAND HIT THE HOUSING BLADE CUTTING HIS THUMB ON THE LEFT HAND.	CUT, PUNCTURE, SCRAPE	Laceration
15	EV2008044563	DURHAM	5/30/2008	Head (multiple injuries; combination of parts)	EMPLOYEE LOST FOOTING ON A STEEP SLOPE AND FELL AND ROLLED INTO A FENCE STRIKING HEAD. THE COLLISION CAUSED A LACERATION TO HIS HEAD.	FALL, SLIP OR TRIP	Laceration
16	EV2008044573	WILSON	5/7/2008	EYE(S)	EMPLOYEE WAS FLAGGING TRAFFIC ON NC 111/222 IN WILSON COUNTY FOR WORK BEING PERFORMED ON CULVERT 131. EMPLOYEE WAS WEARING HIS SAFETY GLASSES DURING FLAGGING OPERATION BUT HAD REMOVED THEM TO WIPE DIRT AND SWEAT FROM HIS	Foreign Body in Eye	Foreign Object
17	EV2008045176	BRUNSWICK	9/9/2008	Back-Lower (Lumbar, Lumbosacral)	EMPLOYEE CLIMBED INTO THE FULL BED OF A PICKUP TRUCK, REMOVED A CHAINSAW FROM THE TOOLBOX, CLOSED THE LID, PLACED THE SAW ON TOP OF THE TOOLBOX, JUMPED DOWN OFF THE PICKUP FROM THE SIDE, AND FELT SHARP PAIN IN HIS BACK	Jumping	Strain
18	EV2008045401	Martin	10/16/2008	Hip	EMPLOYEE WAS REPAIRING TIRE ON BOOM TRACTOR. WHILE EXITING REAR OF TRUCK HIS FOOT SLIPPED OFF BUMPER CAUSING PAIN TO HIS HIP AREA	CLIMBING OR STEPPING UP/DOWN	Strain
19	EV2008045352	Martin	10/6/2008	Hand	EMPLOYEE WS PULLING FENCE WIRE THAT WRAPPED AROUND MOWER WHEN WIRE STUCK INTO HIS LEFT HAND. EMPLOYEE WAS WEARING GLOVES BUT REMOVED THEM	Cut, Puncture	Puncture

<b>ID#</b>	<b>Event No.</b>	<b>County</b>	<b>Date</b>	<b>Body Part</b>	<b>Operation</b>	<b>Cause</b>	<b>Nature</b>
20	EV2009046408	Martin	3/23/2009	Near Miss	EMPLOYEE WAS TRAVELING DOWN THURMAN GRIFFITH ROAD AND HE SAW A DOG IN THE ROAD. THE DOG STAYED IN HIS LANE AND HAD TO BRAKE HARD TO AVOID HITTING THE DOG. HE THEN SLID THE TRUCK INTO THE DITCH HITTING A TREE.	Animal or Insect	None listed
21	EV2009045900	Craven	1/12/2009	Lower Leg	EMPLOYEE SLIPPED AND FELL IN ENGINE ROOM DUE TO CONDENSATION ON BILGE. EMPLOYEE FELT PAIN IN LOWER LEFT LEG	FALL FROM	Contusion
22	EV2008045175	CRAVEN	9/5/2008	SHOULDER(S) (armpit, rot cuff, trapezius, clavicle)	EMPLOYEE WAS TRYING TO LIFT CHAIN HOIST WHEN, HE FELT PAIN IN HIS RIGHT SHOULDER.	Object Being Lifted or Handled	Strain
23	EV2008045399	Perquimans	5/8/2008	Foot	EMPLOYEE WAS ATTEMPTING TO BREAK A CASTER ADAPTER FROM THE CASING USING A 36" WRNECH WITH A 4" CHEATER BAR. EMPLOYEE WAS STANDING ON THE WRENCH WHEN IT BROKE AND SNAPPED UPWARD CAUSING INJURY TO RIGHT FOOT	Hand Tool, Utensil	Strain
24	EV2008045372	Pasquotank	10/8/2008	Knee	EMPLOYEE WAS CUTTING CORES OMN ROANOKE AVE WITH CORING MACHINE WHEN THE CORING MACHINE BIT SEIZED IN THE HOLE CAUSING MACHINE TO ROTATE AND STRIKE HIM ON THE LEFT KNEE. THE IMPACT LIFTED HIM OFF THE GROUND. HE LANDED ON BUTTOCKS.	Machine, machinery	Contusion
25	EV2008044600	CUMBERLAND	6/5/2008	SHOULDER(S) (armpit, rot cuff, trapezius, clavicle)	EMPLOYEE WAS HELPING ANOTHER EMPLOYEE CUT A 4X8 PIECE OF PLYWOOD WHEN, HIS SIDE SLIPPED, HE TIRED TO CATCH IT, AND FELT PAIN IN HIS LEFT SHOULDER.	Hand Tool or Machine in Use	Sprain
26	EV2008045211	HARNETT	9/4/2008	Head (multiple injuries; combination of parts)	EMPLOYEE WAS HOLDING BENT SIGN POST FOR BACKHOE TO GRAB WITH BACK JAW BUCKET AS BACKHOE GRABBED THE BENT POST, IT TWIST HITTING EMPLOYEE IN HEAD AND ARM. EMPLOYEE WAS KNOCKED TO GROUND.	Struck By Object	Contusion
27	EV2008043791	WAKE	1/18/2008	Back-Lower (Lumbar, Lumbo-sacral)	EMPLOYEE (HINTON) WAS LIFTING FILE STORAGE BOXES FOR RETENTION TO SUPPLY ROOM WHEN, SHE FELT PAIN IN HER BACK. SUPERVISOR: DOUG DUNNAGAN EMPLOYEE (JARRETT) WAS LIFTING FILE STORAGE BOXES	Lifting	Strain

### Incident Investigation Meetings

We attended Divisional incident investigation meetings and attended six meetings in four divisions in Edenton (2), Greenville (2), Wilmington, and Durham. The purpose of attending these meetings was to build relationships with the safety engineers in each division and to better understand each division's incident investigation process. These meetings were valuable to understand the processes utilized by each division.

### Interviews

Interviews with the employee(s) involved in the accident and their supervisor was coordinated with the assistance of the Divisional Safety Engineers, supervisors, and employees involved. Each interview lasted approximately 20 minutes to 1.5 hours depending on the detail and complexity of the accident. The investigator utilized the Gibb-Haslam model as a guide during the interview, which was in an open-ended type format. There was no specific list of questions utilized during the interview. Question lists and check boxes limit the investigator's ability to think critically about the information being transferred by the interviewee. The interviews started with the interviewee's account of the accident with the interviewer taking notes and relating information to the Gibb model keywords. When issues came up related to the four immediate factors (work team, work place, materials, and equipment) they were followed-up on and discussed further to discover whether there were shaping factors and originating influences that could be identified.

### Model verification

The initial twenty-seven accidents were performed with the ECU investigator having the NC DOT investigation information. Once these were complete, we wanted to test the Gibb-Haslam model without any prior information to ensure that the model could be utilized in this manner as this is how it would be utilized in real life. We selected two accidents with help and input from the Divisional Safety Engineers; one in Division 6 and one in Division 3. The same protocol in the model verification stage was utilized as in the initial twenty-seven investigations. That is, we talked with the employee involved and the supervisor. In addition, we had the scenes of the accidents re-created to the extent possible. Pictures were taken. The complete reports of these are included in Findings Section on page XX.

## **FINDINGS**

The twenty-seven complete incident investigation vignettes are on pages 16 through 77. Table 6 is a summary of findings using Gibb-Haslam model of the 27 selected incidents on pages 78 - 79. The top five causes and influences identified using the Gibb-Haslam model are, with the number of times linked to the incident in parenthesis risk management (19), worker actions and behaviors (16), worker capabilities including skill and knowledge (16), safety culture (15), and local hazards (11). One-hundred and sixty-two (162) total causes were identified within the 27 incidents reviewed for an average of 6 causes/influences identified per incident. The model was successful at leading the investigation to multiple causes and influences. If risk reduction efforts could be channeled at these causes and influences, NC DOT may experience less accidents overall.

Included at the end of each vignette is a summary of the findings of each incident linked to the NC DOT Safety and Health Management System. Table 4 on page 80 is a summary of findings

using NC DOT SHMS model of the 27 selected incidents. Leadership, policies and procedures, training, awareness, and audits are the areas that would be indicative of prevention activities. We linked the information gathered from each investigation to these activities and found that areas that demonstrated 74 total causes using this model, or about 2.7 causes of a possible 5 per incident. These numbers again demonstrate multiple causes and influences in DOT accidents. The strongest linkages in the 27 incidents were policies and procedures (22), awareness (21), leadership (17), training (10), and audits (4).

The categories of causes and influences from the Gibb-Haslam model were answered as a dichotomous yes/no; either the cause or influence category was determined to be a cause or it wasn't. Correlation provides a statistical method to find relationships between variables. For dichotomous variables, a phi correlation is utilized. All possible correlations among variables were explored. Output from SPSS is included below when significant ( $p < 0.05$ ) relationships were found. The first set of tables shows the relationship between the two cause categories and the yes/no distribution. The second table shows the phi value and the p-value (approx. sig.).

For example, worker capabilities, including knowledge/skills and worker action and behaviors were negatively correlated, meaning that when one was found to be a causal factor, the other was not likely to be a cause. In 18 of the 27 cases, the identified cause was either one or the other, and in 7 of the cases it was both. Communication and immediate supervision were positively correlated. These categories were usually either determined to be not related to the incident or related to the causes of the incident. In fact in 23 out of the 27 incidents there were determined to be similar, with most of them being not included (18 of 27). The most interesting relationship is drawn between safety culture and risk management where in 15 of the 27 (56%) cases these two influences were found together. It may be that employees are taking short cuts and this culture of taking shortcuts is related to employees or their supervisors not identifying the risk inherent in the tasks about to be accomplished. For example, in one incident where dust was embedded in an employee's eye it was unclear whether the employee knew the safety glasses were recommended or if they really are required (risk management); the lack of understanding of the safety glass policy is indicative that other hazards and risks may also be dismissed (safety culture).

The small tables beginning on page 21 shows the breakdown of the various nature of incident codes and days of the week with each Gibb-Haslam model and the NC DOT SHMS categories. Each table was visually evaluated to look for trends not consistent with the totals in each table. Interesting findings are noted in bold and italics font within the table. Monday appeared to be an interesting day. Five of the incidents occurred on Monday. All five were identified to have a component of worker knowledge or capabilities and risk management from the Gibb-Haslam model and awareness from the NC DOT SHMS model. However, in none of those cases was immediate supervision identified as an influence. What does this mean? It may mean that on Mondays, workers are more likely to not pay attention to supervisors' instructions, go beyond their capabilities to get jobs done, not properly identify risks in the field, and are not aware of the hazards they face. The NC DOT should possibly further investigate the structure of what is happening on Mondays for possible risk minimization strategies.

**Worker capabilities, including knowledge/skills \* Worker action and behaviors**

**Crosstab**

Count				
		Worker action and behaviors		
		No	Yes	Total
Worker capabilities, including knowledge/skills	No	2	9	11
	Yes	9	7	16
	Total	11	16	27

**Symmetric Measures**

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.381	.048
	Cramer's V	.381	.048
	N of Valid Cases	27	

**Communication \* Immediate Supervision**

**Crosstab**

Count				
		Immediate Supervision		
		No	Yes	Total
Communication	No	18	2	20
	Yes	2	5	7
	Total	20	7	27

**Symmetric Measures**

		Value	Approx. Sig.
Nominal by Nominal	Phi	.614	.001
	Cramer's V	.614	.001
	N of Valid Cases	27	

# Communication \* ProjMgmt

Crosstab				
Count				
		ProjMgmt		
		No	Yes	Total
Communication	No	15	5	20
	Yes	1	6	7
	Total	16	11	27

## Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.542	.005
	Cramer's V	.542	.005
	N of Valid Cases	27	

# Communication \* RiskMgmt

Crosstab				
Count				
		RiskMgmt		
		No	Yes	Total
Communication	No	8	12	20
	Yes	0	7	7
	Total	8	19	27

## Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.384	.046
	Cramer's V	.384	.046
	N of Valid Cases	27	



### Immediate Supervision \* ProjMgmt

**Crosstab**

Count				
		ProjMgmt		
		No	Yes	Total
Immediate Supervision	No	16	4	20
	Yes	0	7	7
	Total	16	11	27

**Symmetric Measures**

		Value	Approx. Sig.
Nominal by Nominal	Phi	.714	.000
	Cramer's V	.714	.000
	N of Valid Cases	27	

### Safety Culture \* RiskMgmt

**Crosstab**

Count				
		RiskMgmt		
		No	Yes	Total
Safety Culture	No	8	4	12
	Yes	0	15	15
	Total	8	19	27

**Symmetric Measures**

		Value	Approx. Sig.
Nominal by Nominal	Phi	.725	.000
	Cramer's V	.725	.000
	N of Valid Cases	27	

# Local Hazards \* Site Constraints

**Crosstab**

Count				
		Site Constraints		
		No	Yes	Total
Local Hazards	No	10	3	13
	Yes	5	9	14
	Total	15	12	27

**Symmetric Measures**

		Value	Approx. Sig.
Nominal by Nominal	Phi	.414	.031
	Cramer's V	.414	.031
	N of Valid Cases	27	

**RMNature \* Leadership Crosstabulation**

	Leadership		
	No	Yes	Total
Laceration	1	1	2
Contusion	2	3	5
Foreign Obj	0	2	2
Strain	5	6	11
Fracture	0	1	1
None Listed	2	3	5
Puncture	0	1	1
Total	10	17	27

**RMNature \* PolProc Crosstabulation**

	PolProc		
	No	Yes	Total
Laceration	0	2	2
Contusion	1	4	5
Foreign Obj	0	2	2
Strain	3	8	11
Fracture	0	1	1
None Listed	1	4	5
Puncture	0	1	1
Puncture	1	0	1
Total	17	10	27

**RMNature \* PolProc Crosstabulation**

	PolProc		
	No	Yes	Total
Laceration	0	2	2
Contusion	1	4	5
Foreign Obj	0	2	2
Strain	3	8	11
Fracture	0	1	1
None Listed	1	4	5
Puncture	0	1	1
Total	5	22	27

**RMNature \* Awareness Crosstabulation**

	Awareness		
	No	Yes	Total
Laceration	1	1	2
Contusion	2	3	5
Foreign Obj	0	2	2
Strain	3	8	11
Fracture	0	1	1
None Listed	0	5	5
Puncture	0	1	1
Total	6	21	27

**RMNature \* Training Crosstabulation**

	Training		
	No	Yes	Total
Laceration	1	1	2
Contusion	3	2	5
Foreign Obj	1	1	2
Strain	8	3	11
Fracture	1	0	1
None Listed	2	3	5

**RMNature \* Audits Crosstabulation**

	Audits		
	No	Yes	Total
Laceration	2	0	2
Contusion	5	0	5
Foreign Obj	2	0	2
Strain	8	3	11
Fracture	1	0	1

**RMNature \* Awareness Crosstabulation**

	Awareness		
	No	Yes	Total
Laceration	1	1	2
Contusion	2	3	5
Foreign Obj	0	2	2
Strain	3	8	11
Fracture	0	1	1
None Listed	0	5	5
Puncture	0	1	1
None Listed	4	1	5
Puncture	1	0	1
Total	23	4	27

	No	Yes	Total
Monday	2	3	5
<b>Tuesday</b>	<b>1</b>	<b>4</b>	<b>5</b>
<b>Wednesday</b>	<b>0</b>	<b>5</b>	<b>5</b>
<b>Thursday</b>	<b>0</b>	<b>8</b>	<b>8</b>
Friday	1	2	3
Weekend	1	0	1
Total	5	22	27

**DayofWeek \* Training Crosstabulation**

	Training		
	No	Yes	Total
Monday	2	3	5
Tuesday	2	3	5
Wednesday	3	2	5
Thursday	8	0	8
Friday	1	2	3
Weekend	1	0	1
Total	17	10	27

**DayofWeek \* Leadership Crosstabulation**

	Leadership		
	No	Yes	Total
Monday	2	3	5
Tuesday	2	3	5
Wednesday	1	4	5
Thursday	3	5	8
Friday	1	2	3
Weekend	1	0	1
Total	10	17	27

**DayofWeek \* Awareness Crosstabulation**

	Awareness		
	No	Yes	Total
<b>Monday</b>	<b>0</b>	<b>5</b>	<b>5</b>
Tuesday	1	4	5
Wednesday	2	3	5
Thursday	2	6	8
Friday	1	2	3
Weekend	0	1	1
Total	6	21	27

**DayofWeek \* PolProc Crosstabulation**

	PolProc
--	---------

**DayofWeek \* Audits Crosstabulation**

	Audits
--	--------

	No	Yes	Total
Monday	4	1	5
Tuesday	5	0	5
Wednesday	4	1	5
Thursday	6	2	8
Friday	3	0	3
Weekend	1	0	1
Total	23	4	27

**DayofWeek \* Worker action and behaviors**

**Crosstabulation**

	Worker action and behaviors		
	No	Yes	Total
Monday	2	3	5
Tuesday	1	4	5
Wednesday	4	1	5
Thursday	2	6	8
Friday	2	1	3
Weekend	0	1	1
Total	11	16	27

**DayofWeek \* Worker capabilities, incg knowledge/skills Crosstabulation**

	Worker capabilities, including knowledge/skills		
	No	Yes	Total
<b>Monday</b>	<b>0</b>	<b>5</b>	<b>5</b>
Tuesday	4	1	5
Wednesday	2	3	5
Thursday	3	5	8
Friday	1	2	3
Weekend	1	0	1
Total	11	16	27

**DayofWeek \* Communication**

**Crosstabulation**

	Communication		
	No	Yes	Total
Monday	4	1	5
Tuesday	4	1	5
Wednesday	3	2	5
Thursday	6	2	8
Friday	2	1	3
Weekend	1	0	1
Total	20	7	27

**DayofWeek \* Immediate Supervision**

**Crosstabulation**

	Immediate Supervision		
	No	Yes	Total
<b>Monday</b>	<b>5</b>	<b>0</b>	<b>5</b>
Tuesday	4	1	5
Wednesday	3	2	5
Thursday	6	2	8
Friday	1	2	3
Weekend	1	0	1
Total	20	7	27

**DayofWeek \* Worker health and fatigue**

**Crosstabulation**

	Worker health and fatigue		
	No	Yes	Total
Monday	5	0	5
Tuesday	4	1	5
Wednesday	5	0	5
Thursday	6	2	8
Friday	2	1	3

**DayofWeek \* Immediate Supervision**

**Crosstabulation**

	Immediate Supervision		
	No	Yes	Total
<b>Monday</b>	<b>5</b>	<b>0</b>	<b>5</b>
Tuesday	4	1	5
Wednesday	3	2	5
Thursday	6	2	8
Friday	1	2	3
Weekend	1	0	1
Weekend	1	0	1
Total	23	4	27

**DayofWeek \* LocalHazards Crosstabulation**

	LocalHazards		
	No	Yes	Total
Monday	3	2	5
Tuesday	4	1	5
Wednesday	1	4	5
Thursday	4	4	8
Friday	1	2	3
Weekend	0	1	1
Total	13	14	27

**DayofWeek \* SiteConditions Crosstabulation**

	SiteConditions		
	No	Yes	Total
Monday	5	0	5
Tuesday	5	0	5
Wednesday	4	1	5
Thursday	7	1	8
Friday	2	1	3
Weekend	0	1	1
Total	23	4	27

**DayofWeek \* SiteConstraints**

**Crosstabulation**

	SiteConstraints		
	No	Yes	Total
Monday	5	0	5
Tuesday	3	2	5
Wednesday	2	3	5
Thursday	3	5	8
Friday	1	2	3
Weekend	1	0	1
Total	15	12	27

**DayofWeek \* WorkingEnv Crosstabulation**

	WorkingEnv		
	No	Yes	Total
Monday	5	0	5
Tuesday	5	0	5
Wednesday	3	2	5
Thursday	7	1	8
<b>Friday</b>	<b>0</b>	<b>3</b>	<b>3</b>
Weekend	1	0	1
Total	21	6	27

**DayofWeek \* SiteConstraints**

**Crosstabulation**

	SiteConstraints		
	No	Yes	Total
Monday	5	0	5
Tuesday	3	2	5
Wednesday	2	3	5
Thursday	3	5	8
Friday	1	2	3
Weekend	1	0	1

**DayofWeek \* SuitabilEquip Crosstabulation**

	SuitabilityEquip		
	No	Yes	Total
Monday	3	2	5
Tuesday	5	0	5
Wednesday	3	2	5
Thursday	6	2	8
Friday	3	0	3
Weekend	1	0	1
Total	21	6	27

**DayofWeek \* UsabilityEquip**

**Crosstabulation**

	UsabilityEquip		
	No	Yes	Total
Monday	4	1	5
Tuesday	5	0	5
Wednesday	4	1	5
Thursday	4	4	8
Friday	3	0	3
Weekend	1	0	1
Total	21	6	27

**DayofWeek \* UsabilityEquip****Crosstabulation**

	UsabilityEquip		
	No	Yes	Total
Monday	4	1	5
Tuesday	5	0	5
Wednesday	4	1	5
Thursday	4	4	8
Friday	3	0	3
Weekend	1	0	1

**DayofWeek \* ConditionEquip****Crosstabulation**

	ConditionEquip		
	No	Yes	Total
Monday	4	1	5
Tuesday	5	0	5
Wednesday	4	1	5
Thursday	7	1	8
Friday	3	0	3
Weekend	1	0	1
Total	24	3	27

**DayofWeek \* WorksDesign Crosstabulation**

	WorksDesign		
	No	Yes	Total
Monday	3	2	5
Tuesday	5	0	5
Wednesday	4	1	5
Thursday	4	4	8
Friday	3	0	3
Weekend	0	1	1
Total	19	8	27

**DayofWeek \* ProjMgmt Crosstabulation**

	ProjMgmt		
	No	Yes	Total
Monday	4	1	5
Tuesday	3	2	5
Wednesday	3	2	5
Thursday	5	3	8
Friday	1	2	3
Weekend	0	1	1
Total	16	11	27

**DayofWeek \* ConstructionProcesses****Crosstabulation**

	ConstructionProcesses		
	No	Yes	Total
Monday	5	0	5
Tuesday	5	0	5
Wednesday	2	3	5
Thursday	7	1	8
Friday	3	0	3
Weekend	1	0	1
Total	23	4	27

**DayofWeek \* SafetyCulture Crosstabulation**

	SafetyCulture		
	No	Yes	Total
Monday	1	4	5
Tuesday	1	4	5
Wednesday	1	4	5
Thursday	6	2	8
Friday	2	1	3
Weekend	1	0	1
Total	12	15	27

**DayofWeek \* RiskMgmt Crosstabulation**



	RiskMgmt		
	No	Yes	Total
<b>Monday</b>	0	5	5
Tuesday	1	4	5
Wednesday	1	4	5
Thursday	4	4	8
Friday	1	2	3
Weekend	1	0	1
Total	8	19	27

**RMNature \* Worker action and behaviors Crosstabulation**

	Worker action and behaviors		
	No	Yes	Total
Laceration	1	1	2
Contusion	2	3	5
Foreign Obj	1	1	2
Strain	5	6	11
Fracture	0	1	1
None Listed	2	3	5
Puncture	0	1	1
Total	11	16	27

**RMNature \* Worker capabilities, including knowledge/skills Crosstabulation**

	Worker capabilities, including knowledge/skills		
	No	Yes	Total
Laceration	2	0	2
Contusion	1	4	5
Foreign Obj	1	1	2
Strain	4	7	11
Fracture	0	1	1
None Listed	2	3	5
Puncture	1	0	1

**DayofWeek \* RiskMgmt Crosstabulation**

	RiskMgmt		
	No	Yes	Total
<b>Monday</b>	0	5	5
Tuesday	1	4	5
Wednesday	1	4	5
Thursday	4	4	8
Friday	1	2	3
Weekend	1	0	1
Total	11	16	27

**RMNature \* Communication Crosstabulation**

	Communication		
	No	Yes	Total
Laceration	2	0	2
Contusion	2	3	5
Foreign Obj	1	1	2
Strain	9	2	11
Fracture	1	0	1
None Listed	4	1	5
Puncture	1	0	1
Total	20	7	27

**RMNature \* Immediate Supervision Crosstabulation**

	Immediate Supervision		
	No	Yes	Total
Laceration	2	0	2
Contusion	2	3	5
Foreign Obj	1	1	2
Strain	9	2	11
Fracture	1	0	1
None Listed	4	1	5

Puncture	1	0	1
Total	20	7	27

**RMNature \* Worker health and fatigue**

**Crosstabulation**

	Worker health and fatigue		
	No	Yes	Total
Laceration	2	0	2
Contusion	4	1	5
Foreign Obj	2	0	2
Strain	8	3	11
Fracture	1	0	1
None Listed	5	0	5
Puncture	1	0	1
Total	23	4	27

**RMNature \* LocalHazards Crosstabulation**

	LocalHazards		
	No	Yes	Total
Laceration	0	2	2
Contusion	2	3	5
Foreign Obj	1	1	2
Strain	8	3	11
Fracture	1	0	1
None Listed	0	5	5
Puncture	1	0	1
Total	13	14	27

**RMNature \* SiteConditions Crosstabulation**

	SiteConditions
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	No	Yes	Total
Laceration	1	1	2
Contusion	4	1	5
Foreign Obj	1	1	2
Strain	11	0	11
Fracture	1	0	1
None Listed	4	1	5
Puncture	1	0	1
Total	23	4	27

**RMNature \* SiteConstraints Crosstabulation**

	SiteConstraints		
	No	Yes	Total
Laceration	1	1	2
Contusion	2	3	5
Foreign Obj	2	0	2
Strain	5	6	11
Fracture	1	0	1
None Listed	3	2	5
Puncture	1	0	1
Total	15	12	27

**RMNature \* WorkingEnv Crosstabulation**

	WorkingEnv		
	No	Yes	Total
Laceration	1	1	2
Contusion	5	0	5
Foreign Obj	1	1	2
Strain	8	3	11
Fracture	1	0	1
None Listed	4	1	5
Puncture	1	0	1
Total	21	6	27

**RMNature \* WorkScheduling Crosstabulation**

	WorkScheduling		
	No	Yes	Total
Laceration	2	0	2
Contusion	4	1	5
Foreign Obj	2	0	2
Strain	11	0	11
Fracture	1	0	1
None Listed	5	0	5
Puncture	1	0	1
Total	26	1	27

**RMNature \* Housekeeping Crosstabulation**

	Housekeeping		
	No	Yes	Total
Laceration	2	0	2
Contusion	5	0	5
Foreign Obj	2	0	2
Strain	11	0	11
Fracture	1	0	1
None Listed	4	1	5
Puncture	1	0	1
Total	26	1	27

**RMNature \* SuitabilityMats Crosstabulation**

	SuitabilityMats
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	No	Yes	Total
Laceration	2	0	2
Contusion	5	0	5
Foreign Obj	2	0	2
Strain	11	0	11
Fracture	1	0	1
None Listed	5	0	5
Puncture	0	1	1
Total	26	1	27

**RMNature \* SuitabilityEquip Crosstabulation**

	SuitabilityEquip		
	No	Yes	Total
Laceration	2	0	2
Contusion	4	1	5
Foreign Obj	2	0	2
Strain	9	2	11
Fracture	1	0	1
None Listed	2	3	5
Puncture	1	0	1
Total	21	6	27

**RMNature \* UsabilityEquip Crosstabulation**

	UsabilityEquip		
	No	Yes	Total
Laceration	2	0	2
Contusion	4	1	5
Foreign Obj	2	0	2
Strain	7	4	11
Fracture	1	0	1
None Listed	4	1	5
Puncture	1	0	1

**RMNature \* UsabilityEquip Crosstabulation**

	UsabilityEquip		
	No	Yes	Total
Laceration	2	0	2
Contusion	4	1	5
Foreign Obj	2	0	2
Strain	7	4	11
Fracture	1	0	1
None Listed	4	1	5
Puncture	1	0	1
Total	21	6	27

**RMNature \* ConditionEquip Crosstabulation**

	ConditionEquip		
	No	Yes	Total
Laceration	2	0	2
Contusion	5	0	5
Foreign Obj	2	0	2
Strain	10	1	11
Fracture	0	1	1
None Listed	4	1	5
Puncture	1	0	1
Total	24	3	27

**RMNature \* WorksDesign Crosstabulation**

	WorksDesign		
	No	Yes	Total
Laceration	2	0	2
Contusion	3	2	5
Foreign Obj	2	0	2
Strain	8	3	11

Fracture	0	1	1
None Listed	3	2	5
Puncture	1	0	1
Total	19	8	27

**RMNature \* ProjMgmt Crosstabulation**

	ProjMgmt		
	No	Yes	Total
Laceration	1	1	2
Contusion	1	4	5
Foreign Obj	1	1	2
Strain	8	3	11
Fracture	1	0	1
None Listed	3	2	5
Puncture	1	0	1
Total	16	11	27

**RMNature \* ConstructionProcesses Crosstabulation**

	ConstructionProcesses		
	No	Yes	Total
Laceration	2	0	2
Contusion	3	2	5
Foreign Obj	2	0	2
Strain	11	0	11
Fracture	1	0	1
None Listed	3	2	5
Puncture	1	0	1
Total	23	4	27

**RMNature \* SafetyCulture Crosstabulation**

	SafetyCulture		
	No	Yes	Total
Laceration	1	1	2
Contusion	3	2	5
Foreign Obj	0	2	2
Strain	7	4	11
Fracture	0	1	1
None Listed	1	4	5
Puncture	0	1	1
Total	12	15	27

	RiskMgmt		
	No	Yes	Total
Laceration	1	1	2
Contusion	2	3	5
Foreign Obj	0	2	2
Strain	4	7	11
Fracture	0	1	1
None Listed	1	4	5
Puncture	0	1	1
Total	8	19	27

**RMNature \* RiskMgmt Crosstabulation**

1) EV2008045071, Division 2

Riskmaster description: Employee hooked up the chain to pull another tractor out because he was stuck. While pulling the tractor out the chain broke. A piece of the chain went through the rear window of the tractor.

