Environmental Remediation Drilling Safety Guideline

A summary of industry practices and techniques to help drillers enhance safety performance, environmental performance, and overall project quality

Revision 1 – 09/2008

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This document is under the care of the Safety Subcommittee to Professional Development of the National Ground Water Association (NGWA). All updates and revisions are undertaken by the above mentioned subcommittee. Any questions or comments should be directed to said committee at the following information:

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AntiEntropics, Inc. and the collective authors would like to thank the National Drilling Association (NDA) for the permission to use selected content from their *Drilling Safety Guide*. The *Drilling Safety Guide* is recognized throughout the U.S. as a guideline for the safe operation of drilling equipment. It is available through the NDA by contacting them at:

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We would also like to thank the many companies that shared information reflecting the practices they use to achieve safe and successful remediation well drilling projects. Their goal is to enhance safety and environmental performance across the industry.

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INTRODUCTION

This publication gives guidance to address some of the most common safety concerns that should be considered while performing drilling activities. It is not intended to address every possible situation that may arise or every hazard which may come to exist during drilling activities.

The intended audience for this guideline includes:

- Customers and client companies the work is performed for
- Facility managers
- Engineers
- Geologists
- Project managers
- Environmental health and safety professionals and managers
- Site health, environmental, and safety (HES) officers
- Drillers and rig operators
- Driller helpers
- Field technicians
- Utility clearance companies and field crews

Your safety is an ongoing concern for you, the organization for which you work, and the companies that you perform work for…in other words, safety is everyone's concern.

This drilling safety guideline has been prepared to assist the environmental remediation industry in understanding drilling and direct push safety guidelines and common practices. When working on a project where more stringent safety practices are required, always defer to the more conservative practice. It contains suggested safety practices and is not intended to establish standard industry requirements. This guideline is to assist workers associated with the environmental remediation industry to work safely and with close adherence to environmental requirements. Many aspects of drilling and direct push safety can only be accomplished by using every worker's intelligence, careful attention to detail, and common sense.

The vision of this guideline is to provide a brief summary of some of the best available drilling safety knowledge in the remediation industry. By adopting these proven practices, you can reduce the potential for personal injury and safety related losses.

THE PURPOSE AND SCOPE OF THIS GUIDELINE

This guideline's purpose is to assist in preventing losses to the following four situations during environmental remediation drilling and direct push operations:

- Injury to workers
- Negative impact on the community
- Negative impact on the environment
- Damage to surface and subsurface structures

Our goal is to augment, not replace, site-specific safety plans. This guideline is a collection of safety practices and lessons learned and compiled by knowledgeable remediation drilling and safety, health, and environmental professionals. As our industries progress and learn new techniques, we hope to keep this guideline evergreen by revising it periodically to evolve with new practices and technology so that it reflects future remediation drilling practices.

The following sections include guidance for:

- Drilling pre-clearance,
- Borehole siting,
- Drilling and direct push operating equipment,
- Mobilizing and demobilizing equipment,
- Well construction,

DEFINITIONS

Term	Definition
Access and Egress	Entry and exit.
Air Drilling	A method of rotary drilling that uses compressed air as its circulation medium to remove cuttings from the borehole.
Air Knife	A device that directs compressed air to advance a hole. Usually used in conjunction with a vacuum truck. Generally used to safely advance a borehole through depths where underground utilities are generally present but may have not been otherwise identified.
Angle Drilling	Drilling that is deliberately made to depart significantly from the vertical. Usually performed with standard drilling rig with the mast deliberately set non-vertical. Allows for installation of wells adjacent to, or just beneath surface structures.
Annular Space	The space between two well casings or between the casing and the wall of the drilled hole.
Auger Fork	A U-shaped tool that is inserted around the auger flights to hold them in place on the surface of a borehole.
Auger Head	The part of the auger that is attached to the drilling drive (gimbal and kelly).
Auger/Auger Flight	Any of various tools or devices having a helical shaft or member that are used for boring holes.
Bit	The cutting or boring element used in drilling wells.
Boom Truck	A vehicle with a crane arm used for lifting augers, casing, or other heavy equipment.
Borehole	The hole drilled by the bit. A borehole may have casing in it or may be open (uncased), or a portion of it may be cased and a portion of it may be open.
Casing	A tubular retaining structure which is installed in the well bore to maintain the well opening.
Casing Advancer Drilling	A drill method that pushes casing forward as the drill bit is advanced (air hammer)
Cathead	A spool-shaped attachment on the end of the cat shaft, around which rope for hoisting and moving heavy equipment on or near the rig floor is wound.
Chemical	Any element, chemical compound, or mixture of elements or compounds.

Term	Definition
Clearance Techniques	Application of specialized equipment used to detect the presence of buried structures.
Combustible liquid	Any liquid having a flash point at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flash points of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.
Compressed gas	Any compound that exhibits the following characteristics: • A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psig at 70 deg. F. • A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psig at 130 deg. F. regardless of the pressure at 70 deg. F. • A liquid having a vapor pressure exceeding 40 psig at 100 deg. F.
Concrete Coring	The cutting of surface concrete so drilling may be conducted in the soil beneath. This may be done with a circular drill bits or flat saws.
Container	Any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers.
Core Barrels	A tubular device run in place of a bit and used to cut (collect) a core sample.
Coupling and Decoupling Augers	The act of joining or separating two augers by adding or removing auger bolts or screwing/unscrewing the augers.
Critical Areas	The subsurface spaces within ten feet of a structure where items may exist that if compromised could result in injuries, damaged equipment, damaged property, or at a minimum, disruption of utility services.
Critical Zones	An area of the drilling site that poses special hazards or increased risk to personnel.
Cuttings	The fragments of rock and soil dislodged by the bit and brought to the surface in the drilling mud or by the rotation of the auger.
Decontamination	The act of cleaning equipment to remove unwanted materials or chemicals. Commonly done by pressure washing, steam cleaning, or hand scrubbing with soap and water.
Direct Push	A drilling technique that uses percussion hammer or hydraulic ram to *push* or *hammer* various sample tooling into the subsurface, Geotechnical sampling, continuous soil sampling, in situ groundwater sampling, or small diameter well installation can be performed with these units.

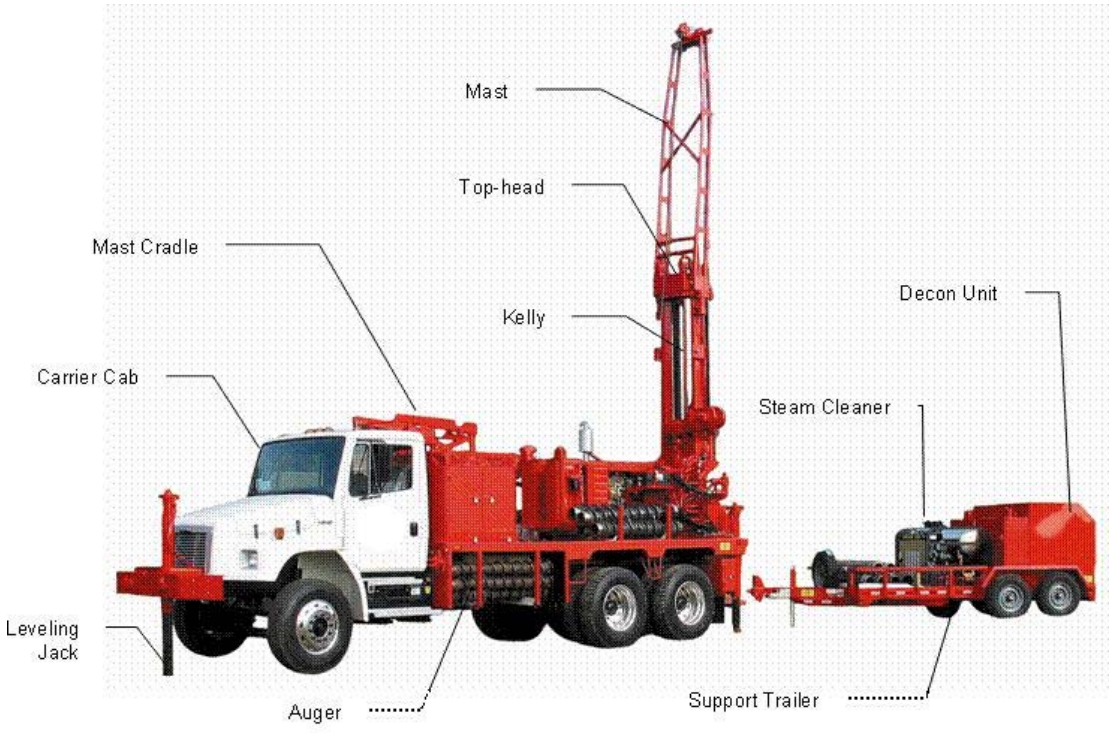
Term	Definition
Directional Drilling	Drilling that is deliberately made to depart significantly from the vertical.
Drill Rig Types	Hollow stem auger, flight auger, air rotary, casing hammer, mud rotary, rotosonic drilling, or direct push.
Drill Rod Chuck Jaws	Hydraulic driven equipment that holds the drill stem stable as the drill is rotated and advanced.
Drill Stem (Drill Rods)	All members in the assembly used for drilling by the rotary method from the swivel to the bit, including the kelly, drill pipe and tool joints, drill collars, stabilizers, and various subsequent items.
Driller (Rig Operator)	The employee of the drilling company directly in charge of a drilling rig and crew. Their main duty is operation of the drilling rig and hoisting equipment, but they are also responsible for the down-hole condition of the well, operation of down-hole tools, and pipe measurements.
Driller Helper	An assistant to the driller that moves the augers in and out, decouples and attaches the drive head, shovels cuttings, and otherwise assists the driller in all aspects of the operation except for the direct operation of the drill.
Drilling Fluid	Circulating fluid, one function of which is to force cuttings out of the borehole and to the surface. While a mixture of clay, water, and other chemical additives is the most common drilling fluid, boreholes can also be drilled using air, gas, or water as the drilling fluid.
Drive Hammer	A hydraulically driven hammer that advances casing as the drill bit advances.
Exclusion Zone	The exclusion zone is an area where inhalation, ingestion, or dermal contact with contaminants is plausible. The exclusion zone is sometimes called the hot zone. It is the area where the personnel have to be properly dressed in PPE and make sure any required respiratory protection is being worn.
Explosive	A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.
Exposure or exposed	When an employee is subjected in the course of employment to a chemical that is a physical or health hazard, and includes potential (incidental or possible) exposure. Subjected in terms of health hazards includes any route of entry (such as inhalation and ingestion)