Riskmaster cause code: struck by object

Riskmaster nature code: none listed

Incident description (from the NC DOT forms): Employee hookup the chain to pull another tractor out because he was stuck. While pulling the tractor out the chain broke.

Root causes identified by Division: While pulling the tractor out the chain broke and busted the front and back glass out of the tractor.

Were immediate causes and shaping factors identified by the NCDOT: No

Were originating influences identified by the NCDOT: No

### **ECU Investigation**

The chain provided and used is rated at 7200 lb; the mowing tractors are 12,900 lb. The employees did not know the chain capacity before the accident occurred. They had heard of chains breaking before but it never happened to them. The mowers get stuck approximately once per day and they use the chain to pull it out. Some days the mowers might get stuck 4 -5 times under wet conditions. If they can't get it out they call a motor grader. The general conditions on the day of the accident were dry, but the area that the mower got stuck in was very wet; the area was sloped and water pooled there. The employees were mowing on a primary road (264), and they normally mow on secondary roads but were assigned here because the mowing there was behind on the schedule. The chain snapped and flew through the both cab windows and probably out across 264, but they could not find the broken piece. The chain went within 12 inches of the operator's head. If they had to do it again, they wouldn't have mowed that spot. They have the authority to make that call. They pulled front to back meaning the towing mower hooked the chain on the front of the towing mower to the back (exposed) end of the struck mower. They had done this or back to back towing whichever seemed more feasible. They had not heard of a work rule to always tow back to back.

Inadequate construction planning, inadequate work method statement. The operators did not know about any other work methods.

Inappropriate construction procedure, improper construction procedure. There were using a chain rated for 7200 lb on a stuck 12,900 lb machine.

Inappropriate site condition, inappropriate ground condition. Although they did not recognize the wet ground in this location, the wet ground contributed to the conditions of being stuck. Additionally, there was a slope here of at least 45 degrees.

Tractors are powered by rear wheels so pulling back to back is not always feasible. A strength test is never performed on the chains.

Employees visually inspect the chains as part of the pre-trip inspection.

Supervisor has to replace about 5 chains per year due to wear and tear, but usually they don't break. In 20 years, he's seen about 3 – 4 broken chains from this operation described.

The SOP for this job is inadequate because you cannot always pull back to back.

They believe the straps rated at a higher force will help solve the problem but you'll still have to have a hook to snap onto the mower as you will not always have access to tie a strap around the areas if mower is stuck deep.

We only use SOP's to bring them out and show that someone did something wrong but not to teach people how to do jobs. They never saw this SOP.

#### Immediate causes and shaping factors

Knowledge/skill - They were using a chain rated for 7200 lb on a stuck 12,900 lb machine. Did they pull from front or back? There are inconsistencies on this answer.

Workplace/local hazard/site constraints - They did not recognize the wet ground in this location and the wet ground contributed to the conditions of being stuck. Additionally, there was a slope here of at least 45 degrees.

Suitability of equipment – are chains suitable for the job, or should they use safety nylon straps

Usability of the equipment - They were using a chain rated for 7200 lb on a stuck 12,900 lb machine.

Condition of equipment - Strength tests not performed. Was there a weak link? Was it 'detectable' in the pre-trip inspection?

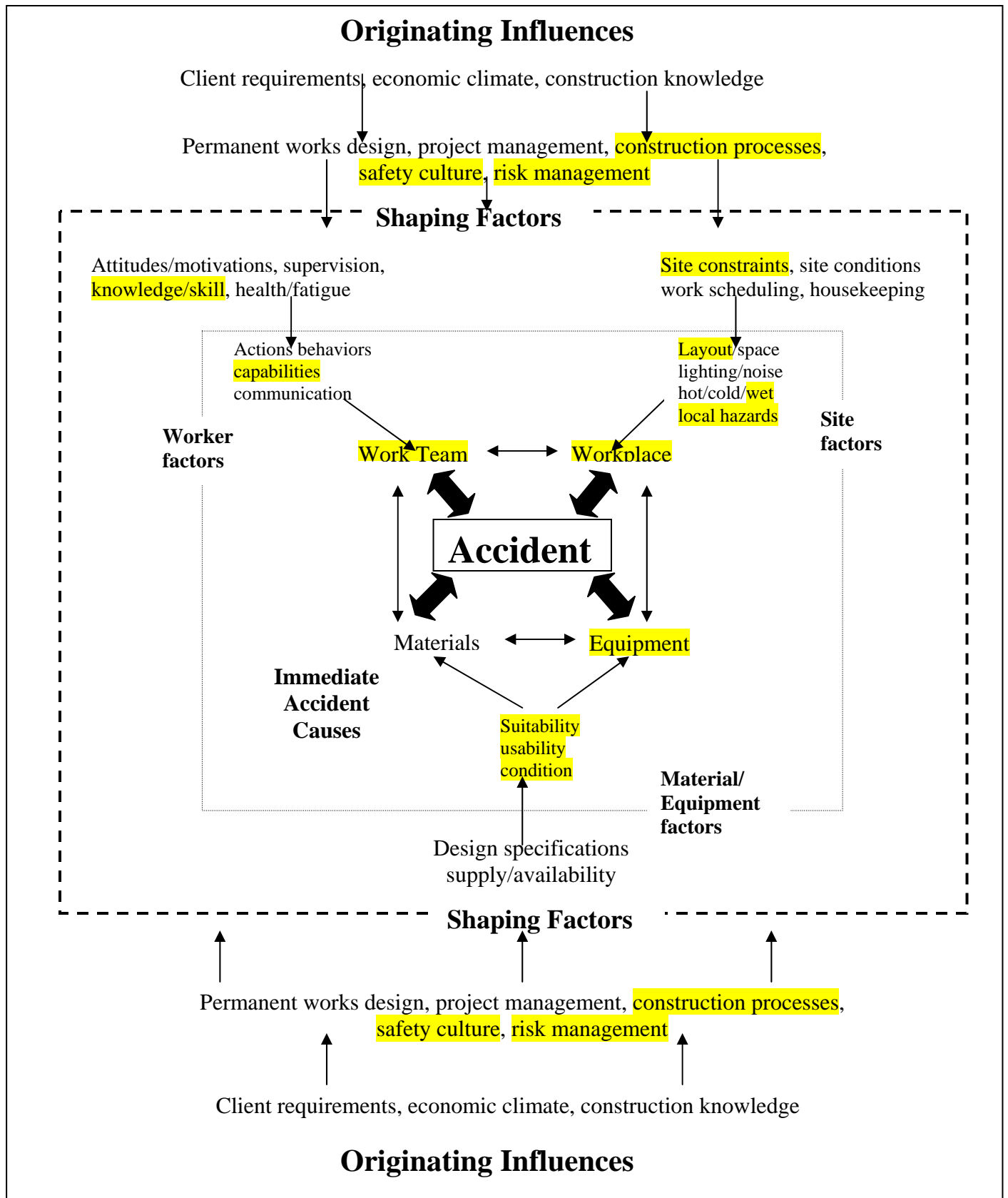
#### Originating influences

Construction processes – Method statement is not used. Probable improper tools for job.

Safety Culture – They never saw the SOP. Statement on how SOP's are used.

Risk Management - They were using a chain rated for 7200 lb on a stuck 12,900 lb machine

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Gaps in how SOP's are used	Review use of SOP's as part of leadership plan
Policy and Procedures	Employees never saw the SOP	Review policies on reviewing SOP's.
Training	Detecting weak chain	Train on stress testing to detect during the pre-trip inspection
Awareness	Be aware of limitations of equipment and techniques to pull out stuck tractor	Substitute chains for straps
Audits	Strength tests not performed.	Investigate the criteria for strength testing





2) EV2008046326, Division 2, 10/8/08

Riskmaster description: Employee was installing driveway pipe on SR 1722 (S. Savannah Road). Employee was leveling stone on driveway when the boom of the rubber tire excavator hit a service line causing the sling that applies tension to the service pole to break. This caused the service line to drop approximately 2-3' lower than the original height.

Riskmaster cause code: Hit stationary object

Riskmaster nature code: None listed

Incident description (from the NC DOT forms): Employee was installing a driveway pipe on SR 1722 (South Savannah road). Employee was leveling stone on the driveway when the boom of the rubber tire excavator hit a service line causing the sling that applies tension to the service line at the service pole to break. This caused the serviced line to drop approximately 2' to 3' lower than its original height.

Root causes identified by Division: Employees had been working close to the power line all day and had two spotters assigned. The spotters and the equipment operator should have paid more attention to their surroundings. Inattention to surroundings.

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

#### **Employees**

The traffic supervisor (TS-3), county maintenance engineer, and district engineer were all at the site prior to the incident. The employees were told to be careful with regards to the service line. The employees stated that they had done similar jobs before and were given the same 'be careful' instructions. The project was behind schedule. The second spotter had just got to the site 20 minutes prior and was helping to spot. He felt like a victim of circumstance.

The spotters were disciplined for this incident, but the operator was not. There were upset at this and felt it was a supervisory issue and that they could not control the actions of the operator.

The rubber tire excavator was being used on this job due to both backhoes being in the shop for repairs. The rubber tire excavator was probably not the best choice of equipment for this job site. However, even with the backhoe they would have been close to the service line. They said the line should have been moved and the upper lines disconnected to properly comply with the 10' rule for proximity to power lines.

#### **Supervisor**

The employees should have stopped the job. The spotters should have notified the operator of the closeness to the line.

### Immediate causes and Shaping factors

Worker actions and behaviors / attitude and motivation – should have identified the risk

Communication – between laborer and operator and between crew and supervision

Immediate supervision – supervision should have identified the risk

Site Constraints/layout/space – the relationship between the work and the hazard

Suitability of the equipment – was this the correct piece of equipment for the job?

### Originating influences

Project management – from the outset it appears this project was destined to have a high level of risk associated with it. This is due to poor oversight of the risk and the tasks to be performed.

Construction processes – Inadequate instructions

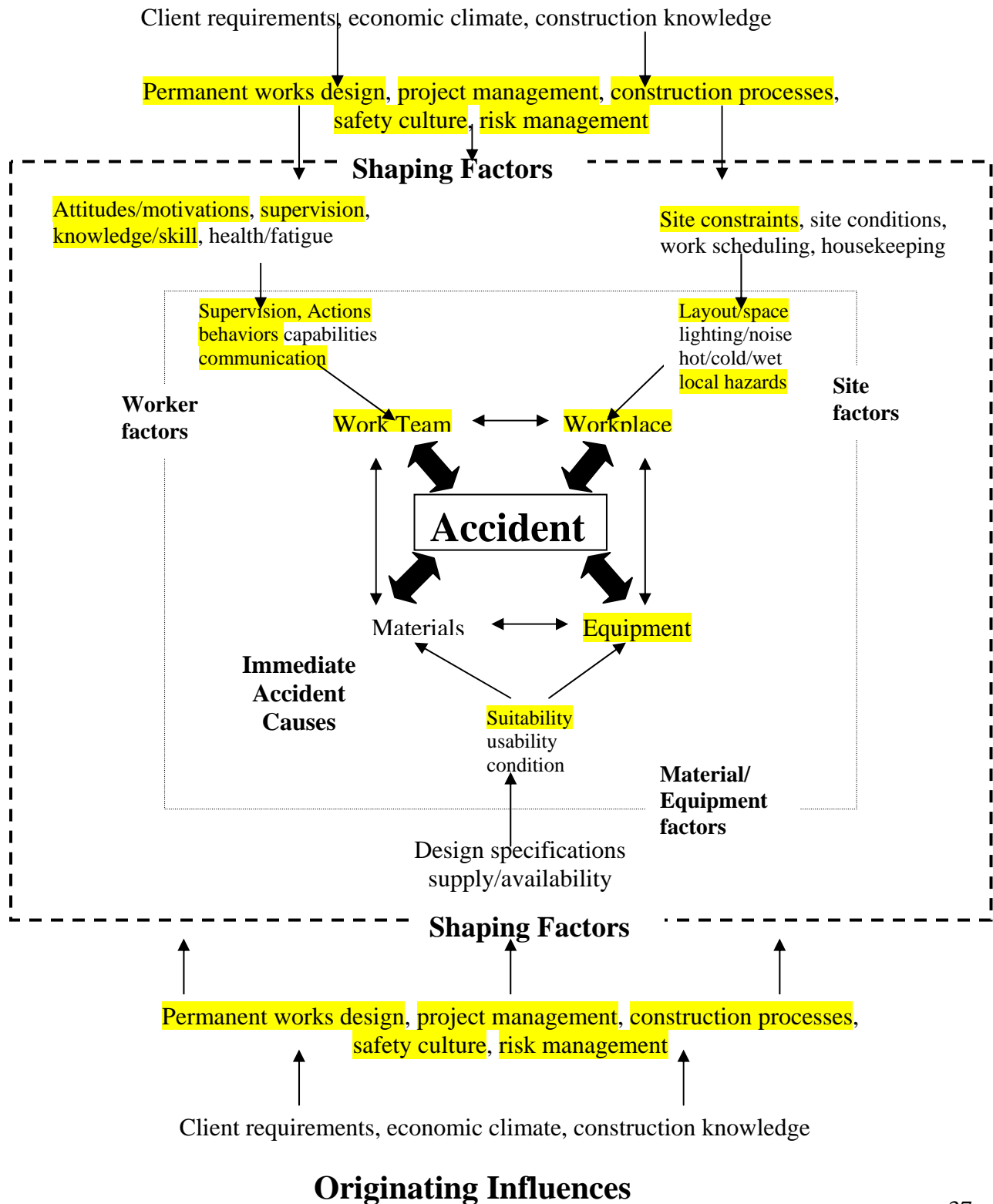
Safety Culture – there appears to be the notion that getting close to overhead powerlines is not uncommon. The poor communication between crew and supervisor appears to be rooted in group level values.

Risk Management – the hazards and risks were not properly identified or were ignored.

Permanent works design – the permanent features of the job area (powerlines) in relation to the task to be performed should have been considered.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	The supervisors were on the scene to scope the job and the risk was not identified.	Integrate safety into project management and planning
Policy and Procedures	This may not have been the best equipment choice for the job	If there was a better choice of equipment it should be used
Training		
Awareness	Must be aware of height regarding the boom of the tire excavator.	There were plenty of spotters, however, better attention may have prevented this incident
Audits		

## Originating Influences



3) EV2008044843, Division 5, 1/15/09

Riskmaster description: Employee was securing cones on the trailer with the rope that is used to tie them off. As he pulled the rope tight, it slipped off the stack of cones striking himself in the right eye.

Riskmaster cause code: Falling, Rolling or Flying Object

Riskmaster nature code: Foreign Object

Incident description (from the NC DOT forms): Employee was securing cones on the trailer with the rope that is used to tie them off. As he pulled the rope tight, it slipped off the stack of cones causing the employee to strike himself in the right eye with his hand.

Root causes identified by Division: Unsafe condition, inadequately secured

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

They were done coning off area for inmate litter pick-up on I-540 and they were getting ready to leave. They were securing cones to leave for the day. A row of cones slipped and it created slack in the rope which he holding and then he slipped and he hit himself in the eye. There were other employees around that could have assisted in the process. The employee was the only person performing this task. They are changing to a ratchet strap to more safely secure the cones. The supervisor confirmed the employees' statement.

### Immediate causes and Shaping factors

Worker actions and behaviors / attitudes and motivation – Acting alone, the action itself

Communication – Other employees present; could have asked for assistance

Immediate Supervision – No supervision of the task

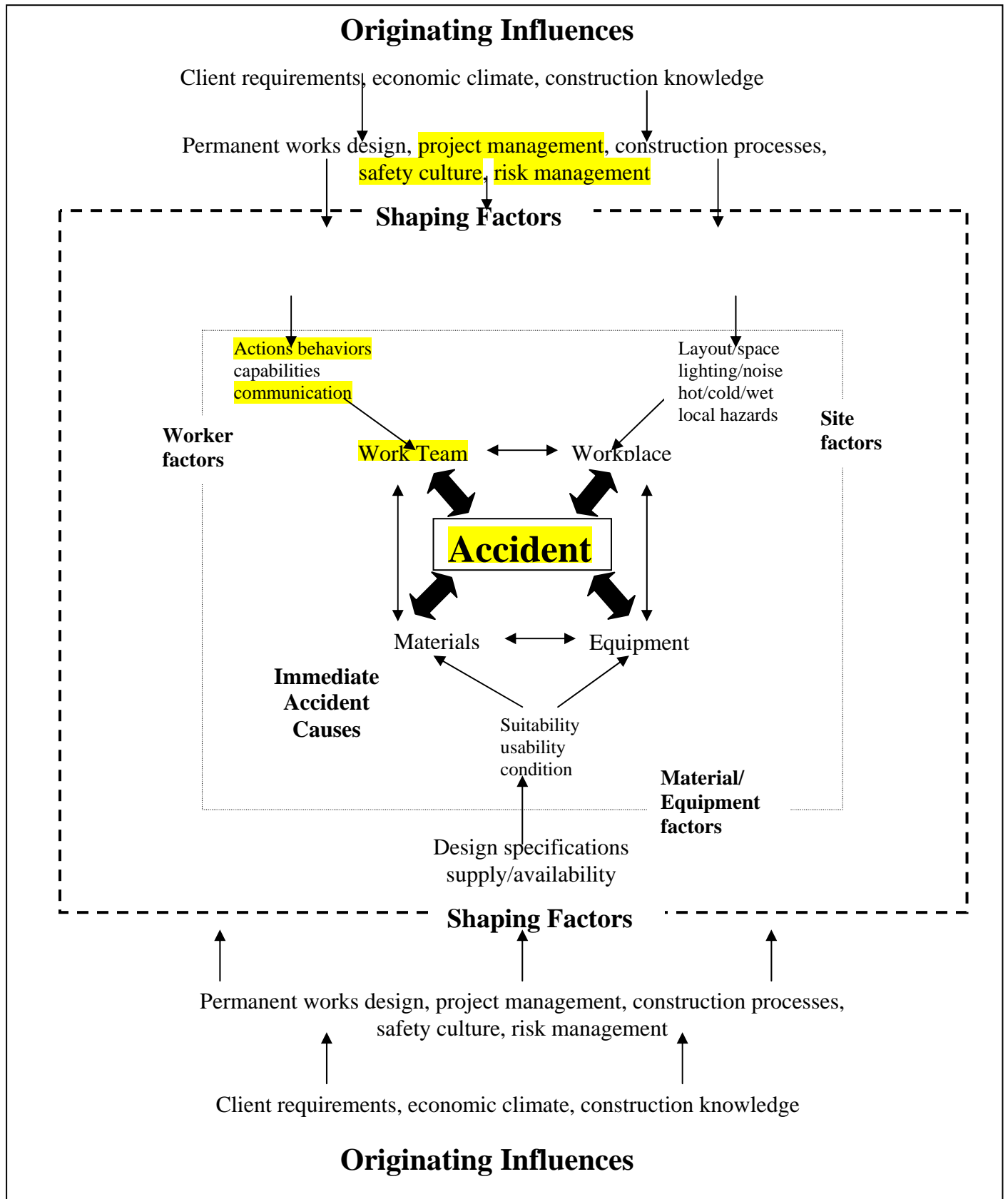
### Originating influences

Project Management – No oversight during this specific process

Safety Culture – Why wouldn't the employee ask for help during the task?

Risk Management – Not recognizing hazards faced during this operation and identifying risks associated with the task.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Limited supervision of the task.	Investigate how supervisors are relaying safety information and values
Policy and Procedures	Was not a one person task for both ease and safety	Use more than one worker to do the task
Training	Were employees trained to work together on this type of task	Increase awareness and retrain if necessary
Awareness	The condition's allowed for an unstable environment	Secure the work task using other workers
Audits		



4) EV2008044013, Division 5, 1/14/09

Riskmaster description: Employee turned around to start walking and walking into a metal post filled with concrete. Employee felt pain in his chest area.

Riskmaster cause code: Hit stationary object

Riskmaster nature code: Contusion

Incident description (from the NC DOT forms): The employee was at the method shop to get some oil in his pick-up truck. He pulled up to the garage door and then knocked on the window because he saw people inside and wanted to get someone's attention inside to open the door for him. No one heard him because it was loud inside. Although he should have just gone inside to get someone, knocking was standard procedure we he would pull up and needed something. When he turned he turned directly into a concrete post used to prevent trucks from backing into doors/buildings.

Root causes identified by Division: Not paying attention

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

Same as incident description: The employee was at the method shop to get some oil in his pick-up truck. He pulled up to the garage door and then knocked on the window because he saw people inside and wanted to get someone's attention inside to open the door for him. No one heard him because it was loud inside. Although he should have just gone inside to get someone, knocking was standard procedure we he would pull up and needed something. When he turned he turned directly into a concrete post used to prevent trucks from backing into doors/buildings.

### Immediate causes and Shaping factors

Worker actions and behaviors / attitudes and motivation – the act itself, being in a rush, using garage door instead of side door

Local Hazards – concrete post

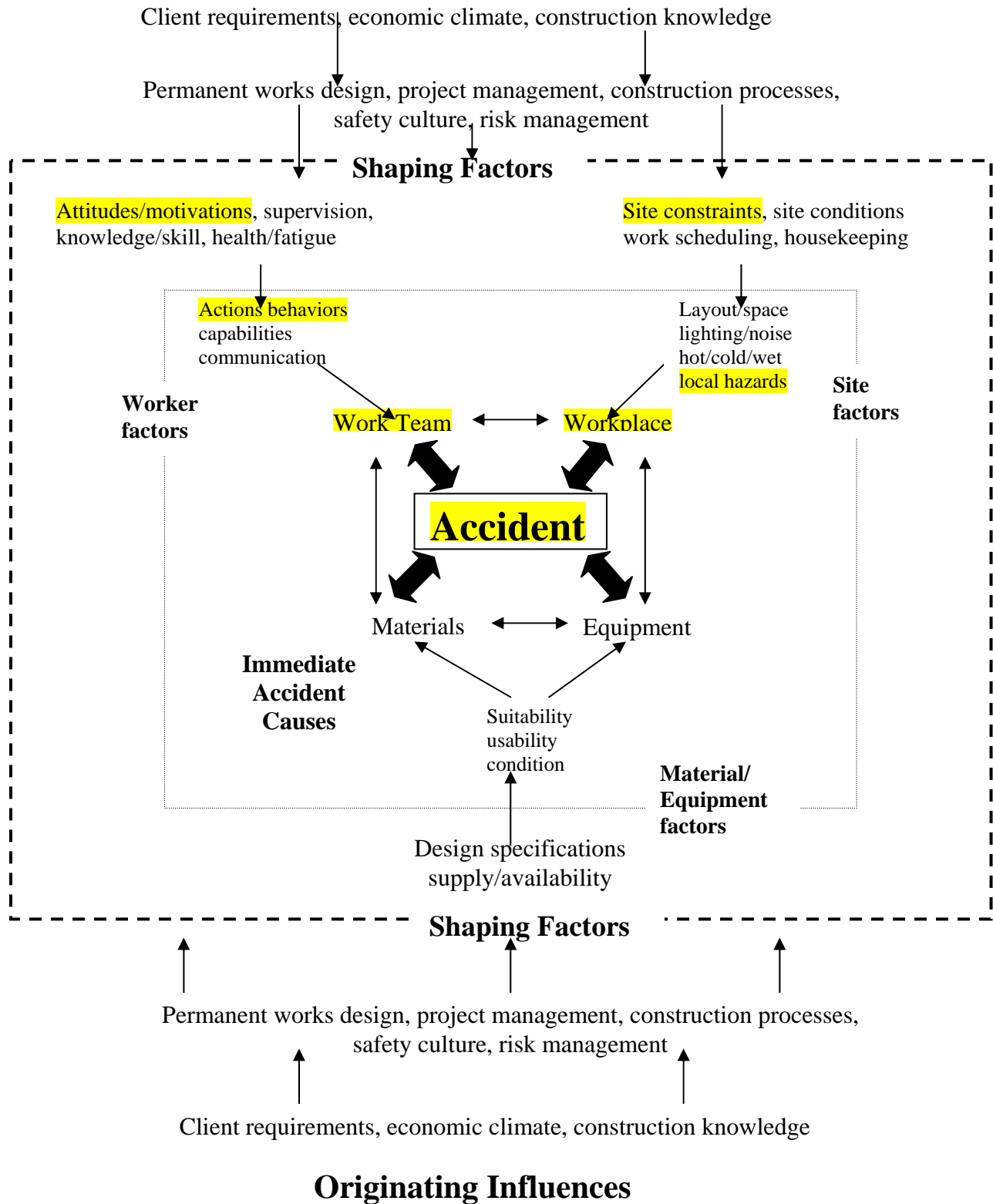
Site constraints – limited area to get other workers attention creating a limited area to avoid accident

### Originating influences

None identified

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures	Should be a policy regarding which door is appropriate to enter at this location	Choose one “common” entrance
Training		
Awareness	Should have been aware of his immediate surroundings in his hurried state of mind	Consider using the main entrance rather than bring attention to one's self at the garage entrances
Audits		

## Originating Influences



5) EV2008043797, Division 5, 1/14/08

Riskmaster description: Employee was chipping up branches from trees. Employee was exposed to something that caused a rash on face.

Riskmaster cause code: Allergic reaction/rash

Riskmaster nature code: None listed

Incident description (from the NC DOT forms): Employee was chipping up branch from trees that had been pruned by another employee. Employee was exposed to something that caused a rash on his face

Root causes identified by Division: Chipping up branches which made the debris airborne

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

Employee was following all safety procedures (SOP12B-3 Brush Chipper) Employee was wearing (hardhat, safety shoes, safety glasses, gloves, hearing protection. Employee was wearing a long sleeve shirt. Consider using protective barrier cream product on face when future exposure is anticipated.

#### Immediate causes and Shaping factors

Local hazards – poison ivy/oak. Chipping operations allow for these items to become airborne. Capabilities/knowledge - was the hazard (poison ivy) recognizable by the employees?

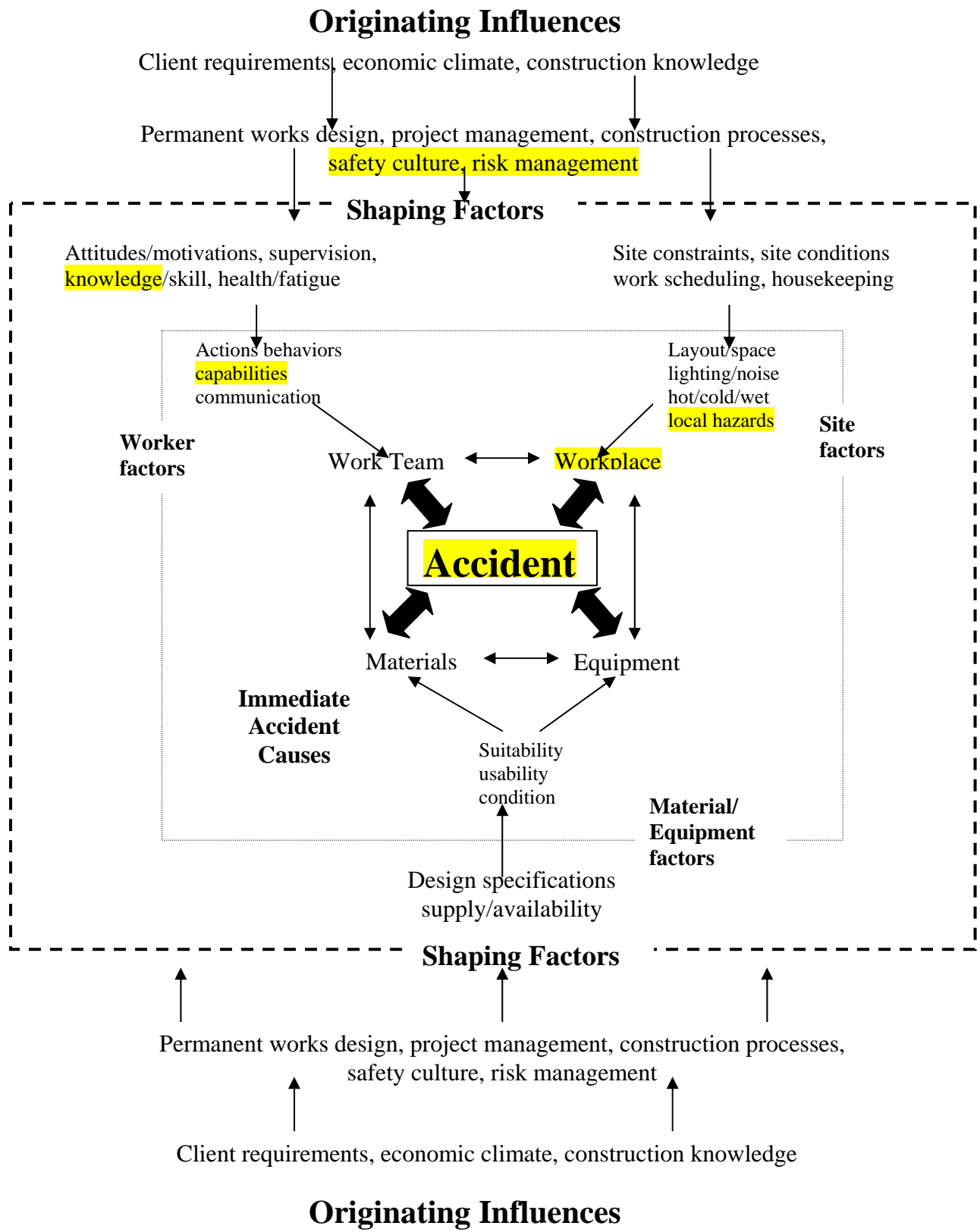
#### Originating influences

Safety Culture – should the barrier cream be worn during all activities were poison ivy is possible? Does DOT accept this risk as an organization?

Risk Management – if the hazard (poison ivy) was recognized and anticipated by the employees, why was barrier cream used?

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	When doing this type of work, supervisors should set an example to the employees regarding poison ivy exposure by using protective creams and clothing and promoting such tactics with employees	Set the example for the employees and promote these protective measures when working in brush or wooded areas
Policy and Procedures	The policy and procedures for this type of work is nebulous	Make protective measures mandatory
Training	Employees are trained regarding this type of exposure	Implement the training received
Awareness	Employees must be aware of the hazards when working in wooded areas or working with brush	PPE
Audits		





6) EV2008045498, Division 2, 11/06/08

Riskmaster description: Employee was using drill to mix concrete when he went to reposition hand toward bottom of drill chuck and pulled his arm and hand. The machine ripped the glove off his hand and twisted his left arm/wrist.

Riskmaster cause code: Caught in under, or between

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): Employee was mixing cement with a 23" auger bit in a 5 gallon drum. Employee took hand off top handle while still running drill and placed hand on drill chuck.

Root causes identified by Division: Do not place hand on moving part of drill. Mix less cement in bucket.

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

There was no handle on the drill but they found one. Supervisor and employee agree they should mix less cement. There seems to be a lack of knowledge and agreement on the thickness or consistency of the cement. Supervisor focused on cement rather than handle. It seems both are equally important.

### Originating influences

Worker actions / behaviors / attitude / motivations – employee should have had the equipment (job) to do the job. He shouldn't have put his hand on the moving part, and he shouldn't have mixed so much cement.

Capabilities / knowledge – how much is too much cement? What is the correct consistency?

Usability of equipment – handle for the drill was not with the drill. Drill not usable for this job without the handle.

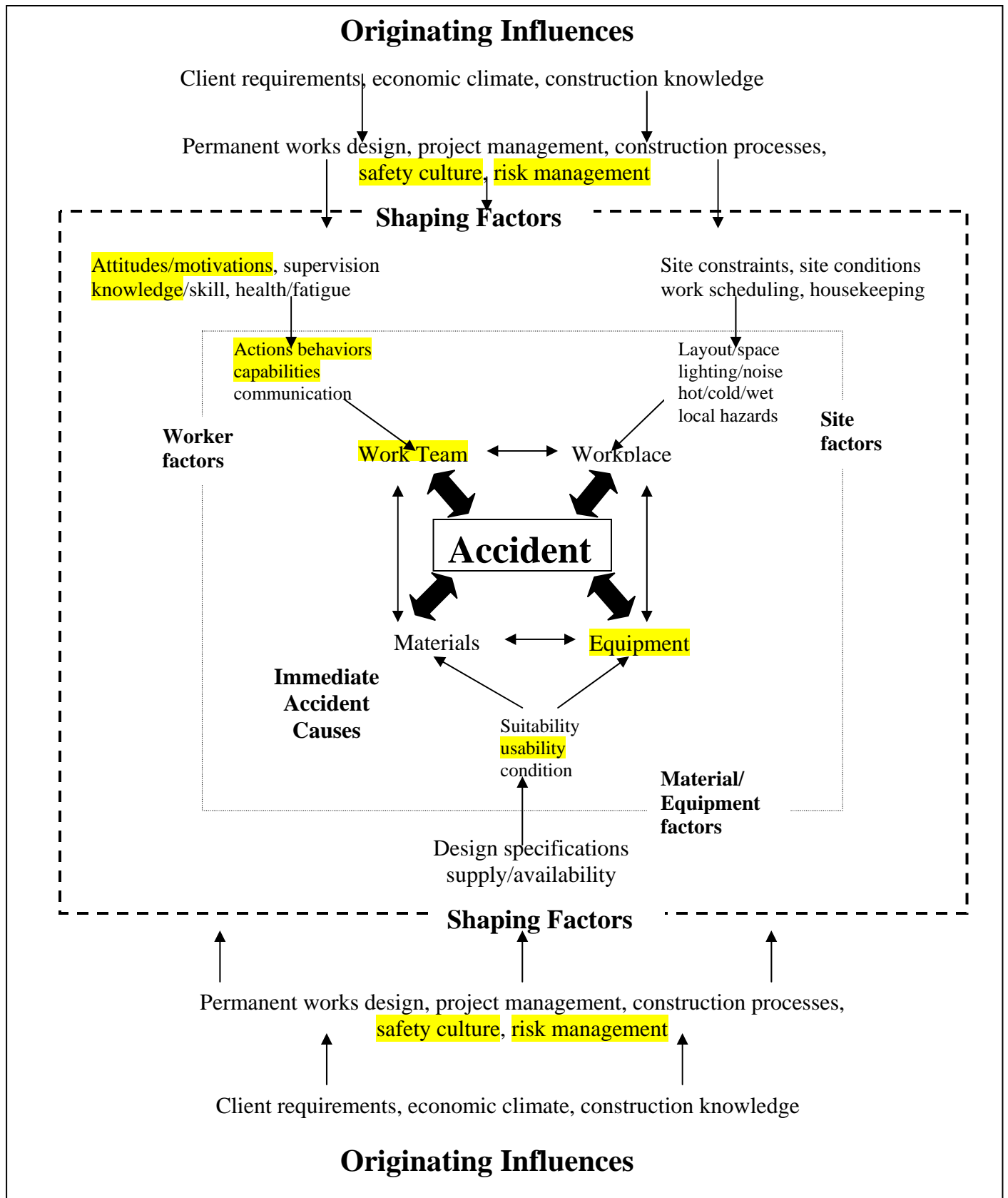
### Immediate causes and Shaping factors

Safety culture – the risk of using the drill without the handle seems to be (or was) acceptable.

The risk of mixing too much cement seems to be acceptable.

Risk Management – there is no written procedure for how much cement to mix and the appropriate amount varies from employee to employee.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Supervisor should focus equally on safety and project needs	Use suitable/usable equipment
Policy and Procedures	There is no written procedure.	Investigate whether a SOP needs to be written and how it is communicated
Training		
Awareness	Be aware of inadequacies of equipment	Use suitable/usable equipment if there is a deficiency in the equipment
Audits		



7) EV2008045545, Division 2

Riskmaster description: Employee was unloading signs and cones out of the back of the back of a crew cab truck. After the signs were unloaded he went to climb down from the bed and stepped on the tire when the wood railing broke causing him to land hard on both feet.

Riskmaster cause code: climbing or stepping

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): Employee was unloading signs and cones out of the back of the crew cab truck. After the signs were unloaded he decided to climb down from the bed on the tire and the wood rail broke and he landed hard on his feet causing back pain.

Root causes identified by Division: Wooden rail failure

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

The truck is equipped with a ladder that is stowed underneath the bed of the truck. Instead of using the ladder the employee climbed off the side using the tire as a step. The employee did use the handrail on the side of the truck, however, the rail broke causing him to land on his feet which lead to back pain.

The supervisor's statement: Employee has a degenerative back condition and should have known better. He has been advised to allow younger employees to do any type of "tough" labor. The employee should have done a pre-trip inspection and known of the condition of the rails.

### Immediate causes and Shaping factors

Worker actions and behaviors / attitude and motivation – Using the tire to dismount rather than using the supplied ladder.

Worker capabilities – Was worker capable of this type of action considering his health

Communication – Making note of the wooden rails on the truck during the pretrip inspection.

Worker health/fatigue – his age and health as a factor

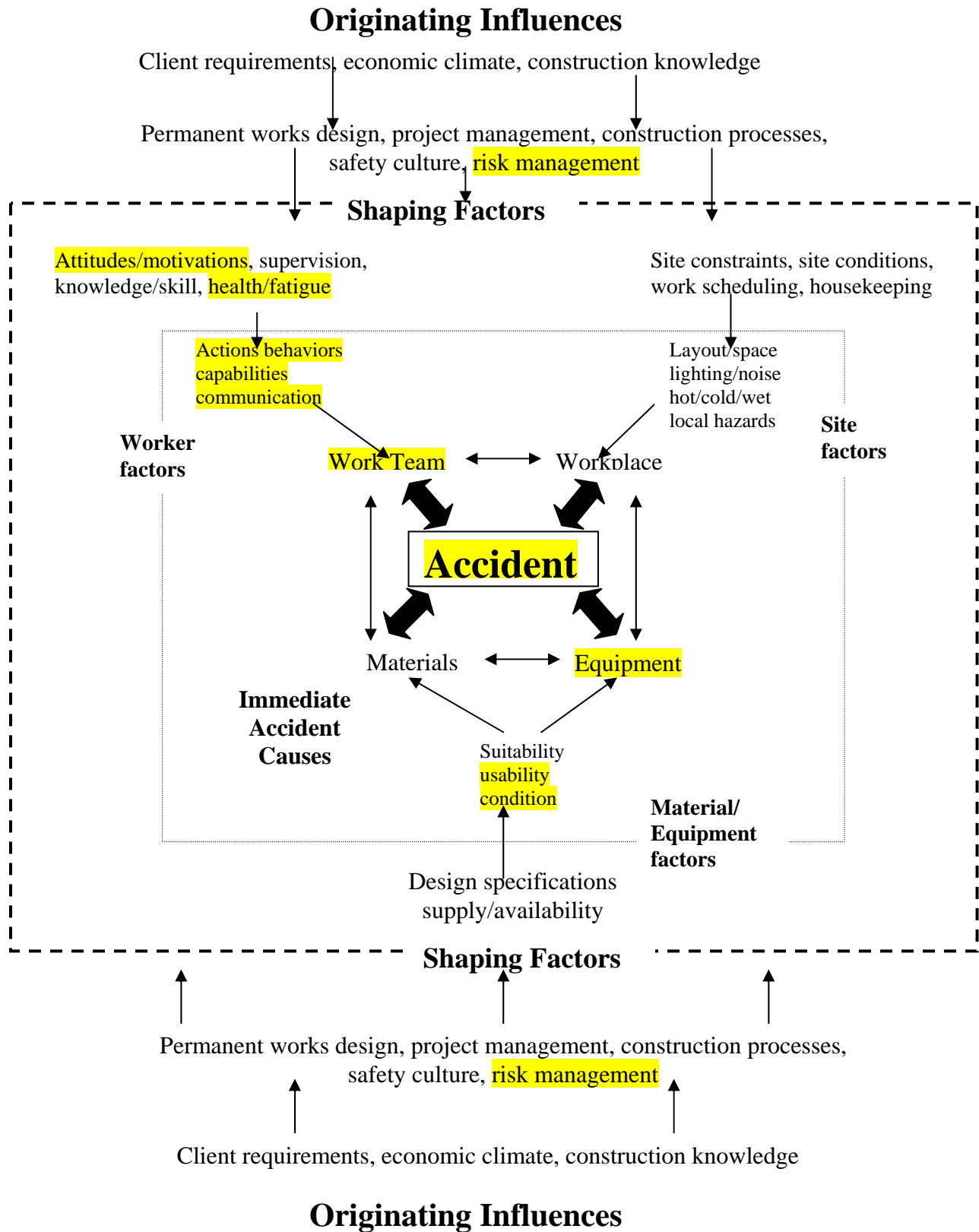
Usability of equipment – is it the easiest route or action to take

Condition of equipment – rotten wooden rails led to failure of stronghold which caused employee to fall.

### Originating influences

Risk management – employee did not identify risk of this action. No pre-trip measures to fix wooden rail.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	This is a common practice of dismounting the vehicle	Everyone should follow the best strategy for exiting the vehicle to establish a standard method
Policy and Procedures	Using the tire rather than the provided footing to exit the truck bed; pre-trip inspection should have caught the poor condition of the wooden railings	Use ladder rather than tire to dismount from vehicle; when observations are made during the pre-trip, one should take correct actions
Training		
Awareness	Using the tire to dismount rather than using the supplied ladder.	Investigate why employees would think this is acceptable.
Audits		



8) EV2008044859, Division 3

Riskmaster description: Employee was removing crown strip from cap on bridge 111 in Duplin Co. Employee was on pontoon with another employee when the weight of the crown strip caused the pontoon to shift and they both lost their footing. One employee went into the water and in the process struck his side on cross bracing.

Riskmaster cause code: Caught in, under, between

Riskmaster nature code: Contusion

Incident description (from the NC DOT forms): While removing a crown-strip from the cap the employee was on one end of the boat and another employee on the other end. This is a pontoon boat. When they lifted the crown-strip off the cap the weight of the crown-strip caused the pontoon to shift causing the employee to loose his footing. This action caused him to fall off the boat which slammed him into the cross-brace and pinned him between the pontoon and the cross-brace on his left side. He fell partly in the water.

Root causes identified by Division: Extreme weight of crown-strip timber

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

Old pilings left below water line from old bridges such as these hinder positioning of the pontoon to access work properly. The nature of this work in removing the crown causes weight to be shifted constantly. The pontoon itself has many employees working in a small space; at times simultaneously. The pontoon itself had debris on the floor contributing to factors to maneuver around. The workers perform this task in a hunched over posture, unless the water levels are high which forces them to work on their knees. Supervisors noted that the boat should have been tied off on both ends to prevent unnecessary shifting.

#### Immediate causes and Shaping factors

Worker capabilities / skill – inability to control weight shift during crown strip removal

Immediate supervision – Lacked supervision of any sort, new employee

Local hazards – trip hazards within boat, working on water

Site constraints/layout/space – not enough room to work in a careful manner

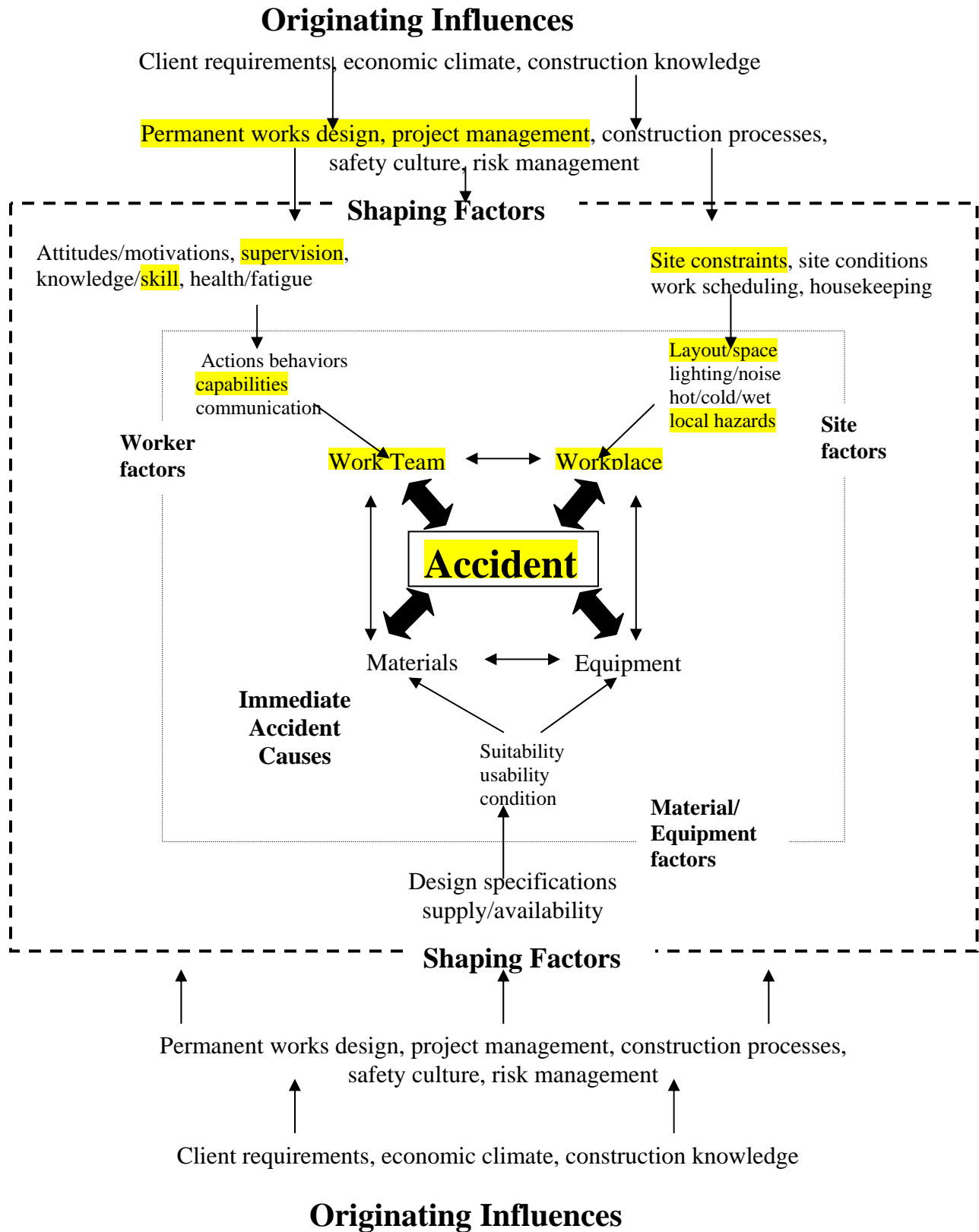
#### Originating influences

Permanent works design – the nature of the work and the surroundings limit the ability to avoid accidents of this type

Project management – lacked oversight

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Lacked supervision of any sort.	Review new employee orientation to jobs
Policy and Procedures	There should be a policy related to securing the boat	A best practice might be to secure the boat at both ends by tying off to pylons.
Training		
Awareness		
Audits		





9) EV2008043985, Division 5, 1/15/09

Riskmaster description: Employee was attempting to adjust forks on loader to fit lift points on salt tanks when, he mashed his right center finger between the rods on the fork.

Riskmaster cause code: Caught in, under, or between

Riskmaster nature code: Fracture

Incident description (from the NC DOT forms): Employee was attempting to adjust forks on loader to fit lift points on salt tanks when he smashed his right center finger between the rods on the fork.

Root causes identified by Division: Unsafe act, improper handling

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

He was adjusting the width of the forks. The forks swing. He put one hand on the fork and one hand at the pinch point where the fork swings. No sign indicated pinch sign at this location. Largest gap is 3 inches but it closes to touching. He's done this before but no near misses before. It had never been a problem. He smashed his finger and it is deformed. 10 stitches and was out of work for 5 weeks. We are unsure how the fork could be moved in the position described because of the weight of the fork and the distance to cause a gap/pinch point with a one-person move. One possibility is that the other person helped to move it because the action of him moving it caused the pinch point and this could not have happened. However, likely the second man was on the forklift was operating the lift mechanism and it dropped causing the forks to go up and cause the pinch point. We believe this is the only way to cause the pinch this severe. There appeared to be a lack of communication during the investigation. Investigator got the impression they were all friends and did not one to get in trouble.

### Immediate causes and Shaping factors

Worker actions and behaviors / attitudes and motivation – The act itself, working alone, unaware of hazards

Worker capabilities – A task requiring heavy lifting; not a one man job

Condition – Should there be placards indicating pinch points

Supervision – were the risks adequately identified?