Term	Definition
Flammable and Combustible Material	Flammable and combustible liquids are liquids that can burn. They are classified, or grouped as either flammable or combustible, by their flashpoints (the temperature at which they start to burn). Generally speaking, flammable liquids will ignite (catch on fire) and burn easily usually at normal working temperatures. Combustible liquids have the ability to burn at temperatures that are usually above working temperatures. Flammable material is designated by a flashpoint of under 100^{o} F and combustible material is designated by a flashpoint between 100^{o} F and 200^{o} F.
Grouting	To fill the annulus between the casing and borehole with liquid slurry of grout (cement and/or bentonite) and water to support the casing and prevent fluid migration between permeable zones.
Hoisting Cables and Ropes	Ropes or metal cables that are used to lift or move augers, casing, and sampling tools. Usually attached to sheaves on the mast.
Hydraulic Ram	A fluid-pressurized device that pushes casing or sampling tools down.
Job Safety Analysis (JSA)	A step-by-step breakdown of a task. With each step, the hazard risks and precautions are identified. A JSA is frequently conducted using a three column document in which the first column is the step, the second the hazards which may be potentially encountered and the third column the precautions to take to avoid the hazard risk. Usually included in, attached to, or referenced by the Health and Safety Plan.
Kelly	The heavy square or hexagonal steel member suspended from the mast through the rotary table and connected to the topmost joint of drill pipe to turn the drill stem. Not for direct push or most hollow stem rigs.
Kill Switch	A safety device, normally a button or toggle stick that will turn off the drill rig engine when actuated. Usually located in the back of the rig near where the drilling is conducted.
Mast	A movable derrick capable of being raised as a unit, as distinguished from a standard derrick, which cannot be raised to a working position as a unit.
MSDS	A Material Safety Data Sheet (MSDS) is a report with descriptions of the physical properties, compatibilities, hazardous properties and other characteristic information of a material or chemical. MSDSs are usually attached to the Health and Safety Plan.
Mud	A liquid that may be used to circulate through the borehole during rotary drilling and work-over operations.
Non-Indigenous Material	Gravel or fill dirt that was used as backfill in a previous excavation or boring. Any material not naturally deposited.