Knowledge /skills – the employees may not have had the skills to do the job safely

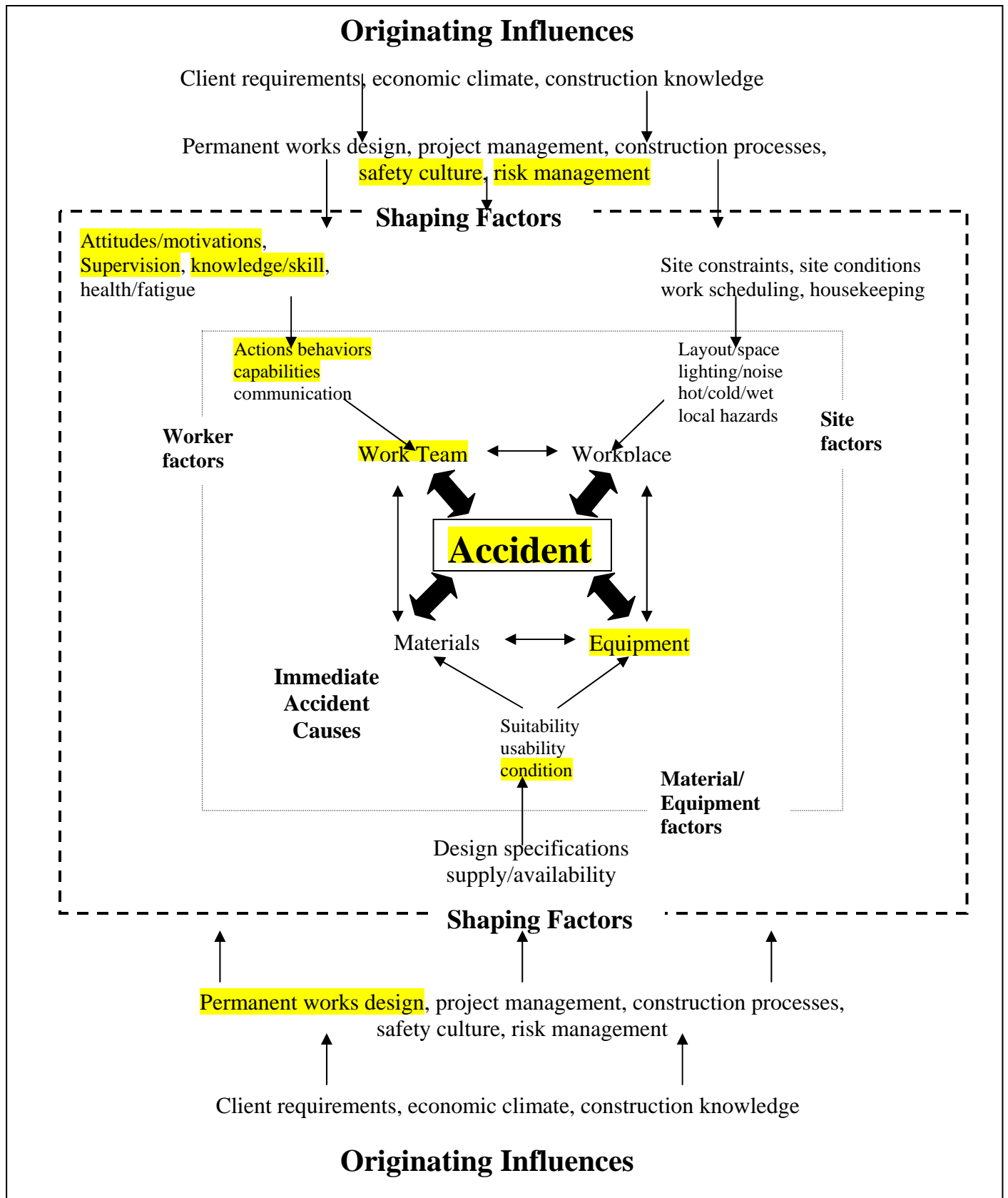
### Originating influences

Permanent works design – The design of the equipment and process to do the task increased the opportunity for injury

Safety Culture – The story did not seem to add up. It seems that employees were covering for one another rather than being honest about the situation

Risk Management – Poor risk identification by work team and supervisor

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Other employees should take the lead and help during fork adjustment	Ask for help from others
Policy and Procedures	A policy should be taken during fork adjustment to have extra employee help during this process	Ask for help from others
Training		
Awareness	Employee should be aware of various pinch points on this machine	Corrective action was taken and signs were posted identifying pinch points
Audits		



10) EV2008044220, DMV

Riskmaster description: Employee was stepping down out of a cab of a ten wheeler truck for the plate agency. He was holding onto the cab bar and stepped to the ground and twisted his back. His back popped.

Riskmaster cause code: Climbing or stepping up/down

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): Employee was stepping down out of the cab of a 10 wheeler which serves as a delivery truck. The employee was holding on to the cab bar and stepped down two sets of stairs. Upon landing on the ground the employee felt a pain in his back. The pain has persisted ever since.

Root causes identified by Division: None, but this could be related to the repetitive nature of this job

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

ECU team actually went outside to examine the truck. I had the notion that there may have been some difficulty getting into or out of the truck. I thought that there may have been too few steps to enter and exit the vehicle. I also wanted to note the position of the cab bar to see what type of motion take place. I found no issues regarding the equipment's condition upon the inspection. Employee mentioned that he enters and exits the truck 15-20 times a day and has performed this task for 24 years. This appears to be a repetitive task that came to a head on this day.

### Immediate causes and Shaping factors

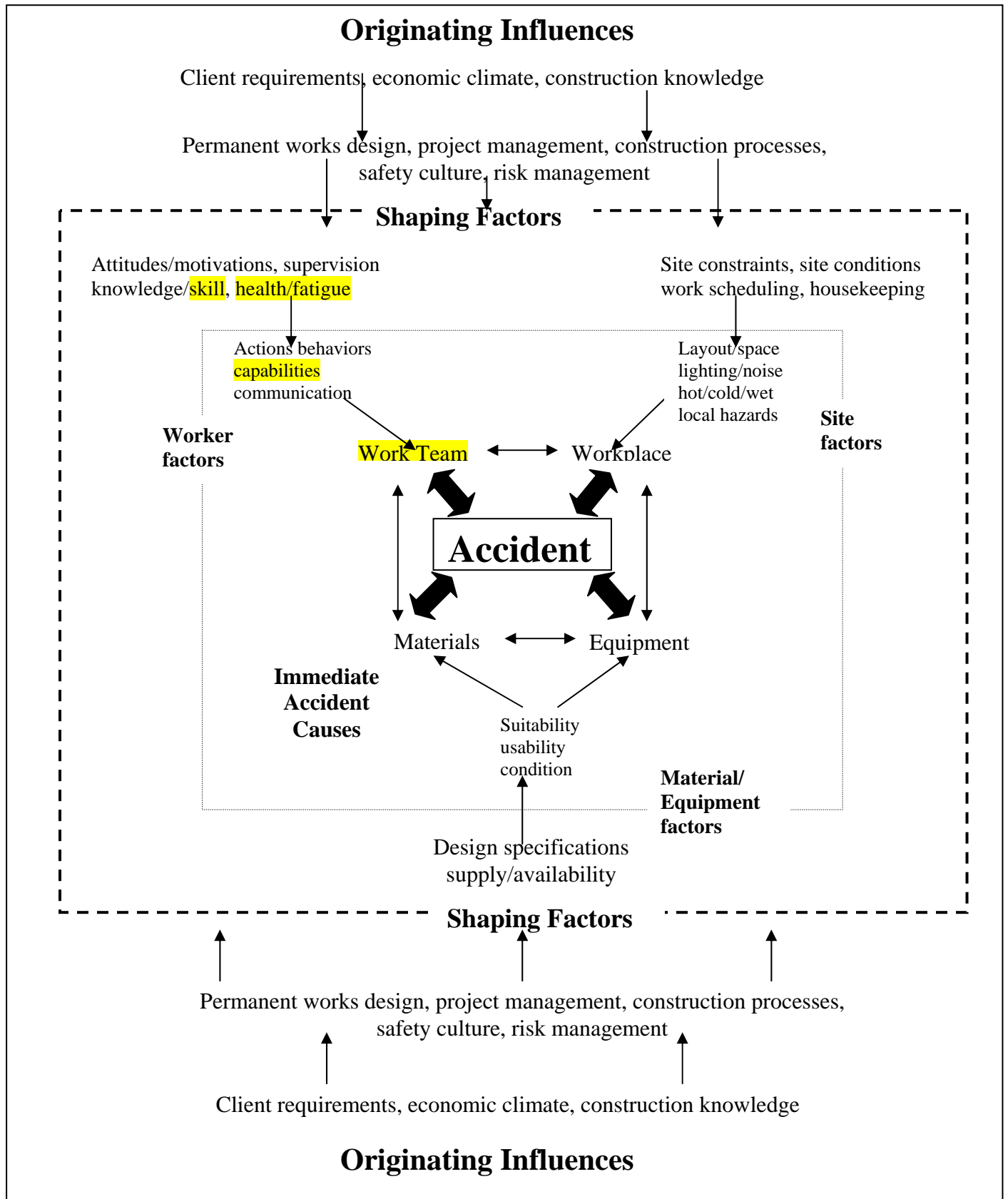
Worker capabilities / skill – is the worker capable of doing this repetitive nature job as he has for the past 24 years

Worker health/fatigue – an older gentleman who exerts himself physically daily

### Originating influences

None

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures		
Training		
Awareness	This is a repetitive motion done many times throughout the day	Ensure that dismount from vehicle is done safely with minimal impact
Audits		



11) EV2008044253, Division 5, 4/2/08

Riskmaster description: Employee states while traveling down I-40, a private vehicle hit us from the side merging into our traffic lane.

Riskmaster cause code: Collision with another vehicle

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): Private vehicle merged from an on-ramp across an open lane into the state vehicle

Root causes identified by Division: Private vehicle made an improper movement across an open lane into the state vehicle

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

Employee was indicated by the supervisor as not following SOP for defensive driving. The employee stated that "I had no choice but to allow the vehicle to hit us. In that moment if I had swerved off the road I would have hit a light pole instead. There was traffic directly behind me so slamming the brakes would have caused another type of collision." Due to the culture of the organization, they had to place some blame on the employee since traffic accidents require such disciplinary action (at least in this instance/division). They cited the employee as not following defensive driving, even though they thought the employee did what he could and at least tried to avoid the collision.

#### Immediate causes and Shaping factors

Site conditions – unable to avoid oncoming vehicle. If avoided the employee would have been involved in an accident of a different type.

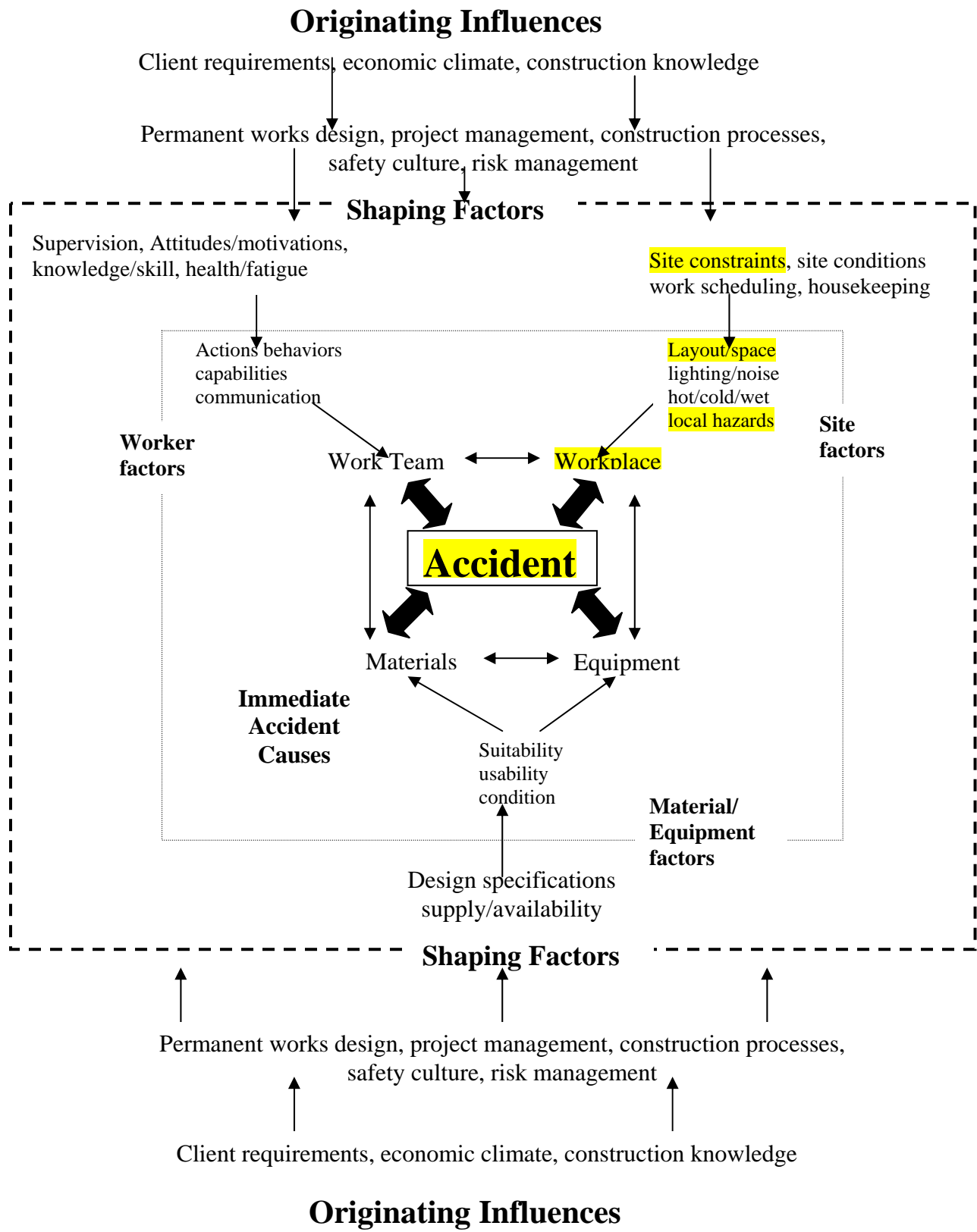
Site constraints/layout/space – The employee had no choice but to allow the accident to take place due to the minimization of space.

Local Hazards – vehicle coming into his lane.

#### Originating influences

None

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures	The employee did the best he could in this situation	Let the other vehicle strike him, or hit the brakes and hope to avoid the event rather than swerving off the road
Training		
Awareness		
Audits		





12) EV2008045001, Division 4, 8/11/08

Riskmaster Description: Employee was operating excavator. As he was pulling on the throttle, he felt a pain in his back

Riskmaster cause code: Pushing or Pulling

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): Employee was operating excavator. As he was pulling on the throttle he felt a pain in his back.

Root causes identified by Division: N/A based on incident investigation. This appears to be an ergonomic issue.

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

The employee had to move seat closer to reach the pedals. This causes the employee to have to reach back further to operate the controls. Operating the controls takes some amount of force. This action caused the employee to pull his back. The employee's suggestion was to allow operators of the equipment be involved in the purchasing process to pick equipment that is best fit or with better capabilities.

#### Immediate causes and Shaping factors

Worker capabilities / skill – due to his short stature, operating the equipment with proper ergonomics may be hard to attain.

Suitability of the equipment – does not fit well to the employee's physical needs

Usability of the equipment – difficult to operate due to short stature

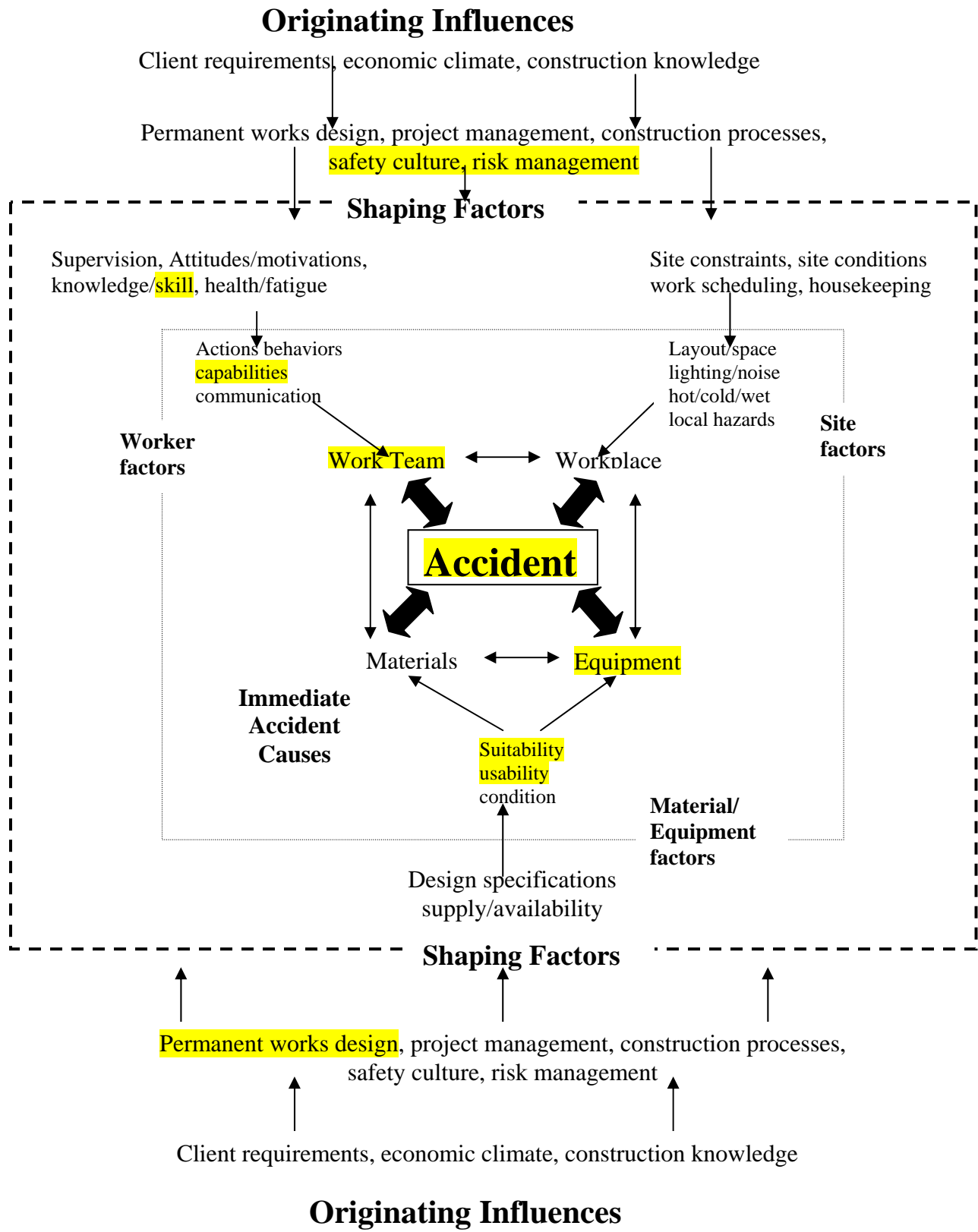
#### Originating influences

Permanent works design – the equipment itself is not tailored to the employees needs.

Safety Culture – the risk was deemed acceptable until the employee got hurt.

Risk Management – Not identifying the risk conditions beforehand which lead to this accident.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Supervisors should ensure that the equipment used is best suited for the employee; consider ergonomics of equipment relating to worker needs	Retrofit equipment or have employee present during equipment purchase
Policy and Procedures		
Training		
Awareness	Be aware of the strain that may take place during operating limitations	Work carefully. Try to avoid excessive strain
Audits	Auditing of the equipment could have possibly identified the risks	Considering auditing how employees fit with equipment



13) EV2008044699, Division 3, 6/21/08

Riskmaster description: Employee put out fire with fire extinguisher when he came into contact with carbon monoxide.

Riskmaster cause code: Contact with chemicals

Riskmaster nature code: None listed

Incident description (from the NC DOT forms): Employee was attempting to open the bridge to let in boat traffic at 3pm. An oil line was situated on the top of the engine battery ruptured. The leaking oil from the line sprayed oil onto one of the battery terminals. This resulted in a fire. The employee used a CO2 fire extinguisher to smother the flames. Once the CO2 started to dissipate the fire re-ignited. The employee smothered the flames once more and in the process managed to inhale some of the CO2.

Root causes identified by Division: Ruptured oil line

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

This incident occurred in a 12x16 room. A breeze pushed CO2 back into the room and contained it there. Maintenance from days earlier had replaced the oil line due to wear. The maintenance crew did not put the line in its correct spot which was away from the engine battery. This was the true trigger of the incident.

#### Immediate causes and Shaping factors

Worker actions and behaviors – using the extinguisher in the closed room would have no option but to lead to a possible overexposure. The act itself.

Local hazards – fire

Site conditions – small area; the design of the structure and the oil line placement

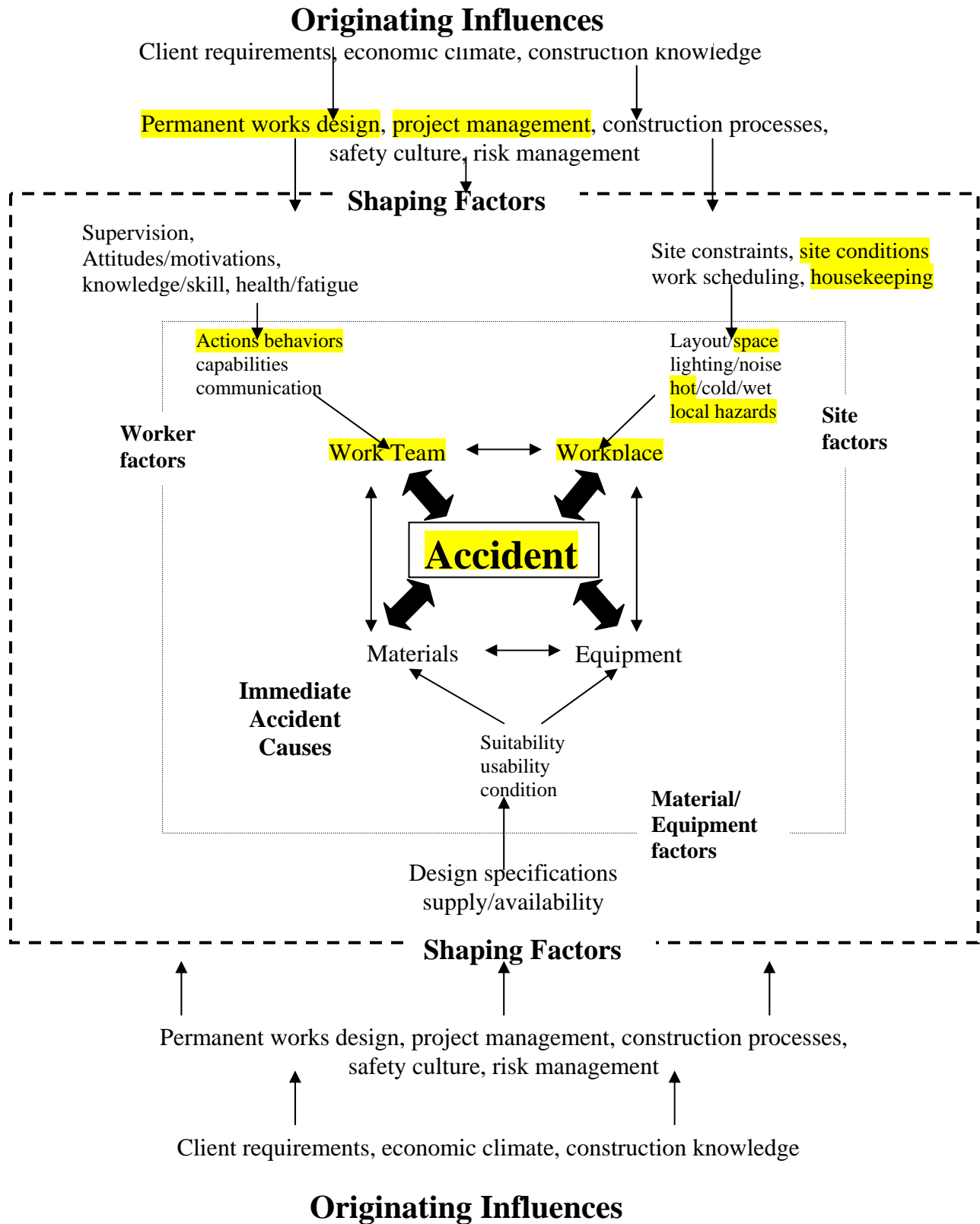
Housekeeping – a different crew left the line in an inappropriate place which led to this event

#### Originating influences

Permanent works design – the combination of design of the structure and the oil line placement led to this accident.

Project management – of the original maintenance procedure

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures		
Training		
Awareness	Be aware of hazards faced when using fire extinguishment	Proper training and risk identification
Audits		



14) EV2008044099, Division 4, 3/4/08

Riskmaster description: Employee states the chute on the chipper was stopped up and employee was using a pipe bar to clean out and the employees foot slipped and his left hand hit the housing blade cutting his thumb on the left hand.

Riskmaster cause code: Cut, Puncture, Scrape

Riskmaster nature code: Laceration

Incident description (from the NC DOT forms): Employee was running chipper on a manual brush and tree control operation. Tree debris got lodged around cover and main blade on top of chipper. Employee shut chipper down. He proceeded to get on top of the chipper and unlatch the blade cover. He took a pry bar to clean debris from cover and around blade. He slipped and hit his left thumb on the cover causing a cut which required three stitches.

Root causes identified by Division: Slipping action leading to laceration on left thumb. No protective gloves.

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

Employee explicitly stated that he should have worn gloves during this operation. This particular type of equipment, “wood chipper”, has a tendency to become jammed. People unrelated to the DOT usually unclog these machines. On this day, the employee felt capable of performing these duties.

#### Immediate causes and Shaping factors

Worker actions and behaviors – unclogging the wood chipper, not his common task. Not wearing appropriate PPE during this task

Local hazards – hazardous nature of the equipment, especially without PPE. Slippery surface

Site constraints, layout/space – limited area and ability to move during this task.