Term	Definition
Non-Invasive GPR	Ground penetrating radar is a geophysical device that uses radar to search for underground structures without physically penetrating the ground.
Operations Foreman	Operations personnel managing/supervising a construction/installation project involving subsurface activities (another term for this position is *tool-pusher*).
Paving Scars	Scars left on pavement by the drill rig stabilizers.
Pinch Points	Any locations in a drilling operation where body parts may be pinched or crushed.
Post-Hole	A hole dug before drilling to search for underground structures or utilities.
Receptor Survey	Identification of utility vaults, monitoring wells, private and public supply wells, surface water bodies, basements, or any other subsurface exposure pathways.
Refusal	When the augers or drill cannot be advanced because of some subsurface blockage.
Rig	The mast, draw-works, and attendant surface equipment of a drilling unit.
Rotary Drilling	A drilling method in which a hole is made by a rotating bit to which a downward force is applied and cuttings are brought to the surface. The bit is fastened to and rotated by the drill stem, which also provides a passageway through which the drilling fluid is circulated. Additional "joints" of drill pipe are added as drilling progresses.
Safety Hammer	A hydraulically driven automatic hammer that advances a sampling tool. Used instead of a slide hammer.
Sampling Tools	Tools that capture and retrieve subsurface soil samples such as a shelby tube, sample extruder, or split barrel sampler.
Sheaves	A grooved pulley over which tape, wire, or cable rides.
Site-specific Health and Safety Plan (HASP)	That document which is designed to recognize potential risks, and identify precautions appropriate to the task. The document typically contains directions to the hospital, emergency contact information and health risk information. The plan will identify potential risks associated with field work, air monitoring requirements, environmental concerns (climate, insects, snakes, etc.), potential exposure to contaminants of concern, and provides requirements and thresholds for use of personal protective equipment to be employed during field operations. The plan may also address: worker training, waste characterization, contingency plans and other health and safety issues.

Term	Definition
Subsurface Activity	Activity carried out by mechanical equipment resulting in an intended disturbance of the earth.
Tenders	A rope attached to equipment hung on a boom that is used to guide the direction of movement.
Utility Mark-outs	The surface marking of underground utilities and structures. There are public services (one call centers) that will mark out underground utilities on public right-of-ways and private locaters that will mark out utilities on private property. A nation-wide one call center director maybe found at www.undergroundfocus.com/
Utility or Structure	Any underground object that could be damaged or cause harm if encountered during subsurface activities.
Water Swivels	A water-tight rotating connection located on top of the drill stem that connects to a hose delivering drilling mud, water or other drilling fluids.
Well Head	Equipment installed at the surface of the borehole when a casing is installed in the borehole. A well head may include such equipment as the casing head and tubing head.
Wire Rope Hoist or Draw Works	An arrangement of pulleys and wire rope used for lifting heavy objects, a winch or similar device.

A typical rig is presented below with major parts labeled



SECTION 1 - PRE-FIELDWORK

1.1 - Introduction

Environmental drilling can be performed safely with proper pre-fieldwork planning and proactive adjustment of planned safe work procedures to actual conditions in the field. As every experienced driller and environmental professional knows, it is very difficult to predict all hazards that may be encountered during drilling fieldwork. The pre-field work preparations suggested here are applicable to mechanical drilling and push probe where portable drill rigs are used for soil boring advancement, subsurface soil and water sample collection, or groundwater monitoring well installation. If these pre-fieldwork preparations are diligently completed, the job can proceed safely and smoothly with less down time. It is recommended that supporting documentation for the pre-fieldwork preparations is retained in the project files.

1.2 - Planning the Project

Project planning begins when the customer's drilling needs are made known to the environmental consultant or driller. Pre-fieldwork planning can be reflected in a proposal to the customer to secure the work assignment, or in a work plan used to communicate the technical approach and work procedures that will be used to safely complete the work. Following award of the project to a contractor, planning and scheduling should focus on preparations that will contribute to a safe and efficient operation at the job site. Much of the responsibility for planning, effective communication, and associated task work rests with the contractor's project manager, however, experience has demonstrated participation by the customer's project manager, (with other key personnel as needed) and the contractor's field team in the planning process significantly contributes to insuring a safe and efficient job site.

The following list of items should be considered during the project planning stage prior to mobilizing to begin fieldwork:

- Scope of work - overall project and drilling task objectives
- Customer, corporate, and job-site health and safety requirements
- Technical approach (the means and methods to accomplish customer scope of work)
- Procurement and vendor selection
    - Technical capabilities and equipment
        - Drillers
        - Public and private utility locators
        - Traffic control and security
        - Laboratory services (including data validation)
        - Waste transportation and disposal
    - Pre-qualification requirements to be considered
        - Safety performance
        - Training and experience of personnel
        - Age and condition of required equipment

        - Medical and substance abuse surveillance
        - Proof of adequate insurance
        - Licenses and registrations
        - References
    - Ability to meet schedule
- Roles and responsibilities (customer, owner, consultant, driller) for communications, work execution, and safety
- Schedule (work phasing and sequencing, prioritization, project kickoff, fieldwork, reporting, closeout)
- Permits and access agreements

1.3 - Preparing the Health and Safety Plan (HASP)

The site-specific hazards and potential risks associated with known conditions at the property or work area should be identified, reviewed, and addressed in the site-specific HASP. The site-specific HASP should be reviewed by project staff and readily available to them onsite during fieldwork. The typical topics addressed in a generic HASP are included as Attachment 1.A - *Typical Health and Safety Plan (HASP) Organization and Contents*.

Drilling activities are inherently dangerous and warrant detailed coverage in project specific health and safety planning. Drilling can be addressed in a HASP and Job Safety Analysis (JSA) developed by the contractor and the field team leader. The safe work procedures specified in the JSAs should be consistent with the overall project HASP, and the customer's site-specific health and safety requirements.

A JSA is a safety analysis tool that breaks down each work task into steps, assesses hazards and potential hazards associated with each step, and identifies corrective measures to mitigate or eliminate the hazard. JSAs should be prepared by workers experienced in the job to be performed and reviewed by the project team before going to the field, and then again onsite during the initial project kickoff and tailgate meetings. Examples of selected JSAs are included as Attachment 1.B and 1.C. The following are tasks that may be addressed by one or more JSA:

- Mobilization and Demobilization
- Traffic control
- Site security and site access
- Delineation and identification of critical zones
- Borehole siting and clearance - subsurface clearance protocol
- Rig maintenance
- Drilling operations
- Equipment decontamination procedures
- Well construction
- Well development
- Surface completions
- Well abandonment
- Well sampling
- Emergency situation notification and procedures

JSAs should be developed, reviewed, and approved prior to the start of field activities, and updated as necessary based on new information or changed conditions.

1.4 - Planning and Facilitating the Kick-off Meeting

Informed planning and communication allows drilling tasks to be consistently performed safely. Essential participants in the review and kickoff process are the customer/owner, consultant, driller, and field personnel that will execute the work. Following review, the participants should formally agree to or suggest revisions to the project plan. They should commit to rigorously implementing the HASP and stopping work when any unforeseen hazards are identified. Topics that may be addressed during the kickoff meeting include:

- Scope of work
    - Customer objectives
    - Technical approach - means and methods
- Roles and responsibilities
    - Site management – owner or operator
    - Project management or field team leader
    - Health and safety management
    - All site workers – stopping unsafe conditions
- Schedules
    - Mobilization
    - Drilling activities
    - Clean-up
    - De-mobilization
    - Sample management (e.g., deciding if rush turnaround services necessary for analytical results)
- Simultaneous operations - on or off site activities that could impact drilling activity logistics or safety
- Changed conditions
    - Access
    - Scope
    - Weather (include heat and cold management)
    - Work hour limitations
    - Construction
- Review, verify and validate hazards and mitigation measures
- Communication between field team, customer, and project mgmt.
    - Clearly communicate to project staff that stop work authority resides with every member of the project staff
    - Reporting incidents
    - Management of Change (MOC)
    - Schedule
- Documentation
    - Sign-off on review and acceptance of HASP
    - Workplace inspection and audits
    - Completed checklists (pre-drill protocol, borehole clearance review, and others)

1.4 - Planning and Facilitating the Kick-off Meeting cont.

Project planning and kickoff set the stage for safe work performance. However, incident free operation will be dependant on daily reviews of work to be performed and associated hazards and mitigation measures. Adjustments to JSAs to accommodate changed conditions should be made before work commences. Before beginning each field task, or when conditions change, employees should:

- Think through the task's work steps,
- Consider the potential for injury, and
- Identify what they must do to prevent injuries or accidents from occurring.

SECTION 2 - BOREHOLE LOCATION POSITIONING AND CLEARANCE

2.1 - Purpose

The purpose of this section is to provide guidance to protect underground facilities, owners of these facilities, the environment, and workers when conducting drilling activities. Risks can be minimized or eliminated when proper clearance procedures are followed. Typical underground facilities include, but are not limited to:

- pipelines of all types,
- utilities,
- electrical conduits,
- overhead structures such as signs or canopies,
- fiber optic lines, and
- tanks.