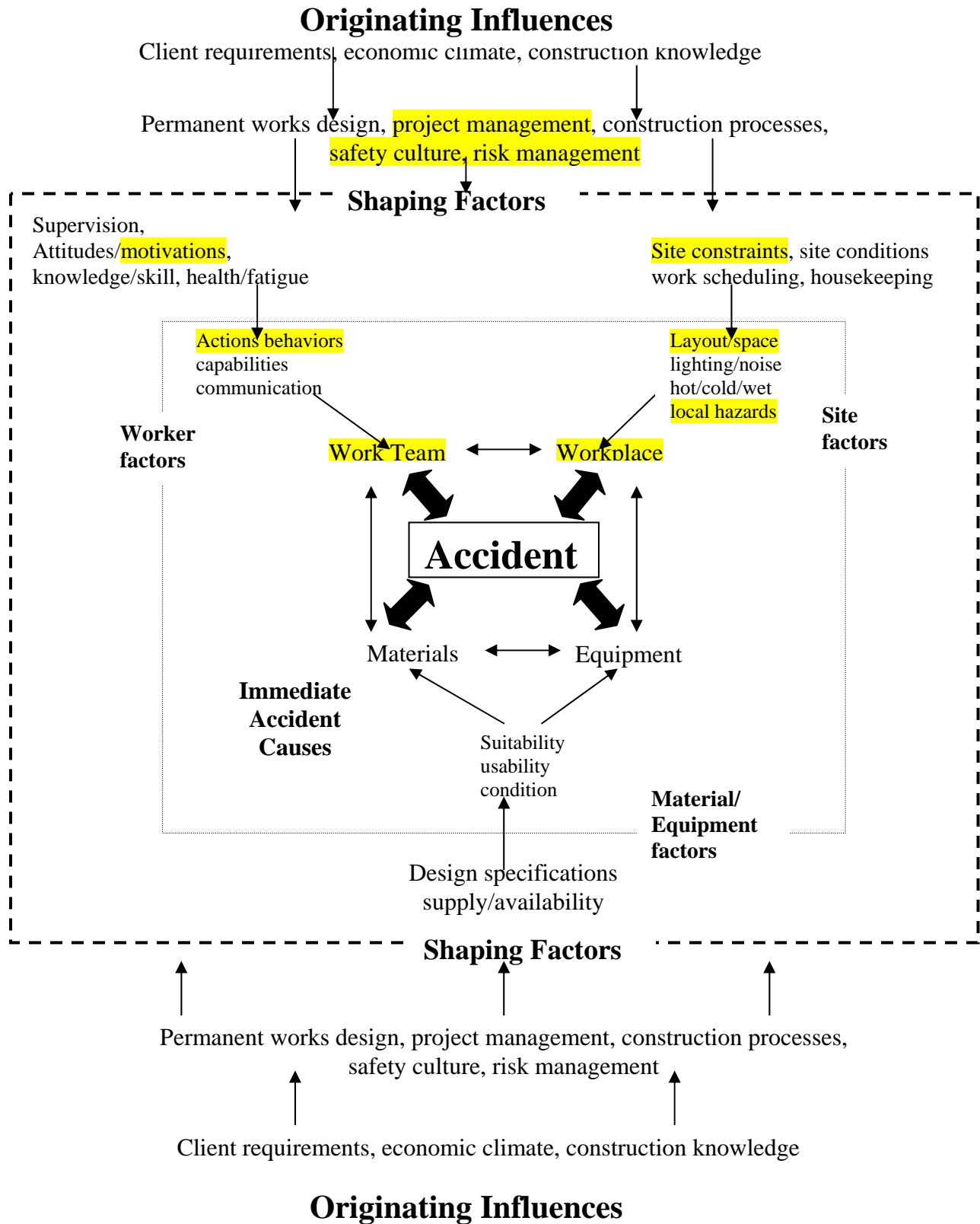
#### Originating influences

Project management – No management of the process at hand. Limited safety oversight.

Safety Culture – Doing the task and bypassing safety to keep up productivity first.

Risk Management – inability to recognize hazards and risks associated with the task.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Supervisors should have stopped employee from taking the task into his own hands	Wait for proper maintenance personnel
Policy and Procedures	A policy should be adopted that only knowledgeable personnel be allowed to fix this type of problem	Wait for proper maintenance personnel
Training	Employee was not trained specifically for this task	If the employee has not received training of this type then he should not be involved in this process
Awareness		
Audits		



15) EV2008044563, Division 5, 5/30/08

Riskmaster description: Employee lost footing on a steep slope and fell and rolled into a fence striking head. The collision caused a laceration to his head.

Riskmaster cause code: Fall, slip, or trip

Riskmaster nature code: Laceration

Incident description (from the NC DOT forms): Employee was walking down a steep slope to check an end bent reference line. The employee lost his footing on muddy ground and fell and struck his head on a silt fence post causing a laceration on his head.

Root causes identified by Division: Muddy, uneven terrain

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

Employee could not have taken a safer route to prevent this event. Employee still found to be at fault. See incident description above.

#### Immediate causes and Shaping factors

Site conditions – wet, muddy, slopped terrain; conditions were conducive of a trip or fall

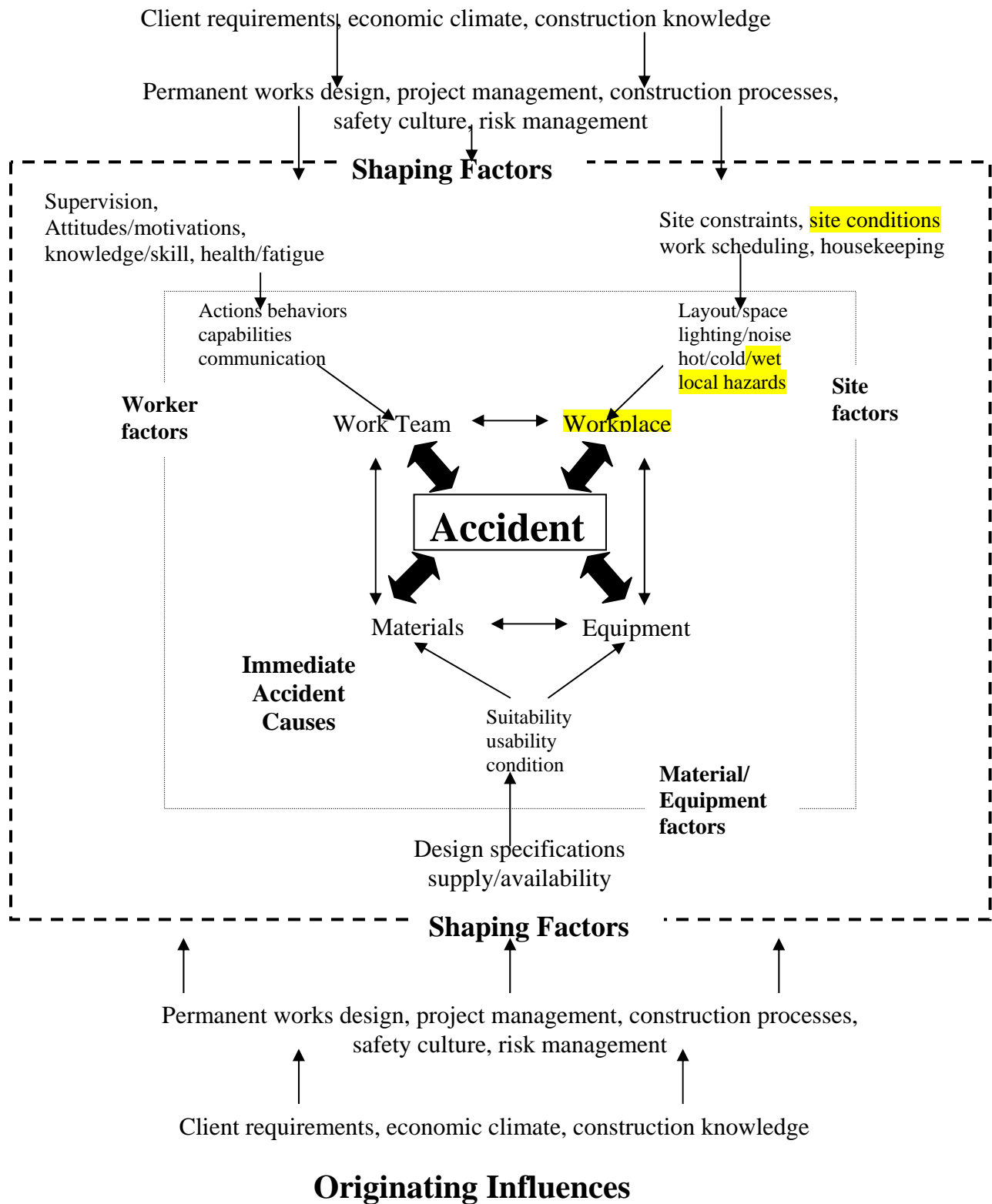
Local hazards / Wet environment – wet, slippery, muddy

#### Originating influences

None

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures	Identify unsafe terrain	Identify unsafe terrain before any work process takes place
Training		
Awareness	Be aware of wet and slopping terrain	Maintain proper footing and choose alternate routes if possible
Audits		

## Originating Influences





16) EV2008044573, Division 4, 5/7/08

Riskmaster description: Employee was flagging traffic on NC 111/222 in Wilson Co. for work being performed on Culvert 131. Employee was wearing his safety glasses during flagging operation but had removed them to wipe dirt and sweat from his eyes and brows.

Riskmaster cause code: Foreign body in eye

Riskmaster nature code: Foreign object

Incident description (from the NC DOT forms): Employee was flagging traffic on NC111/222 in Wilson Co. for work being performed on culvert131. Employee had been wearing his safety glasses but had removed them to wipe the dirt and sweat from his face. During this time employee felt some type of foreign object fly into his right eye. His supervisor on the job got the eye wash from the first aid kit and employee washed his eye out, however, the next morning when he got up his right eye was swollen and uncomfortable.

Root causes identified by Division: Foreign object flying into employees' right eye during the time that the employee had removed his safety glasses to wipe dirt and sweat from his face.

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

The employee stated that he doesn't typically wear safety glasses, these were sunglasses which doubled as safety glasses. Employee stated that he is more aware of debris hazards from traffic.

#### Immediate causes and Shaping factors

Actions / knowledge - are safety glasses required? The sunglasses do not adequately substitute as safety glasses.

Local Hazards – Debris typical from windy conditions and loose terrain/debris

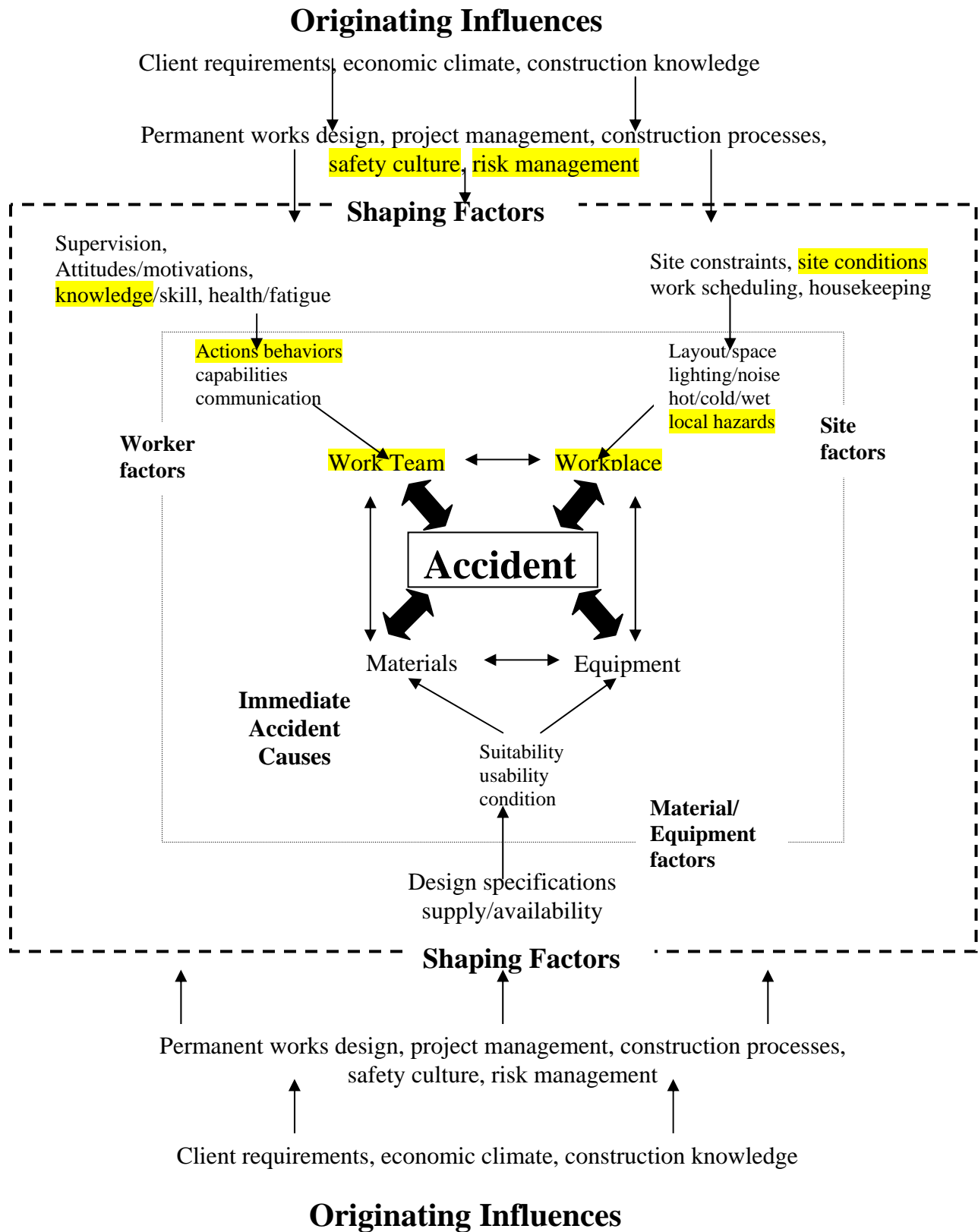
Site conditions – Hazards typical of this environment

#### Originating influences

Risk management – it is unclear whether the employee knew the safety glasses were required or if they really are required. Are the sunglasses appropriate?

Safety culture – the lack of understanding with the group of safety glass policy is indicative that other hazards and risks may also be dismissed.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Since it is unclear whether safety glasses are required, since lack of agreement can be traced to leadership.	Seek to clarify these types of uncertainties consistently
Policy and Procedures	Keep PPE on at all times outdoors during dusty conditions	Go to a separate enclosed location, such as, a vehicle when PPE is removed to wipe sweat or dirt from face/eyes
Training		
Awareness	Be aware of dusty conditions and it hazard	Keep protective eyewear on at all times
Audits		



17) EV2008045176, Division 3, 9/9/08

Riskmaster description: Employee climbed into the full bed of a pickup truck, removed a chainsaw from the toolbox, closed the lid, placed the saw on top of the toolbox, jumped down off the pickup from the side, and felt sharp pain in his back.

Riskmaster cause code: Jumping

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): The employee climbed into the full bed of a pickup truck. The truck was full of debris and work items from the day. The employee removed a chainsaw from the toolbox and placed it on top of the tool box upon removing. The employee jumped down off the pickup from the side of the bed and felt a sharp pain in his back when he landed.

Root causes identified by Division: Dismounting from the truck bed improperly

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

A storm came up this day and the worker's hurried to put equipment into the truck bed. The Employee involved in this incident had to work around a large amount of debris and equipment found in the bed of the truck. He figured that his best route was to go over the side of the truck rather than exiting through the tailgate. The sequence of events occurred as described in the above incident description.

#### Immediate causes and Shaping factors

Worker actions and behaviors / attitudes and motivation – dismounting from the side of the truck improperly led to great impact resulting in back pain. Should have followed appropriate exiting SOPs. He knew that the way he exited was inappropriate.

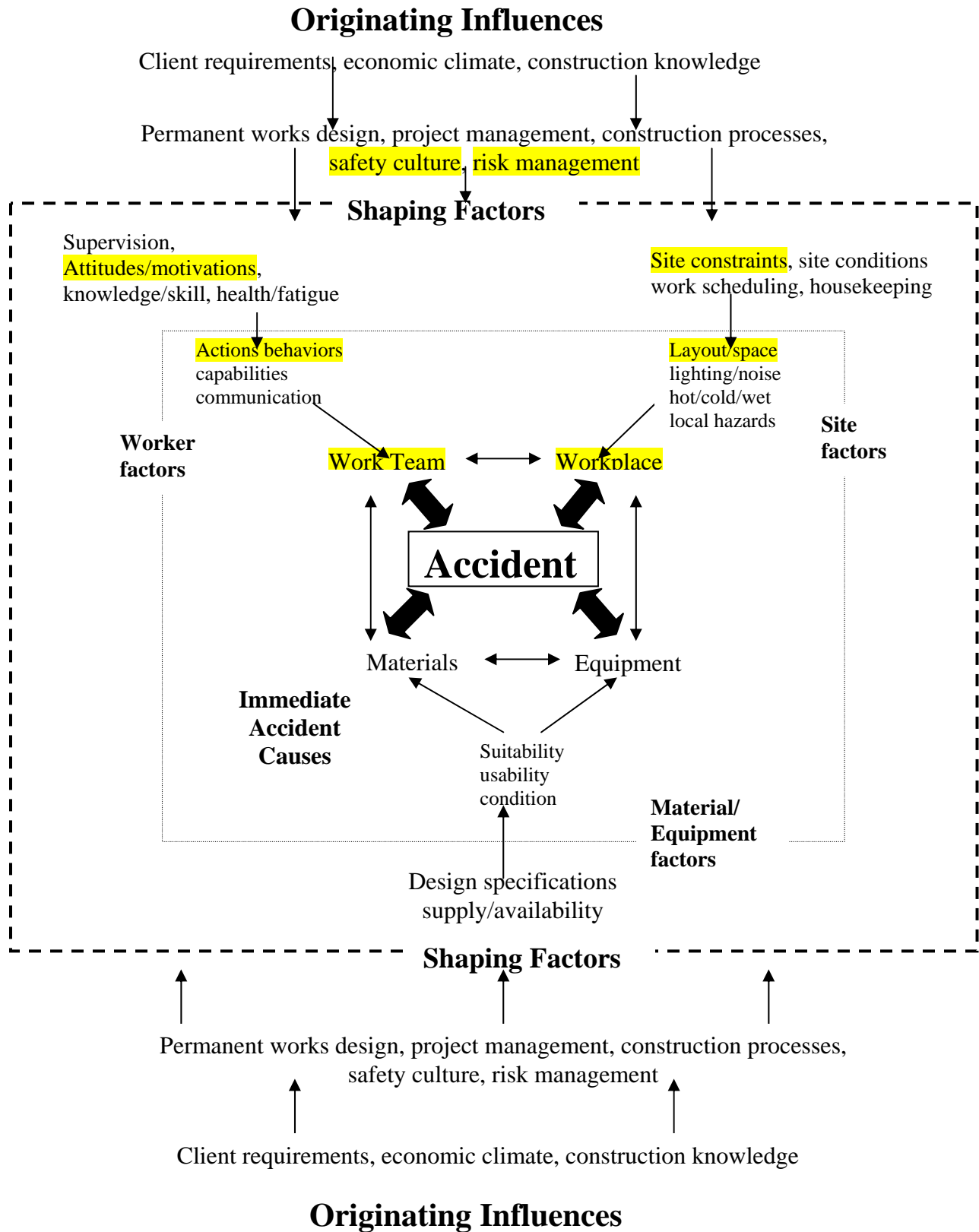
Site constraints/layout/space – the amount of debris in truck bed may have affected employee's judgment to exit the truck as he did.

#### Originating influences

Safety Culture – thinking the risk was acceptable and tolerated within the organization is indicative of a safety culture that allows this to occur. This is likely not isolated.

Risk Management – not identifying risks that would be present by exiting the vehicle in such a violent manner.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures	Dismounting should be done out of the back of the pickup based on current SOP's	Exit out the back of the truck
Training	Unaware if proper training took place with employee	Training on the SOP is recommended
Awareness	Worker was hurried.	He knew the way he exited was inappropriate
Audits		



18) EV2008045401 – Division 1, 10/16/08

Riskmaster description: Employee was repairing tire on boom tractor. While exiting rear of truck his foot slipped off bumper causing pain to his hip area.

Riskmaster cause code: Climbing or stepping up/down

Injury Code: Strain

Incident description (from the NC DOT forms): Employee was repairing a tire on a broom tractor at intersection of 903 and Grimes Road in Martin County. Employee was exiting rear of truck when his foot slipped off bumper. He hurt his hip.

Root causes identified by Division: Improper motivation (to save time); Inadequate engineering (inadequate consideration of human factors/ergonomics)

Were immediate causes and shaping factors identified by NCDOT? Yes

Were originating influences identified by NCDOT? Yes

### **ECU Investigation**

#### Immediate causes and Shaping factors

Worker factors / action / motivation – misstepping off truck

Site factors / wet conditions – Wet high grass, 12-18” grass, wetness on truck back bumper which is used as step (no other way to get on). Could the tailgate be used? It was agreed that this would be more difficult to access the truck.

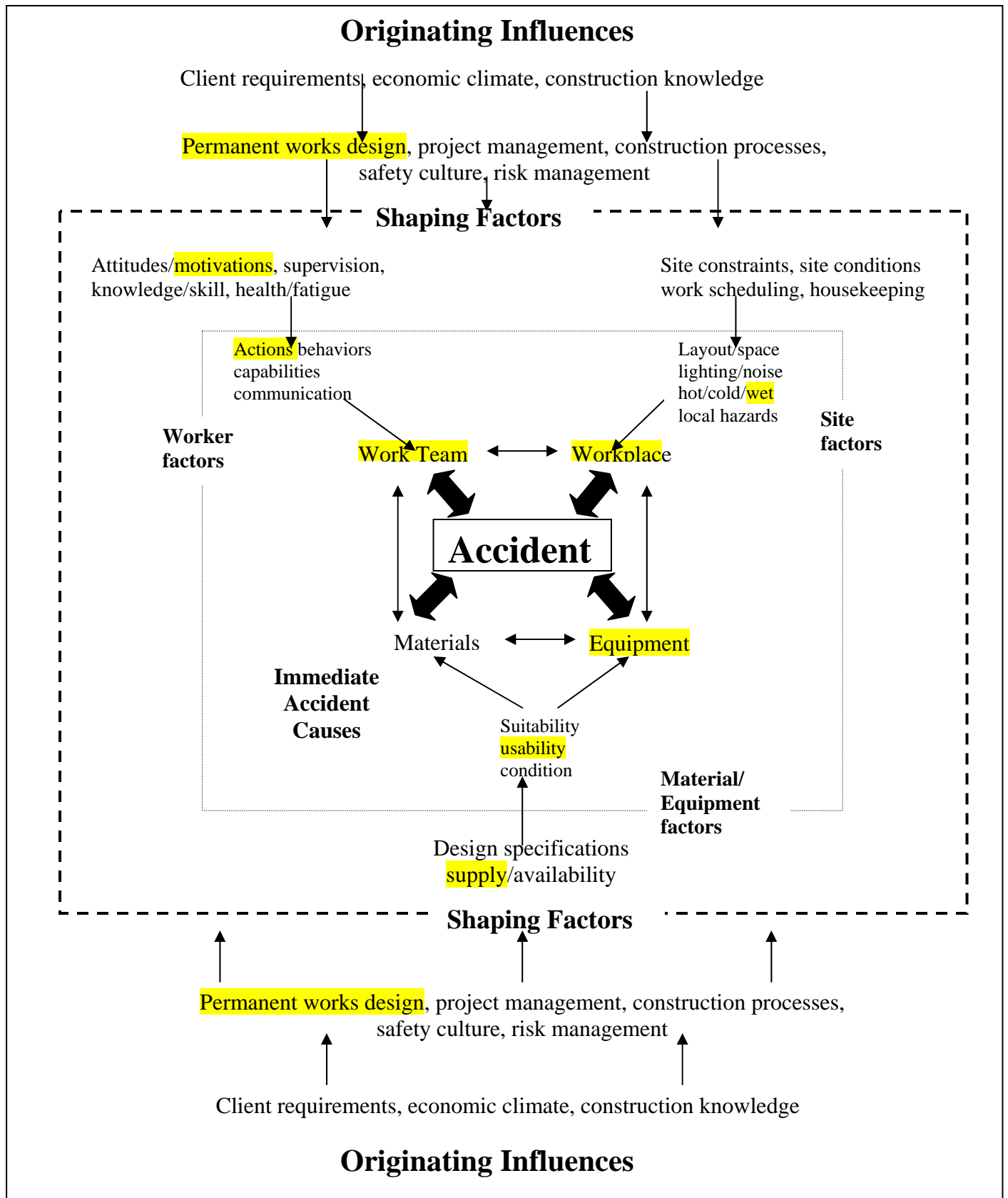
#### Originating influences

Usability of equipment / Permanent works design – Access controls for compressor are in such a position that you must access the back of the truck; suggestion to move the controls to allow safe access without accessing the truck. The area in the back of the truck is also used for tools storage. One root cause is poor design of truck rear access and this will continue to be a risk for tool access even if compressor is re-design.

Usability of equipment / supply of equipment – When new trucks are acquired, will safety and safe access be a consideration in the procurement process? The interviewees stated that the divisional engineers were looking for newer (2000 and later) trucks. It would be prudent to include safety in the procurement process.

Permanent works design –no handrails to allow for safe access and dismount from the truck.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures	Access controls are in poor position	Access controls for compressor are in such a position that you must access the back of the truck; suggestion to move the controls to allow safe access without accessing the truck.
Training		
Awareness		
Audits	Handrails for safe dismount	Handrails should be added to aid in preventing this type of event from occurring



19) EV2008045352, Division 1, 10/6/08

Riskmaster description: Employee was pulling fence wire that wrapped around mower when wire stuck into his left hand. Employee was wearing gloves but removed them.

Riskmaster cause code: Cut, puncture

Riskmaster nature code: Puncture

Incident description (from the NC DOT forms): Employee was pulling wire from the mower with the claw of a hammer. A wire broke loose from the mower and a piece of the wire that was stuck in the claw of the hammer pierced the employee's left hand. The employee had on gloves for a portion of the task but removed them during the time of the incident.

Root causes identified by Division: Failure to use PPE; Improper motivation (inadequate discipline)

Were immediate factors and shaping factors identified? Yes

Were originating influences identified? No

### **ECU Investigation**

#### Immediate and Shaping factors

Worker Action/behaviors – not wearing gloves; the use of gloves may have prevented the incident.

Attitudes/motivations - Should the employee have not used the claw of the hammer and waited until it could be welded away?

Suitability of materials / supply and availability – the gloves provided are standard \$2 gloves.

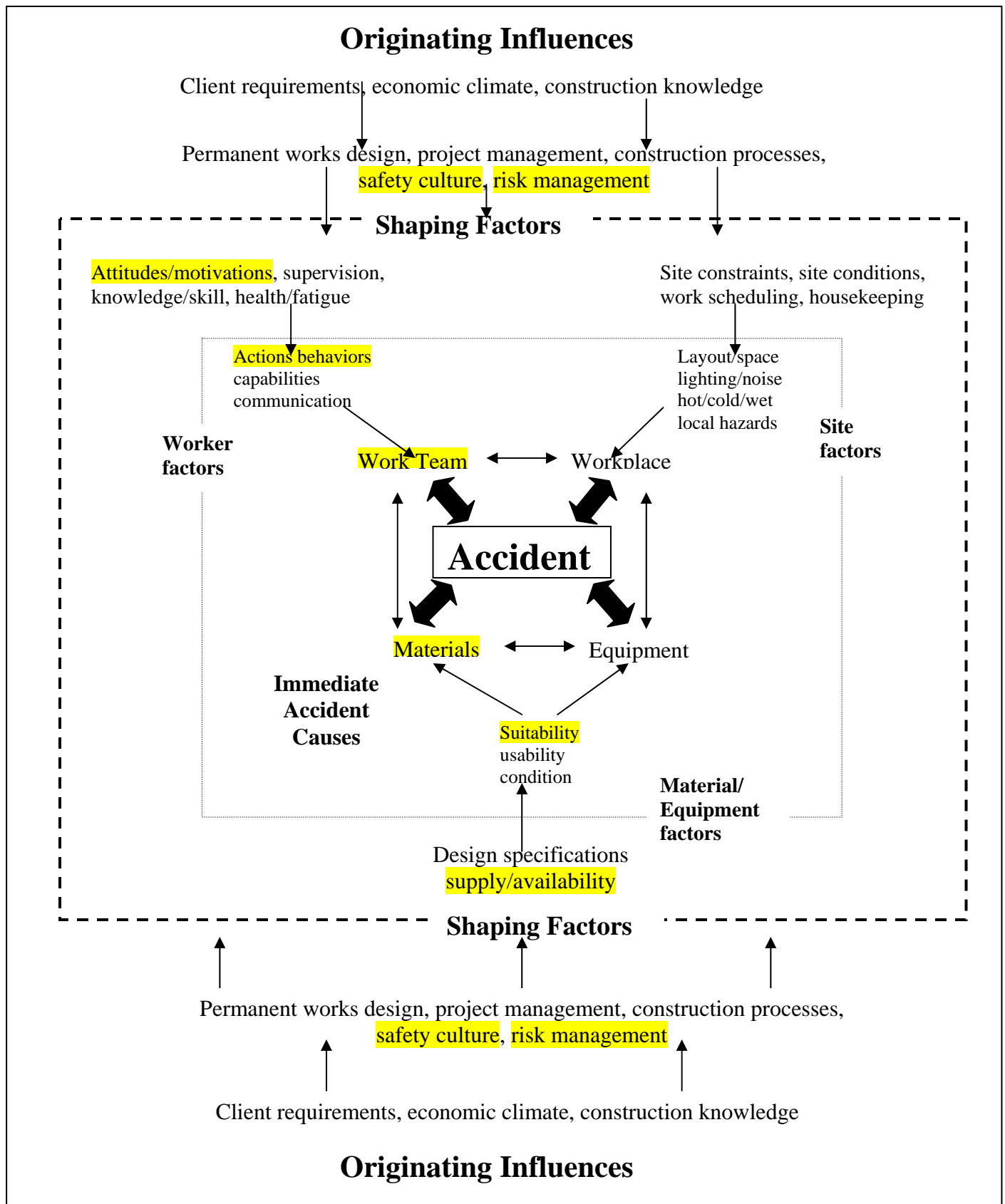
Should better or different gloves be provided?

#### Originating influences

Safety culture – Are suitable gloves provided, and when does employee feel comfortable or empowered making the decision to not continue with a non-routine task that is holding up a scheduled task like mowing.

Risk management – At what point is the risk that has been identified be deemed to be not acceptable?

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Supervisor and coworkers should have noticed unsafe condition	Discuss with employee that safety gloves should be used throughout the process
Policy and Procedures	Should better gloves be provided?	Evaluate glove policy in relation to the hazards and risks faced by employees
Training		
Awareness	Employee removed PPE intentionally during a process which required it	PPE should be used throughout the process
Audits		





20) EV2009046408 Division 3/23/09

Riskmaster description: Employee was traveling down Thurman Griffith road and he saw a dog in the road. The dog stayed in his lane and had to brake hard to avoid hitting the dog. He then slid the truck into the ditch hitting a tree.

Riskmaster cause code: Animal or insect

Riskmaster nature code: None listed (near miss)

Incident description (from the NC DOT forms): Employee attempted to avoid a dog in the road. He applied his brakes and the back tires locked causing him to lose control of his empty dump truck. He slid off the road and struck a tree.

Root causes identified by Division: Lack of experience and driving ability.

Were immediate factors and shaping factors identified? Yes

Were originating influences identified? No

### **ECU Investigation**

#### Immediate and Shaping factors

Worker Action/behaviors – employee should have stayed in the road, braking moderately to avoid the skidding, and should have hit the dog.

Worker capabilities / skills – limited large driving experience (about 3 years); employee did not want to hit the dog.

Local Hazard – dog.

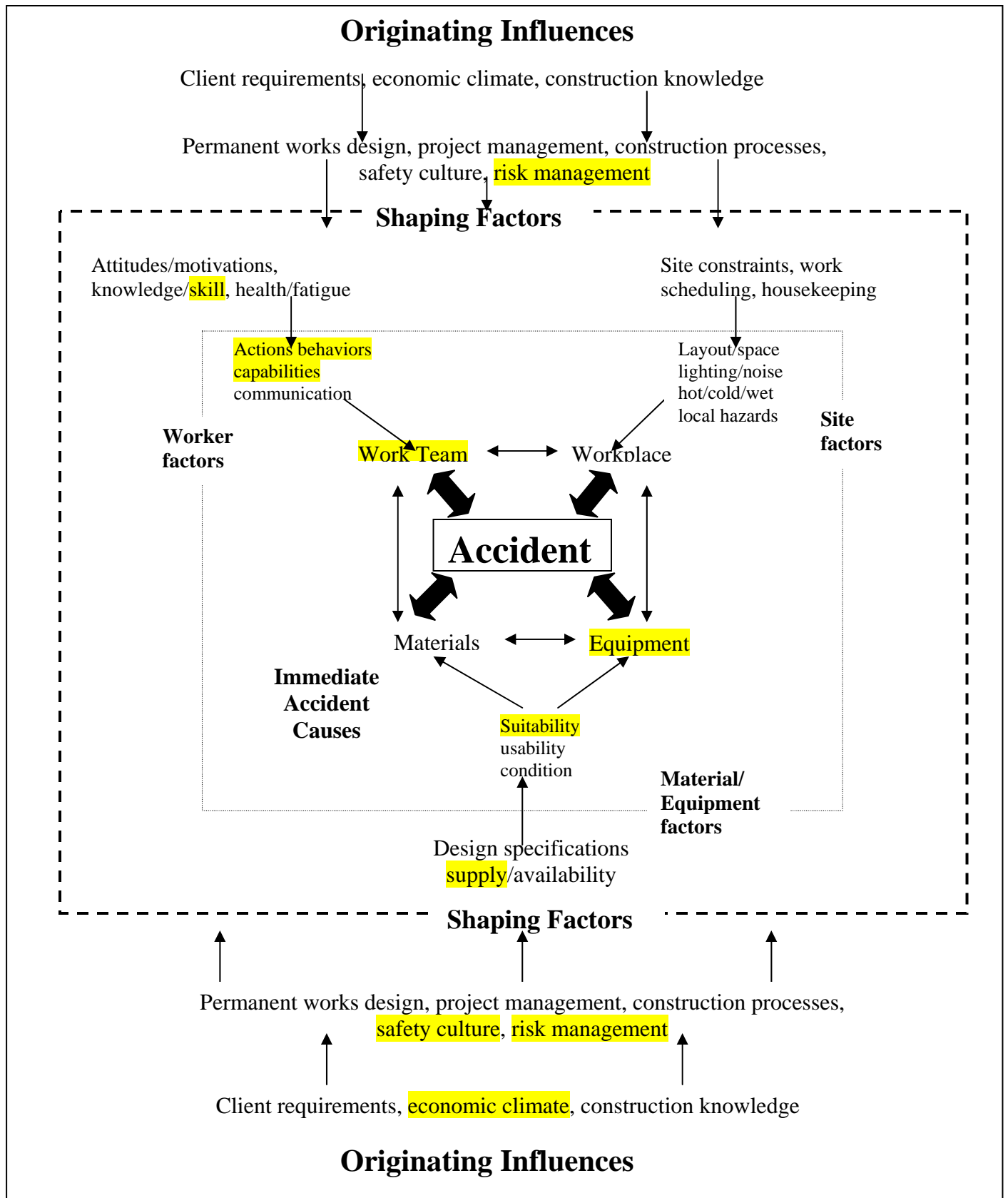
Suitability of and supply of equipment – the truck is past its service life; no ABS brakes. Was it suitable for the conditions of this incident given the workers capabilities and actions?

#### Originating influences

Safety culture – Is it acceptable to run a truck past its service life? What other risks does this pose in other situations?

Risk management – At what point is the risk identified (service life) to be not acceptable?

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures	Use defensive driving SOP's	Risk hitting the dog or swerve to avoid rather than slamming the brakes of a truck which does not have ABS features
Training	Limited experience driving large trucks	None
Awareness	Truck was past its service life	Use vehicles with ABS
Audits		



21) EV2009045900, Division 2, 1/12/09

**Riskmaster information does not match DOT paperwork for this event number.**

Incident description (from the NC DOT forms): Guardrail struck the employees right leg  
Root causes identified by Division: Guardrail was bent and under compression. A bolt that was holding the rail broke or pulled out releasing the rail. The rail popped out and hit employee's leg.

Were immediate causes and shaping factors identified by the NCDOT: No

Were originating influences identified by the NCDOT: No

### **ECU Investigation**

The process involved taking down a rail and putting it into a flatbed truck. They were working with inmates. The rail was kicked into the employee's direction by an inmate; it then struck the employees right leg. They had a meeting in the morning with the inmates to discuss the work. One suggestion by the supervisor was to chain the rail to a stationary object and to have better communication with the inmates regarding hazards.

#### Immediate causes and shaping factors

Communication – discuss hazards and work protocols thoroughly with inmates.

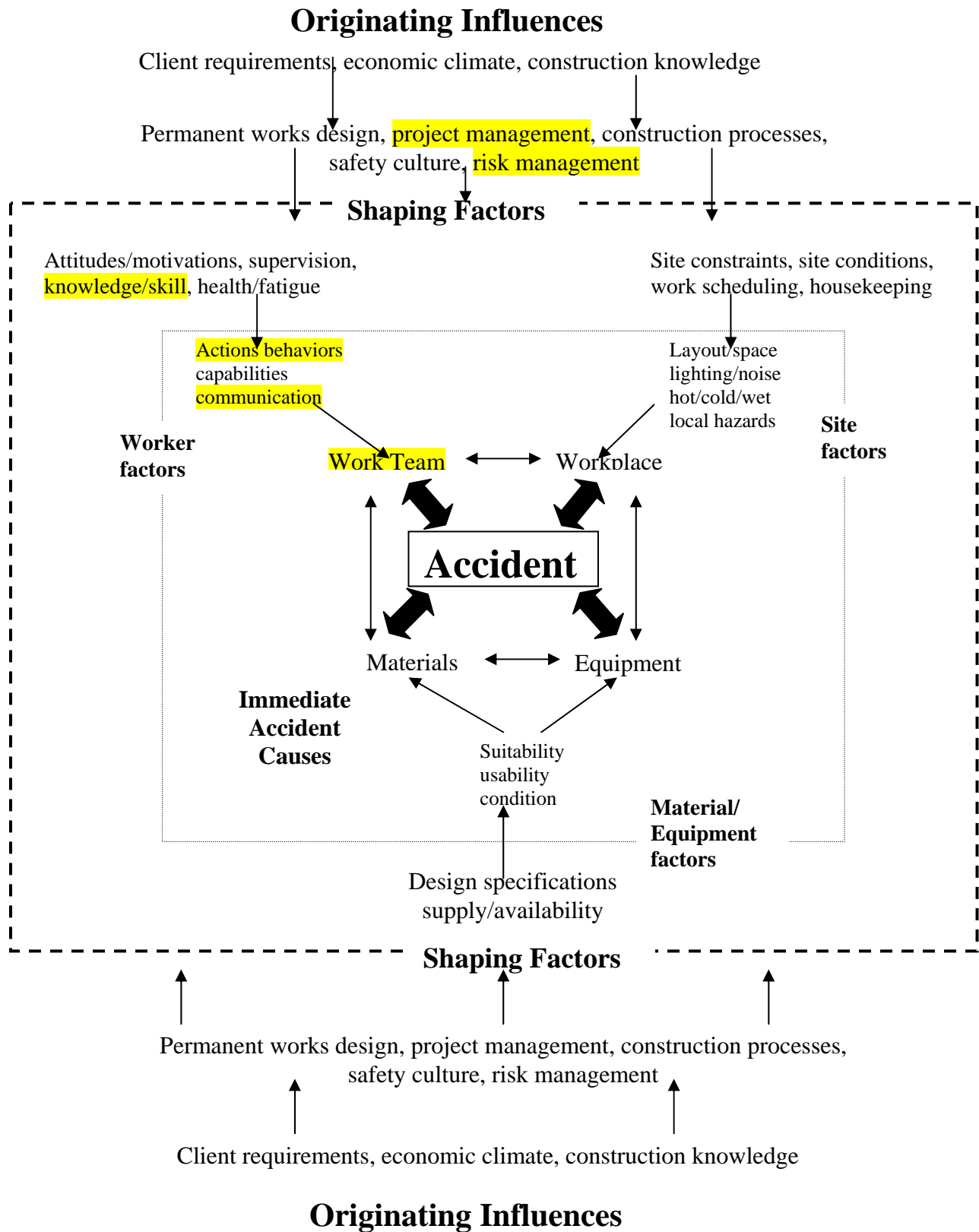
Actions / knowledge and skills – the actions of the inmates itself led to the event; the inmates were did not have appropriate knowledge and skills.

#### Originating influences

Project management – making sure that inmates were fully aware of the task and the hazards.

Risk management – was risk identified and proper measures taken to minimize such risk.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures		
Training	Inmates were not trained appropriately before the task	Train the inmates before the work process
Awareness	Inmates may not have been aware of the hazards posed by this type of operation	Explain all potential hazards and work practices necessary to avoid them
Audits		



22) EV2008045175, Ferry Division, 9/5/08

Riskmaster Description: Employee was trying to lift chain hoist when he felt pain in his right shoulder.

Riskmaster cause code: Object being lifted or handled

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): Crewmember injured shoulder while attempting to lift chain hoist

Root causes identified by Division: Solo attempt to manhandle hoist

Were immediate causes and shaping factors identified by the NCDOT: No

Were originating influences identified by the NCDOT: No

### **ECU Investigation**

The employee was told to take the hoist down off of the ferry. It weighs approximately 100lbs. This is not a one person task. The employee suggested to the superintendent that perhaps they should use the forklift. The superintendent declined on this idea and told the employee to get the job done or go home for the day. The employee noted that this is an entirely uncommon task to remove the hoist. The employee felt pain and decided to wait it out a few hours. He was out of work for 3 days. After this injury, they began to utilize the forklift rather than use manpower.

#### Immediate causes and shaping factors

Communication – not listening to others input considering they are the ones at risk

Capabilities – were any number of workers capable of doing this task safely with a minimal degree of risk

Supervision – not adequately supervised. Told employee to do the job or go home.

Knowledge/skills – unfamiliar task, unknowledgeable, did not have the skills to do this task

Attitudes/motivation – had no choice but to do the task or else be sent home

Local hazards – Slick/wet deck

Layout/space – many trip hazards faced when reaching over water to get hoist

Site constraints – minimal work area, limited range of motion

#### Originating influences

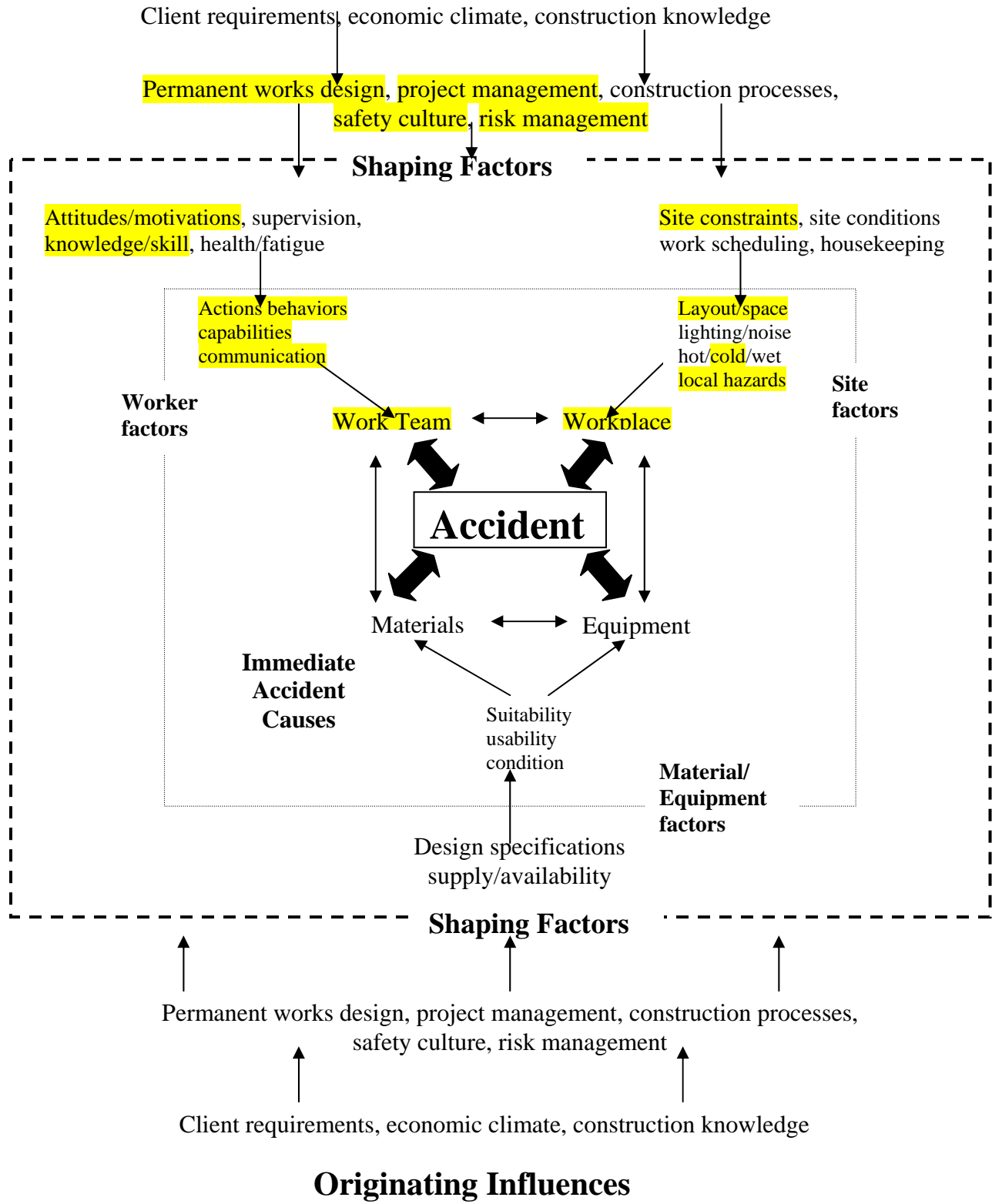
Project management – lacked management, especially considering it as being a new task

Safety culture – Instead of using available equipment (forklift) they used manpower to complete the task. Upon hesitation the employee was threatened to be sent home

Risk Management – Were the risks adequately identified and acceptable

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Supervisors/superintendent should take the lead regarding safe work practices	Consider others opinions on safety as if the risk were their own
Policy and Procedures	This was an unfamiliar task. A policy/procedure should be put in place for this specific task	Use available equipment rather than manpower
Training	This is an uncommon work practice, one should consider awareness instead of training	Train onsite or at the time of the event
Awareness	Be aware of hazards and consider safe implementation of operation	Listen to the employees concerns and allow them to come up with a best practice
Audits		

## Originating Influences



23) EV2008045399, Division 1, 5/8/08

Riskmaster description: Employee was attempting to break a caster adapter from the casing using a 36'' wrench with a 4'' cheater bar. Employee was standing on the wrench when it broke and snapped upward causing injury to the right foot.

Riskmaster cause code: Hand tool, utensil

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): Employee went to the worksite to remove a bent track guide on an excavator. The bolts were so tight that he put a 3' piece of pipe on his pull bar, laying down on his back, scotched his feet against the track for leverage, commenced to pull on the pipe and twisted his back.

Root causes identified by Division: Inadequate tools. Physical stress from constrained movement. Tools were available but were too large for this particular job

Were immediate causes and shaping factors identified by the NCDOT: No

Were originating influences identified by the NCDOT: No

### **ECU Investigation**

The bolts needed to be removed from underneath the excavator in order to fix the track guide. The employee lay under the machine, put pipe under to break the bolt loose. That action caused a twist in his back. Usually they would use an impact gun to break loose, but under conditions in the field they had to use manual labor to do the task. The supervisor stated that employees must purchase their own equipment and tools. This can become a problem when selecting the most suitable tool for the task.

#### Immediate causes and shaping factors

Actions – The action and decision itself led to the injury

Workplace layout/space and local hazards limited the ability to do the task appropriately

Site constraints – limited workspace.

Suitability of equipment – equipment was inadequate to do the job.

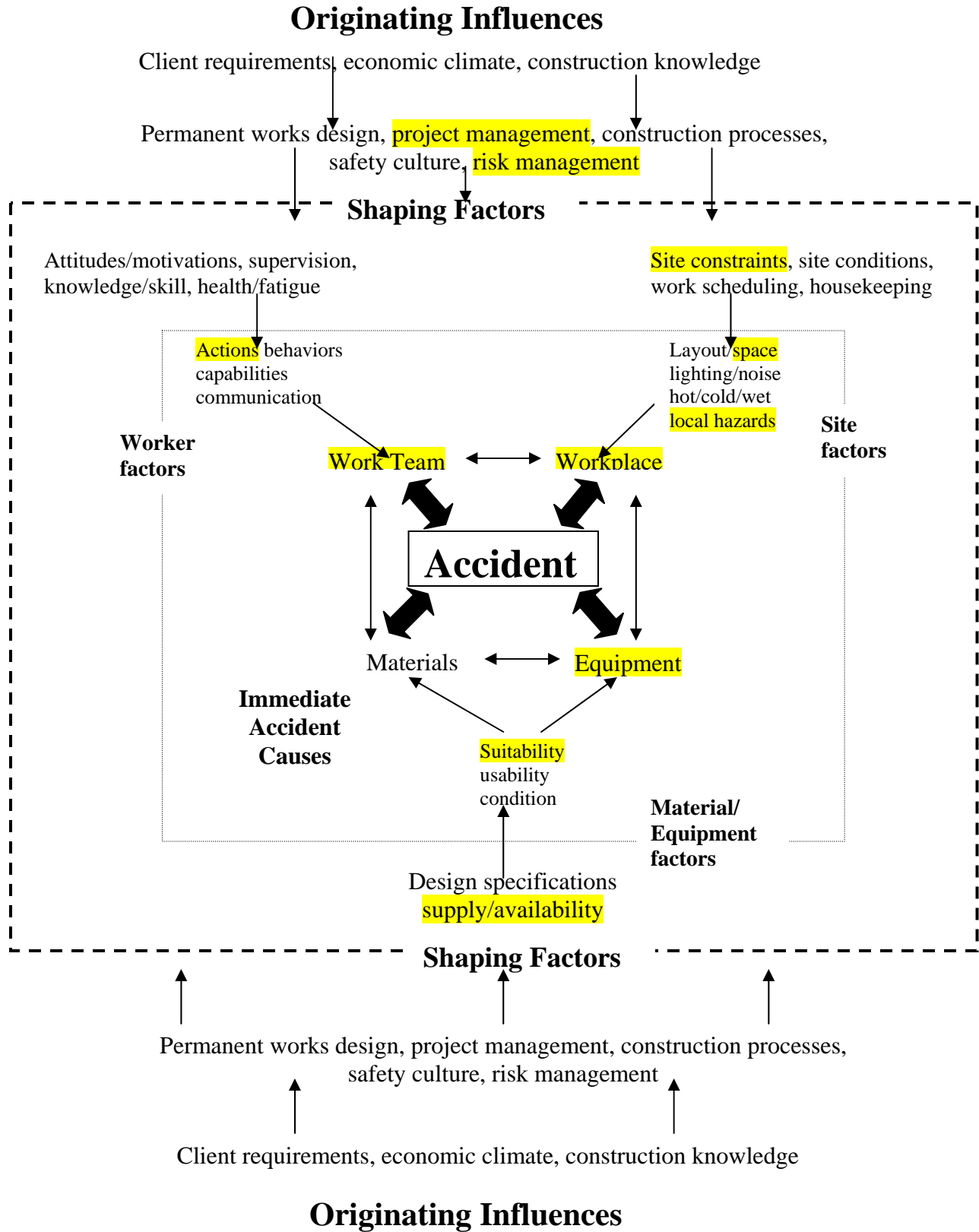
#### Originating influences

Project management – There was no management present to tell the maintenance crew how to best do the task.

Risk Management – were all risks identified and accepted as being reasonable



	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	The risks associated with tool procurement to employees are an organizational decision.	Evaluate tool policy.
Policy and Procedures	The best equipment should be provided by the NCDOT, rather than leaving it up to the employees to purchase equipment. They are likely to buy the cheapest equipment, or to make due with materials that are available	Purchase equipment to fit the employees needs
Training		
Awareness	Be aware of surroundings in such tight spaces	Find the best posture/stance when working in order to avoid awkward motion leading to injury
Audits		



24) EV2008045372, Division 1, 10/8/08

Riskmaster description: Employee was cutting cores on Roanoke Avenue with a coring machine when the coring machine bit seized in the hole causing the machine to rotate and strike him on the left knee. The impact lifted him off the ground. He landed on his buttocks.

Riskmaster cause code: Machine, Machinery

Riskmaster nature code: Contusion

Incident description (from the NC DOT forms): The employee was cutting cores on Roanoke Avenue with a coring machine, the coring bit seized in the hole causing the machine to rotate and strike him on the left knee. The impact lifted him up and threw him to the ground jarring his lower back and causing pain to his buttocks.

Root causes identified by Division: Lack of knowledge/skill. Inadequate orientation/initial training. Inadequate identification and evaluation of loss exposure.

Were immediate causes and shaping factors identified by the NCDOT: Yes

Were originating influences identified by the NCDOT: Yes

### **ECU Investigation**

The employee was using a coring machine. He was unfamiliar with this type of work. The core sample would be used to determine the condition of the road. No one in their department was familiar with the task. The supervisor told the employee that the task would be a “no brainer” and would be able to figure it out.

#### Immediate causes and shaping factors

Capabilities – The employee was not capable due to a lack of training.

Communication – no communication or procedures to follow. Had to figure out the work on his own without training.

Knowledge/skills – unknowledgeable about the task and had no skills in this area.

Supervision – told employee it was easy and he should figure it out.

#### Originating influences

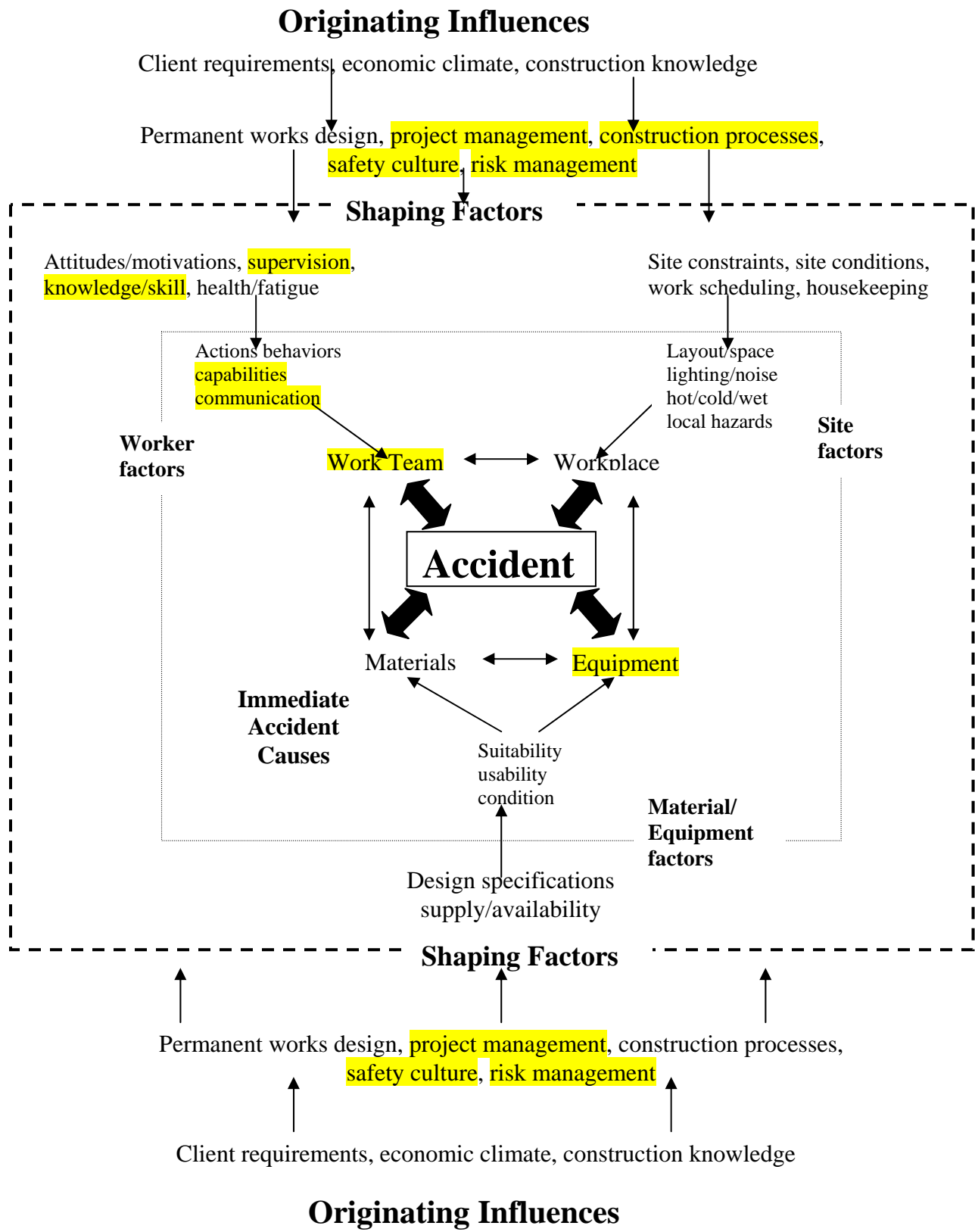
Project management – lacked supervision and proper training.

Construction processes – absence of method statement or verbal instructions.

Safety culture – the assumption that employees now what to do and how to do the job safely contributed to this incident.

Risk management – Risks were not identified and properly managed through proper training.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Supervisors should not assume employee can simply figure out the task without training	Train the employee on use of equipment
Policy and Procedures	Do not assume that the task the employee must complete is “self-explanatory”	Train the employee on use of equipment
Training	Training was not conducted on how to use the coring machine	Train the employee on the use of equipment
Awareness		
Audits		



25) EV2008044600, Division 6

Riskmaster description: Employee was helping another employee cut a 4x8 piece of plywood when, his side slipped, he tried to catch it, and felt pain in his left shoulder.

Riskmaster cause code: Hand tool of machine in use

Riskmaster Nature Code: Strain

Incident description (from the NC DOT forms): Employee and supervisor were cutting 4'x8' plywood. After trimming one side, they started to turn the plywood when the employee's side slipped. He tried to catch it with his left hand. He felt a pull and a pain in his left shoulder.

Root causes identified by Division: Move the saw about 1 foot to allow for more room for the person feeding plywood.

Were immediate causes and shaping factors identified by NCDOT? Yes

Were originating influences identified by NCDOT? Yes.

### **ECU Investigation**

They had already cut the board to 8'x34" and were placing it up to cut the other way. The board hit the rip fence handle and it jarred the board and the employee went to catch it and pull it up. His shoulder popped and then knotted up. This is a job shop where many wood fixtures are built (i.e., someone wants a cabinet or a drawing holder, and they build it)

#### Immediate causes and Shaping factors

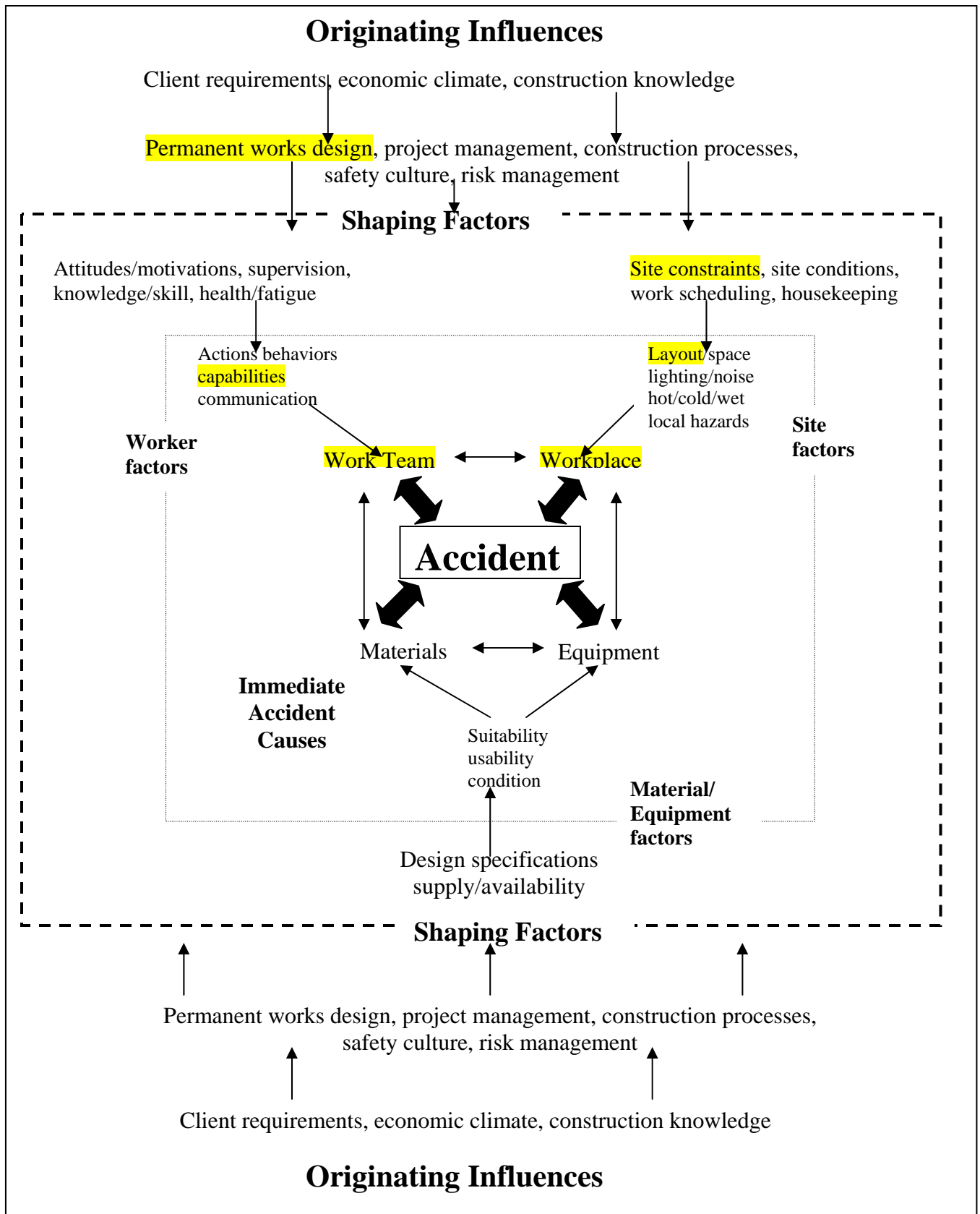
Worker factors / capabilities – moving these large pieces, it was inevitable that some incident would have happened eventually, given the work place constraints.

Workplace / layout / site constraints – The space is a bit cramped for the movement of larger pieces.

#### Originating influences

Permanent works design – could the room be better designed? Probably. Could the work flow table be shifted to better enable moving (sliding) of materials rather than lifting them and pacing them? Probably.

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership		
Policy and Procedures	Moving large wood pieces	Eliminate workplace constraints
Training		
Awareness	Small space to do large job	Consider moving to a larger location or free up some space
Audits	An audit of the room would have brought the tight space to the attention of management in a more formal fashion.	Consider audit program for facilities that includes space issues.



26) EV2008045211, Division 6, 6/5/2008

Riskmaster description: Employee was holding bent sign post for backhoe to grab with back jaw bucket as backhoe grabbed the bent post, it twist hitting employee in head and arm. Employee was knocked to ground.

Riskmaster cause code: Hand tool or machine in use

Riskmaster nature code: Sprain

Incident description (from the NC DOT forms): Backhoe crew was removing debris from a large pipe on SR 1841. The crew was attempting to remove blockage from pipe with several sign posts that had been bolted together. When this method failed another method was used to remove the blockage. The sign posts could not be taken apart with a wrench because the blots had been bent while attempting to remove the blockage. The assembled post was too long to transport back to camp. Therefore, the backhoe was used to break the posts apart. The sign post had been bent during use. Employee was holding the bent sigh post for the backhoe to grab with the back jaw bucket. As the backhoe grabbed the bent post, it twisted hitting the employee in his left arm and side of head, causing the employee to flip and fall to the ground.

Root causes identified by Division: Employee should have left the back hoe jaw bucket grab the post off the ground instead of employee holding the post. Employee was standing to close to work area while equipment was in operation. Follow SOP 12A-22-9. Operator should be aware of employees and others on foot in work zones and be sure area is clear of personnel before lowering stabilizers or moving the boom. The ground man (injured employee) was counseled on paying attention to surroundings and staying clear of operating range of equipment.

Were immediate causes and shaping factors identified by NCDOT? Yes

Were originating influences identified by NCDOT? No

### **ECU Investigation**

This accident was very complicated. The home owner called NCDOT that the pipe was blocked. This could be a potential emergency situation for the public as rains had come and were forecasted and the State Road could have become flooded due to the blocked pipe. Management scoped the job and it was scheduled for the next day. A 30 gallon PVC drum was stuck in the pipe. Four sign posts were bolted together to act as a battering ram to jar the PVC drum loose from the pipe or damage it enough so that the water could drain. The backhoe holds the sign posts at one end and rams it into the blockage. The crew stated that they like to use a tree as the ram and would have in this instance but there were no trees in close proximity of the driveway. This is very normal procedure to use the sign posts and trees. They got the job done and were rushing to get cleaned up so they could get the inmates helping them back for the day. This is when the two of sign posts could not be separated because they were damaged, so the crew decided to break them using the backhoe, and when the employee decided to hold the sign posts for the backhoe. They needed to separate the posts or break them so they could haul them back to camp in the pick-up truck, as they would not fit bolted together.

The supervisor revealed that the PVC drum was stuck because the pipe got smaller as there was an addition on to this pipe that was not added on by NCDOT. The driveway was modified and a

contractor added smaller pipe on to the existing pipe originally installed by NCDOT. This enabled the blockage.

#### Immediate causes and Shaping factors

Worker factors / actions/behaviors – Employee was in the danger zone of the backhoe.

Worker factors / communication – poor communication between employee and backhoe operator

Workplace / layout / site constraints – the pipe was 30' long and the drum was stuck at the end so they had to un-jam this from a distance of close to 30'.

Workplace / local hazards / work scheduling – they had to get this job done or there was a potential public hazard due to the road flooding with the forecasted rains.

Equipment / Suitability and usability / supply/availability – is bolting sign posts together a suitable work method? Is there a better work method with better materials to do the job?

#### Originating influences

Construction processes - There is a Jet Rodder (a machine designed to remove grease and debris from the smaller-diameter sewer pipes with high-velocity jets of water. Also called a high-pressure cleaner, hydraulic cleaner, hydro jet, jet cleaner, or jet rodder), but it is expensive. They think another Division has one. They could rent one but it is \$275 per hour and they are not always available.

Project management (work scheduling) - they had to get this job done or there was a potential public hazard due to the road flooding with the forecasted rains. Should then project have been managed more thoroughly given the constraints?

Project Management (equipment) - is bolting sign posts together a suitable work method? Is there a better work method with better materials to do the job? Could this have been managed better to reduce risk?

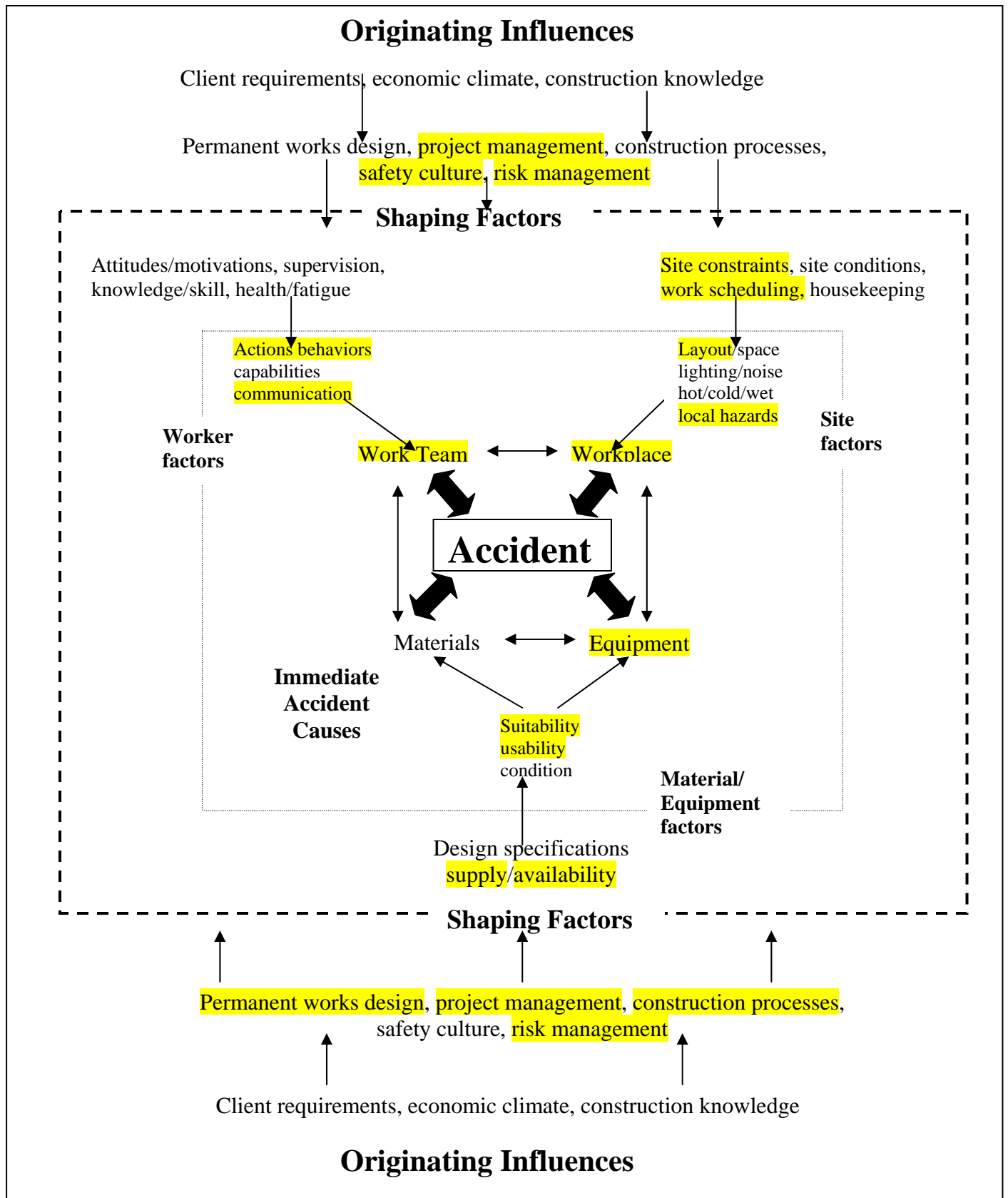
Permanent works design – The re-design addition of the smaller pipe was something that NCDOT could not control.

Safety culture – could safety have been considered more thoroughly in the planning phase of this task?

Risk management - were recognizable hazards and risks properly anticipated and identified in terms of the methods to open the clog in the pipe?

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Better project management given time constraints	Plan such that rushing can be avoided
Policy and Procedures	Poor communication between employee and backhoe operator	Increase communication
Training		
Awareness	Employee was in danger zone of backhoe	Stay outside danger zone
Audits		





27) EV2008043791, DMV, 1/8/08

Riskmaster description: Employee was lifting file storage boxes for retention to supply room when, she felt pain in her back

Riskmaster cause code: Lifting

Riskmaster nature code: Strain

Incident description (from the NC DOT forms): While packing and moving end of year notice and storage file boxes, employee strained back

Root causes identified by Division: Lifting and moving file boxes

Were immediate causes and shaping factors identified by NCDOT? No

Were originating influences identified by NCDOT? No

### **ECU Investigation**

This process is performed annually. Boxes weigh between 35-40lbs. They had to move approximately 250 boxes on this day between 5 employees. About midway through the process she hurt her back. The pain increased while working. Employee mentioned that no back braces were provided and were not advised in proper lifting techniques.

#### Immediate causes and Shaping factors

Worker capabilities – was she capable of such physically exerting tasks?

Immediate supervision – none provided

Local hazards – many objects and areas that require extensive maneuvering

Site constraints/layout/space – extensive maneuvering of heavy boxes (maze-like)

Working conditions – poor lighting

#### Originating influences

Project management – lack of oversight during this process

Risk management – was all risk identified and handled appropriately

	<b>How the component was related to the incident</b>	<b>Corrective action to remedy</b>
Leadership	Management should set aside more time to complete this job so that it does not cause so much fatigue on the employees behalf	Spread the heavy work out over more days
Policy and Procedures		
Training	Proper training on this type of work has not be done with employees	Training on proper lifting techniques should be considered
Awareness		
Audits		

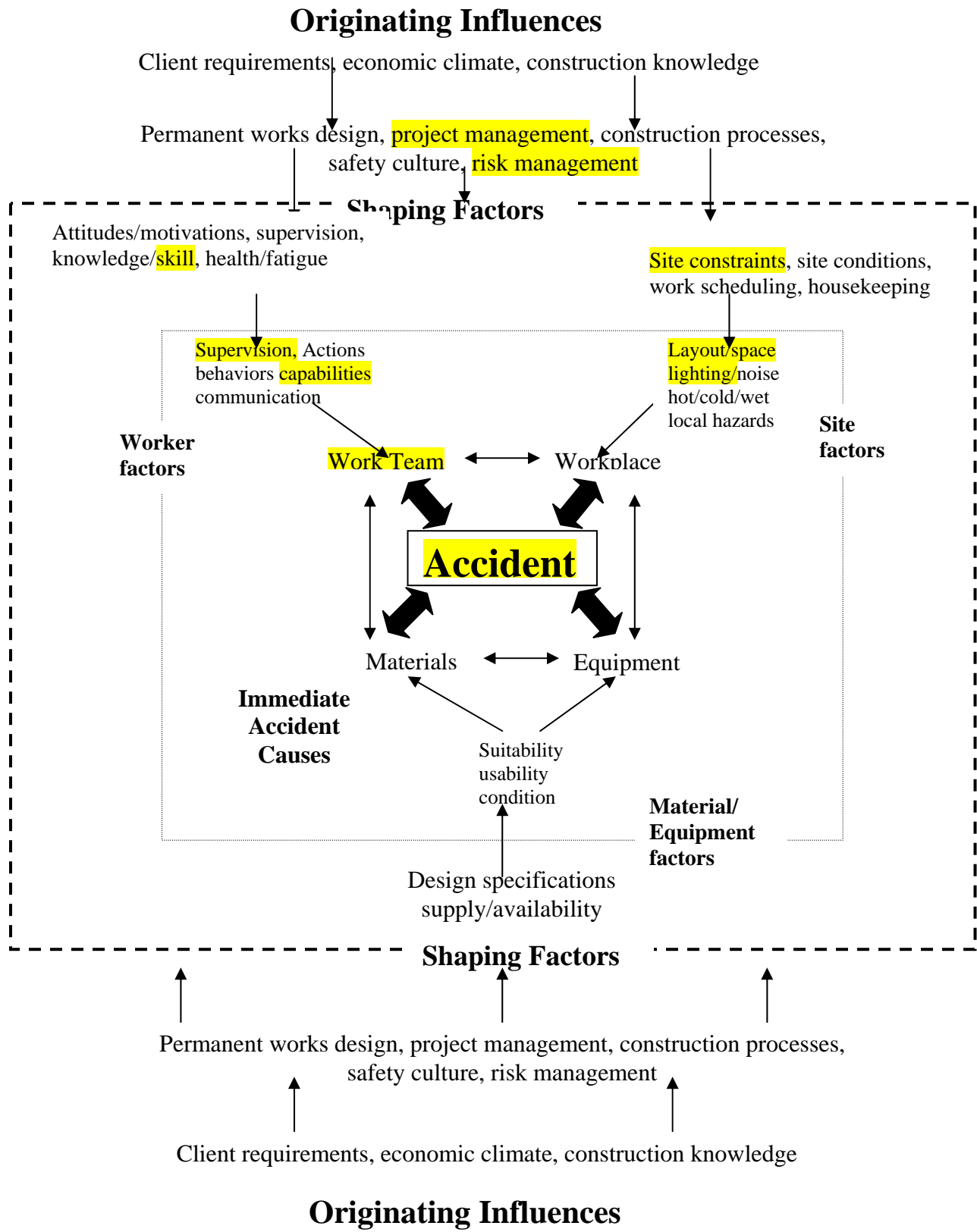


Table 6: Summary of findings using Gibb-Haslam model of the 27 selected incidents

ECU ID#	Event #	Division	worker actions and behaviors	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	local hazards	site conditions (excluding equipment, materials, weather)	site constraints, layout/space	working environment (lighting/noise/hot/cold/wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management
1	EV2008045071	2		✓				✓		✓	✓						✓	✓	✓			✓	✓	✓
2	EV2008045326	2	✓		✓	✓		✓		✓							✓			✓	✓	✓	✓	✓
3	EV2008044843	5	✓		✓	✓															✓		✓	✓
4	EV2008044013	5	✓					✓		✓														
5	EV2008043797	5		✓				✓															✓	✓
6	EV2008045498	2	✓	✓														✓					✓	✓
7	EV2008045545	2	✓	✓	✓		✓											✓	✓					✓
8	EV2008044859	3		✓		✓		✓		✓										✓	✓			
9	EV2008043985	5	✓	✓															✓	✓			✓	✓
10	EV2008044220	DMV		✓			✓																	
11	EV2008044253	5						✓		✓														
12	EV2008045001	4		✓													✓	✓		✓			✓	✓
13	EV2008044699	3	✓					✓	✓				✓							✓	✓			
14	EV2008044099	4	✓					✓		✓											✓		✓	✓
15	EV2008044563	5						✓	✓		✓													
16	EV2008044573	4		✓				✓	✓		✓												✓	✓
17	EV2008045176	3	✓							✓													✓	✓
18	EV2008045401	1	✓								✓							✓		✓				
19	EV2008045352	1	✓											✓									✓	✓
20	EV2009046408	1	✓	✓				✓									✓						✓	✓

ECU ID#	Event #	Division	worker actions and behaviors	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	local hazards	site conditions (excluding equipment, materials, weather)	site constraints, layout/space	working environment (lighting/noise/hot/cold/wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management
21	EV2009045900	2	✓	✓	✓																✓			✓
22	EV2008045175	Ferry	✓	✓	✓	✓		✓		✓	✓										✓		✓	✓
23	EV2008045399	1	✓					✓		✓							✓				✓			✓
24	EV2008045372	1		✓	✓	✓															✓	✓	✓	✓
25	EV2008044600	6		✓						✓										✓				
26	EV2008045211	6	✓	✓	✓	✓	✓	✓	✓	✓		✓					✓	✓		✓	✓	✓	✓	✓
27	EV2008043791	DMV		✓		✓	✓			✓	✓										✓			✓
	TOTALS		16	16	7	7	4	14	4	12	6	1	1	1	0	0	6	6	3	8	11	4	15	19

Table 4: Summary of findings using NC DOT SHMS model of the 27 selected incidents

ECU ID#	Event #	Division	Leadership	Policies and procedures	Training	Awareness	Audits
1	EV2008045071	2	✓	✓	✓	✓	✓
2	EV2008045326	2	✓	✓		✓	
3	EV2008044843	5	✓	✓	✓	✓	
4	EV2008044013	5		✓		✓	
5	EV2008043797	5	✓	✓	✓	✓	
6	EV2008045498	2	✓	✓		✓	
7	EV2008045545	2	✓	✓		✓	
8	EV2008044859	3	✓	✓			
9	EV2008043985	5	✓	✓		✓	
10	EV2008044220	DMV				✓	
11	EV2008044253	5		✓			
12	EV2008045001	4	✓			✓	✓
13	EV2008044699	3				✓	
14	EV2008044099	4	✓	✓	✓		
15	EV2008044563	5		✓		✓	
16	EV2008044573	4	✓	✓		✓	
17	EV2008045176	3		✓	✓	✓	
18	EV2008045401	1		✓			✓
19	EV2008045352	1	✓	✓		✓	
20	EV2009046408	1		✓	✓	✓	
21	EV2009045900	2			✓	✓	
22	EV2008045175	Ferry	✓	✓	✓	✓	
23	EV2008045399	1	✓	✓		✓	
24	EV2008045372	1	✓	✓	✓		
25	EV2008044600	6		✓		✓	✓
26	EV2008045211	6	✓	✓		✓	
27	EV2008043791	DMV	✓		✓		
	TOTALS →	→	17	22	10	21	4

## Model Verification Summaries

After completion of the original twenty-seven incident investigations, two incidents were investigated without the aid of any previous information. The purpose of this exercise was to test the Gibb-Haslam model in a more realistic scenario. For these investigations we also used a new form that we have developed for NC DOT's consideration. Although the form will be introduced in a later section, it is used here for demonstration purposes. These vignettes are below.

### Incident 1

An employee was using a planting auger (10.2" diameter) to dig holes to put sign posts near some reinforced stationary (trees) so that the mowers wouldn't mow over the trees. The holes were dug every 100' and the signs were placed in the holes and covered. It was the end of the day on Thursday. The employee was digging the last hole for the day when the auger hit a rock. The employee was leaning on the auger, and admittedly said that she should not have done that, as she was digging in hard clay. See picture below.



The auger pulled her and the handle/switch hit her mouth and made a large gash. The brake handle hit her leg and shut off the auger or it could have been worse. Since the accident they now do not use the auger, they use a manual post hole driver. This is heavier and it takes longer. See picture below. We question whether this has introduced new and possible larger risks than using the auger. The manual digger poses ergonomic issues. There are different auger bits per the



manufacturers manual, which we evaluated during the investigation. There are smaller earth augers available in small sizes which would be appropriate for signs. The auger diameters available are 1.6, 2.4, 3.5, 4.7, 5.9, and 7.9 inches.



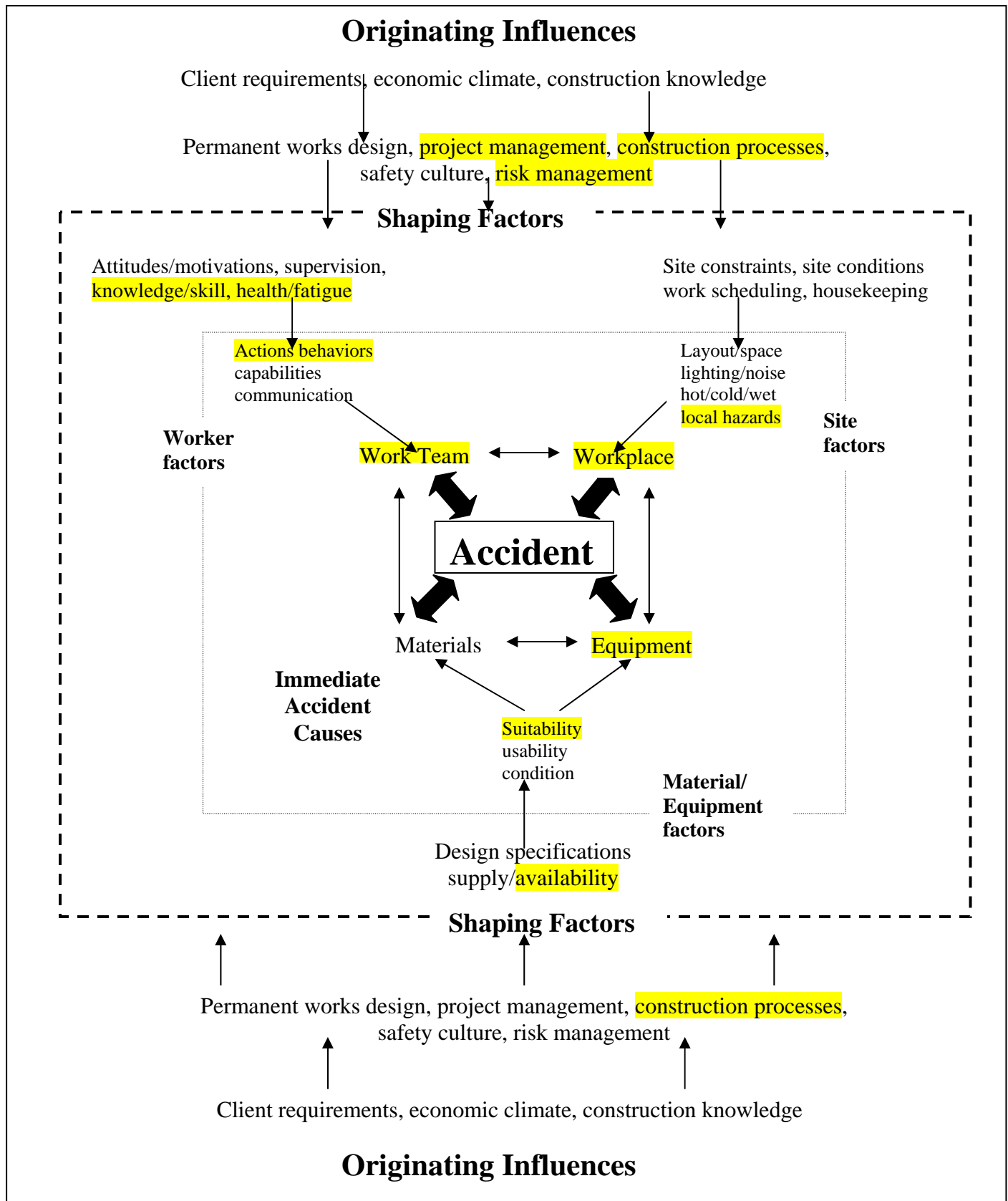


## Accident Investigation Model Documentation Form – Auger Incident

	Factor/Influence	How linked to accident	Ways to reduce risk
<input checked="" type="checkbox"/>	Work Team		
	<input checked="" type="checkbox"/> Actions / behaviors	Leaning on the auger	Use proper technique
	<input type="checkbox"/> Attitudes / motivations		
	<input type="checkbox"/> Communication		
	<input type="checkbox"/> Supervision		
	<input checked="" type="checkbox"/> Knowledge/skill	Always used that auger	Read user's manual
	<input checked="" type="checkbox"/> Health/fatigue	Last dig for the day; dug 100 post holes in that day	Teams of 2; vary tasks
	<input type="checkbox"/> Permanent works design		
	<input checked="" type="checkbox"/> Project Management	Could the project have been planned better with team and tools?	Purchase correct auger bit
	<input checked="" type="checkbox"/> Construction Processes	Improper auger	Purchase correct auger bit
	<input type="checkbox"/> Safety Culture		
	<input checked="" type="checkbox"/> Risk Management	Risk of improper auger not identified Manual digger - more risk?	Read manual. Conduct ergonomic assessment on manual digger
<input checked="" type="checkbox"/>	Workplace		
	<input type="checkbox"/> Layout, space, env. factor		
	<input checked="" type="checkbox"/> Local hazards	Hard clay, hit rock	Proper auger
	<input type="checkbox"/> Site constraints		
	<input type="checkbox"/> Site conditions		

<input type="checkbox"/>	Work Scheduling		
<input type="checkbox"/>	Housekeeping		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		
<input checked="" type="checkbox"/>	Equipment		
<input checked="" type="checkbox"/>	Suitability	The auger was not suitable for the task	Buy appropriate auger
<input type="checkbox"/>	Usability		
<input type="checkbox"/>	Condition		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		

<input checked="" type="checkbox"/>	Construction Processes	Improper auger	Purchase correct auger bit
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		
<input type="checkbox"/>	Materials		
<input type="checkbox"/>	Suitability		
<input type="checkbox"/>	Usability		
<input type="checkbox"/>	Condition		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		



### Incident 2

Employee was using pipe hook to unload pie from the trailer. There were only three pipes left. The employee was trying to insert the pipe hook when the hydraulics of the excavator surged and jerked the pipe and caught his hand. See picture of handling pipe.



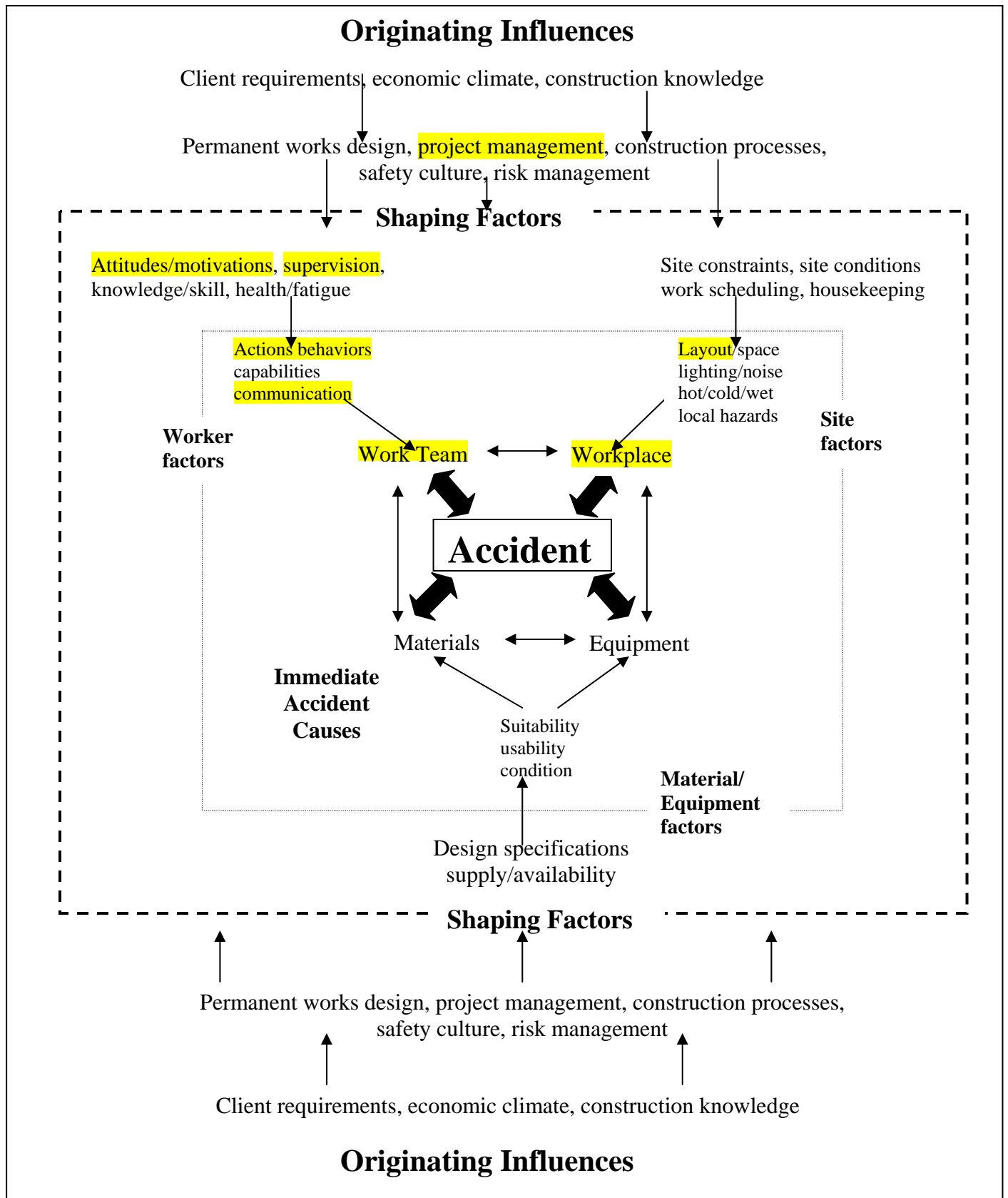
There was questioning of why the operator had set-up the excavator in the manner he did. See picture on next page. He should have moved to the side of the truck to get these pipes from the back off. There was room as the road was closed. There were numerous questionable acts by the excavator operator. This was his third accident. He was dismissed after this incident. The supervisors did not believe that the excavator jerked all by itself and believe the operator was trying to adjust the pipe lifter and that is how the handler's hand got caught.

During the interviews with the TS-III and the County maintenance Engineer, interesting organizational factors were discussed. They seem to believe that the TS-I's are not comfortable with enforcing rules because their work crew members are their friends and they don't want to interrupt that friendship now that they got promoted. Additionally, their knowledge of safe procedures may not be adequate. They discussed the NC DOT Supervisor's Academy of which safety was a part. They would like to see all the TS I, II, and III's go through the Academy sooner and have safety management be a bigger part. The CME did not have any safety management in his undergraduate program.



## Accident Investigation Model Documentation Form – Pipe handling

	Factor/Influence	How linked to accident	Ways to reduce risk
<input checked="" type="checkbox"/>	Work Team		
	<input checked="" type="checkbox"/> Actions / behaviors	Excavator operator actions	He was dismissed.
	<input checked="" type="checkbox"/> Attitudes / motivations	Safety not part of the motivation of the operator and team	Better coaching and pre-task planning
	<input checked="" type="checkbox"/> Communication	Breakdown with operator and supervisor in planning and operator and employee who got hurt	Better planning of the job
	<input checked="" type="checkbox"/> Supervision	Supervisor appeared to have known better way to do position excavator.	Better planning of the job
	<input type="checkbox"/> Knowledge/skill		
	<input type="checkbox"/> Health/fatigue		
	<input type="checkbox"/> Permanent works design		
	<input type="checkbox"/> Project Management		
	<input type="checkbox"/> Construction Processes		
	<input type="checkbox"/> Safety Culture		
	<input type="checkbox"/> Risk Management		
<input checked="" type="checkbox"/>	Workplace		
	<input checked="" type="checkbox"/> Layout, space, env. factor	The position of the excavator	Position at side of truck to get the pipes off.
	<input type="checkbox"/> Local hazards		
	<input type="checkbox"/> Site constraints		
	<input type="checkbox"/> Site conditions		
	<input type="checkbox"/> Work Scheduling		
	<input type="checkbox"/> Housekeeping		
	<input type="checkbox"/> Permanent works design		
	<input checked="" type="checkbox"/> Project Management	Seems the project was not planned and performed with safety in mind.	Pre-task planning should include safety and correct way to get the tasks completed.
	<input type="checkbox"/> Construction Processes		
	<input type="checkbox"/> Safety Culture		
	<input type="checkbox"/> Risk Management		
<input type="checkbox"/>	Equipment		
	<input type="checkbox"/> Suitability		
	<input type="checkbox"/> Usability		
	<input type="checkbox"/> Condition		
	<input type="checkbox"/> Permanent works design		
	<input type="checkbox"/> Project Management		
	<input type="checkbox"/> Construction Processes		
	<input type="checkbox"/> Safety Culture		
	<input type="checkbox"/> Risk Management		
<input type="checkbox"/>	Materials		
	<input type="checkbox"/> Suitability		
	<input type="checkbox"/> Usability		
	<input type="checkbox"/> Condition		
	<input type="checkbox"/> Permanent works design		
	<input type="checkbox"/> Project Management		
	<input type="checkbox"/> Construction Processes		
	<input type="checkbox"/> Safety Culture		
	<input type="checkbox"/> Risk Management		





## **DISCUSSION**

The Gibb-Haslam model is designed to diagnose incident causation by looking beyond the immediate causes of the accidents. As stated in the project proposal, many investigations focus only on immediate causes, acts and conditions. We believed the NC DOT may not have been looking for latent causes (as dubbed by Reason), or originating influences (as dubbed by Gibb and Haslam). Therefore, we analyzed whether or not there was a difference between the causes identified on the NC DOT form and what the Gibb-Haslam investigation diagnosed with a simple yes/no answer to the question “were originating influences found” and compared the two investigations. We used the data from the investigation forms and from Riskmaster inputs to make the determination on the DOT investigations. Using the Gibb-Haslam model, we found originating influences in 22 of the 27 incidents. In NC DOT investigations, in only 3 of the 27 investigations were originating influences found. In two of these three, it was Division 1 that documented originating influences. Division 1 uses a Systematic Cause Analysis Technique (SCAT) to analyze the root causes of their accidents. This is a very good technique; Division 1 personnel appear to be using this diagnostic tool successfully and the feedback is they like the ease of its use. The SCAT and Gibb-Haslam models both help the investigator systematically work backwards from the loss to identify where the organization lacks control over deficiencies that led to the occurrence of the incident. We recommend NC DOT consider using the SCAT model as an alternative for the entire DOT organization because it points the investigator at originating influences and management systems practices for improvement, and seeks to identify multiple causes. It was also these incident investigations meeting where we were most impressed at the level of discussion towards items we would label as originating influences.

### **Recommended changes to Riskmaster**

Working with Riskmaster certainly took some adjustment. Riskmaster is a tool for describing the demographical data of incidents. We do not believe it was meant to be a diagnostic tool for incident investigation and analyzing that type of information. Kathy Barefoot was asked about adding categorical data fields to Riskmaster and she said she was not aware how to add fields. If Riskmaster were to be able to be augmented, we would recommend adding the 22 Gibb-Haslam and the 5 NC DOT SHSMS categories.

### **Recommended changes to forms**

It is recommended that the NC DOT utilize the Gibb-Haslam model at minimum as a thought process to help guide field incident investigators and incident investigation teams. The model itself should be part of all the investigations. Each cause or influence can be highlighted if it is applicable just we have done in the vignette summaries. It is recommended that it be kept and submitted with all other forms. We have also created a Gibb-Haslam Documentation Form (page 104) that could be used in conjunction with the proposed new I-2 forms. We offer two different versions of the I-2 form for NC DOT consideration. One has the Gibb-Haslam terminology (page 105); the other includes the NC DOT SHMS terminology (page 106). The new forms or the existing I-2 could be utilized with the Gibb-Haslam model and documentation form.

## Accident Investigation Model Documentation Form

	Factor/Influence	How linked to accident	Ways to reduce risk
<input type="checkbox"/>	Work Team		
<input type="checkbox"/>	Actions / behaviors		
<input type="checkbox"/>	Attitudes / motivations		
<input type="checkbox"/>	Communication		
<input type="checkbox"/>	Supervision		
<input type="checkbox"/>	Knowledge/skill		
<input type="checkbox"/>	Health/fatigue		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		
<input type="checkbox"/>	Workplace		
<input type="checkbox"/>	Layout, space, env. factor		
<input type="checkbox"/>	Local hazards		
<input type="checkbox"/>	Site constraints		
<input type="checkbox"/>	Site conditions		
<input type="checkbox"/>	Work Scheduling		
<input type="checkbox"/>	Housekeeping		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		
<input type="checkbox"/>	Equipment		
<input type="checkbox"/>	Suitability		
<input type="checkbox"/>	Usability		
<input type="checkbox"/>	Condition		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		
<input type="checkbox"/>	Materials		
<input type="checkbox"/>	Suitability		
<input type="checkbox"/>	Usability		
<input type="checkbox"/>	Condition		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		

# NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

## INCIDENT INVESTIGATION

Employee Name (s) \_\_\_\_\_ Personnel # \_\_\_\_\_  
 \_\_\_\_\_ Personnel # \_\_\_\_\_

Division: \_\_\_\_\_ County: \_\_\_\_\_ Department #: \_\_\_\_\_ No. Employees Injured: \_\_\_\_\_  
 No. Of Private Parties Injured: \_\_\_\_\_ Date of Incident: \_\_\_\_\_ Date Incident Reported: \_\_\_\_\_  
*Note: Form 19 must be completed for each employee injured.*

### Part I: Incident Investigation (To be completed by Incident Investigation Team)

Description of Incident: (What happened?) \_\_\_\_\_

	Factor/Influence	How linked	Ways to reduce risk
<input type="checkbox"/>	Work Team		
<input type="checkbox"/>	Actions / behaviors		
<input type="checkbox"/>	Attitudes / motivations		
<input type="checkbox"/>	Communication		
<input type="checkbox"/>	Supervision		
<input type="checkbox"/>	Knowledge/skill		
<input type="checkbox"/>	Health/fatigue		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		

<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		
<input type="checkbox"/>	Workplace		
<input type="checkbox"/>	Layout, space, env factor		
<input type="checkbox"/>	Local hazards		
<input type="checkbox"/>	Site constraints		
<input type="checkbox"/>	Site conditions		
<input type="checkbox"/>	Work Scheduling		
<input type="checkbox"/>	Housekeeping		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		

<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		
<input type="checkbox"/>	Equipment/Materials		
<input type="checkbox"/>	Suitability		
<input type="checkbox"/>	Usability		

<input type="checkbox"/>	Condition		
<input type="checkbox"/>	Permanent works design		
<input type="checkbox"/>	Project Management		
<input type="checkbox"/>	Construction Processes		
<input type="checkbox"/>	Safety Culture		
<input type="checkbox"/>	Risk Management		

Person responsible for corrective action: \_\_\_\_\_

## PART II: POST ACCIDENT TESTING (To be completed by Incident Investigation Team)

Controlled substance and alcohol test are to be conducted following ANY ACCIDENT an employee is involved in while on duty where:

- A life was lost
- If operating a motor vehicle, the NCDOT driver was cited for a moving traffic violation and individuals involved were transported for medical treatment.
- If operating a motor vehicle, the NCDOT driver was cited for a moving traffic violation and a vehicle involved was disabled and removed from the scene by other than its own power.

YES NO  
☐ ☐  
☐ ☐

Did any of the above conditions result from this accident?

If the previous question was answered yes, was post -accident testing conducted in accordance with NCDOT's Controlled Substance Abuse and Alcohol Misuse Policy and Procedure? If no, please state why no post-accident testing was conducted.

Investigation team members: \_\_\_\_\_

Investigating Supervisor's Signature: \_\_\_\_\_ Date of Investigation \_\_\_\_\_  
 Personnel #: \_\_\_\_\_

*Send completed Parts I, II, and IV to Incident and Injury Investigation Subcommittee:*

## Part III: Status of Corrective Action (To be completed by Incident and Injury Investigation Subcommittee)

Safety Officer/Investigating Supervisor: \_\_\_\_\_

Incident Subcommittee Members: \_\_\_\_\_

Has corrective action been completed? \_\_\_\_\_

Comments: \_\_\_\_\_

Subcommittee Chairman: \_\_\_\_\_ Subcommittee review date: \_\_\_\_\_  
*Send copy of completed package to Safety Unit.*

# NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

## INCIDENT INVESTIGATION

Employee Name (s) \_\_\_\_\_ Personnel ; \_\_\_\_\_  
 \_\_\_\_\_ Personnel # \_\_\_\_\_

Division: \_\_\_\_\_ County: \_\_\_\_\_ Department #: \_\_\_\_\_ No. Employees Injured: \_\_\_\_\_  
 No. Of Private Parties Injured: \_\_\_\_\_ Date of Incident: \_\_\_\_\_ Date Incident Reported: \_\_\_\_\_  
*Note: Form 19 must be completed for each employee injured.*

### Part I: Incident Investigation *(To be completed by Incident Investigation Team)*

Description of Incident: (What happened?) \_\_\_\_\_

Cause Category	Describe how the cause category was related to the incident	Describe the corrective action to remedy
Leadership		
Policy/Procedures		
Training		
Awareness		
Audits		

Person responsible for corrective action: \_\_\_\_\_

### PART II: POST ACCIDENT TESTING *(To be completed by Incident Investigation Team)*

Controlled substance and alcohol test are to be conducted following ANY ACCIDENT an employee is involved in while on duty where:

- A life was lost
- If operating a motor vehicle, the NCDOT driver was cited for a moving traffic violation and individuals involved were transported for medical treatment.
- If operating a motor vehicle, the NCDOT driver was cited for a moving traffic violation and a vehicle involved was disabled and removed from the scene by other than its own power.

YES NO

☐ ☐

Did any of the above conditions result from this accident?

If the previous question was answered yes, was post -accident testing conducted in accordance with NCDOT's Controlled

Substance Abuse and Alcohol Misuse Policy and Procedure? If no, please state why no post-accident testing was conducted.

Investigation team members: \_\_\_\_\_

Investigating Supervisor's Signature: \_\_\_\_\_ Date of Investigation \_\_\_\_\_

Personnel #: \_\_\_\_\_

*Send completed Parts I, II, and IV to Incident and Injury Investigation Subcommittee:*

### Part III: Status of Corrective Action *(To be completed by Incident and Injury Investigation Subcommittee)*

Safety Officer/Investigating Supervisor: \_\_\_\_\_

Incident Subcommittee Members: \_\_\_\_\_

Has corrective action been completed? \_\_\_\_\_

Comments: \_\_\_\_\_

Subcommittee Chairman: \_\_\_\_\_ Subcommittee review date: \_\_\_\_\_

*Send copy of completed package to Safety Unit.*

## **NC DOT Feedback**

Feedback from the Steering Committee towards the completion of the project indicated that the Gibb-Haslam Model is a very detailed approach to indentifying root causes, however the Committee felt that the process may be too complex to disseminate to the NCDOT users for incident investigation process.

## **CONCLUSIONS**

This research project demonstrated that there are multiple causes of NC DOT incidents that can be identified and used to develop risk minimization strategies. NC DOT should consider adopting an incident investigation model that leads the investigator to multiple causes and originating influences. The Gibb-Haslam model is one such model. The SCAT model utilized in Division 1 is also a very appropriate investigation model. This model has the added benefit of already being successfully used in Division 1. New data collection forms are provided are recommended to be utilized so that data can be collected across Divisions to better enable decisions be made about how to minimize risk across the DOT. Unfortunately, the current Riskmaster system is not amenable (that we are aware of) to the addition of data fields. Some other database would have to be utilized to have a DOT wide diagnostic database tool. A simple Excel spreadsheet or statistical package, such as Statistical Package for the Social Science (SPSS), would be an option. Regrettably, this would require double data input in several fields.

The Steering Committee feels that the Gibb-Haslam process is too complicated to be disseminated among NC DOT personnel. However, if the DOT continues to ignore the collection of diagnostic information that includes multiple causes of accidents and originating influences, the DOT's safety effort might become stagnant despite other safety improvement efforts. It must be stated that the use of incident investigation models is just one tool to improve a safety program. An effective incident investigation method that identifies all sources of unacceptable risk allows an organization to develop cost-effective risk reduction strategies and is a compliment to other safety and health program and management systems. An observation counter to the too complicated comment was made during the research endeavor. The Divisions within NC DOT conduct incident investigation meetings on a periodic basis (monthly in some Divisions). The research team observed six of these meetings. During these meetings incidents are reviewed by a committee which includes front-line employees, supervisors, county engineers, and safety personnel. We observed some that excellent incident analysis discussions already occur at these meetings. However, the level of discussion does vary by Division. Nevertheless, some of the Divisions are already discussing the incidents in details and in the detail prescribed by the Gibb-Haslam model. However, the gap is that the discussion and findings at these meetings is loosely collected. The Gibb-Haslam model could be utilized at these meetings as a diagnostic and data collection tool. A final recommendation to NC DOT is to pilot the Gibb-Haslam model in a few Divisions or to try the model as an incident analysis and data collection tool during Divisional incident investigation meetings. It is recommended to use the forms that have been developed on pages 104-106. In particular the form on page 104 demonstrates the Gibb-Haslam model in a checklist type style which could be conducive to the style of NC DOT.

Lastly, we posit that if the NC DOT continues to evaluate incidents using methods devoid of a systematic and consistent level of diagnostic detail, the trend of workplace incidents may continue and resources may not be invested properly.

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