2.2 - Scheduling

Due to project budgets, resource allocation, and subcontractor agreements, scheduling is a key aspect to a successful result. After the client, the facility, and regulatory agency have approved the location(s), permits and any necessary access agreements have been obtained, the schedule should be developed. The following scheduling process should be followed:

1. Site visit (check for critical areas),
2. Schedule acquisition of permits and access agreements,
3. Schedule with the facility (utility locates, pavement cutting, drilling),
4. Schedule meeting with facility staff (underground structure locates),
5. Schedule *One Call* or other utility location representatives to mark public utilities,
6. Schedule private locators (if needed),
7. Schedule pavement removal crews,
8. Schedule drillers, and
9. Schedule traffic control companies.

2.3 - Obtaining Access Agreements

The next phase in the pre-fieldwork preparation is to determine if an access agreement is required to drill on the site property. If an access agreement is required, the proper legal agreements need to be drafted and executed prior to commencing the drilling operation. The project team should keep a copy of the applicable access agreement while on-site and during drilling activities. The following situations will most likely require an access agreement:

- Right of way agreements for access to railroad, county, city and state properties,
- Access to private property,
- Game and Fish permits for drilling within the high-water mark of any water way,
- Local jurisdiction permits as required, and
- Army Corp of Engineers for drilling on a levee.

2.4 - Positioning the Borehole

Some of the tasks involved in positioning the borehole can take place in the office. It is important to gather all the relevant information about each site to assist in identifying hazards, locations, and the necessary permits.

It is difficult to predict all problems that may occur during drilling fieldwork activities. Completing pre-fieldwork preparations will help to ensure that the project proceeds on schedule and in a safe manner. The project work plan should include (if applicable and available):

- Maps and figures showing underground and aboveground equipment, piping, utilities and/or any surface or subsurface hazards,
- Historic site information (maps, photos, files),
- Site as-built drawings,
- Easement maps,
    - Historic plot plans,
- Previous site investigations,
- Fire insurance plans,
- Tank dip charts, and
- Elevations and coordinates maps.

It is helpful to interview individuals who may have historical information. These individuals may be retired at the time the work is conducted, but may still have information needed to help avoid damaging underground facilities.

During pre-planning and site investigations, keep good notes, document preparation activities, question personnel who have historic site knowledge, identify below and above ground providers and services, and identify critical areas. Critical areas are those within ten feet of any structures or general high pressure pipeline corridor. If critical areas are encountered, there could be dramatic health, environmental, or operational impacts. Some examples of critical areas include: general high pressure pipeline corridors, underground storage tanks (USTs), utility lines, areas between an UST and a dispenser, areas between a dispenser rack and the building, areas within ten feet of the dispenser island canopy drip line, and overhead power or utility lines. Critical areas should be twice reviewed and hole clearance procedures completed prior to the drill team drilling.

2.5 - Selecting the Drilling Location

During the pre-fieldwork phase, determine the location and the type of drilling to avoid critical areas and structures. Regulatory requirements and investigation objectives need to be considered in determining the location and drilling types. For example, horizontal (directional) or angled drilling may be selected to drill in a desired location to avoid potentially hazardous or critical zones (including high traffic areas). The following is a list of questions the project team should ask when identifying a location, but note that this list is not all inclusive:

- Does the location allow for clear entry and exit (unobstructed)?
- Is there adequate work space (vertical and horizontal)?
- Will pavement, curbs, or other structures need to be removed?
- Are all locations located outside critical areas?
- Have access agreements been completed?
- Have all appropriate permits been obtained?
- Have selected areas been reviewed for structures, overhead power lines, and critical items?
- Have borehole clearance procedures been completed?

Review and investigate the location selection with the client during an on-site visit. The determined location should be identified on site maps and submitted to the facility, if required, in addition to the regulatory agency for approval.

2.6 - Methodologies for Locating Private Structures

Due to specific site conditions, no single method of locating subsurface utilities is universally fail proof. Surface and subsurface conditions may interfere with the effective use of a specific utility locating technology. Following is a discussion of some technologies available and the relative merits of each.

2.6.1 - Ground Penetrating Radar

Ground penetrating radar (GPR) is an advancing technology used for investigating shallow, geologic, and hydrologic features. The technique is also extremely useful in locating man-made features, such as buried drums, tanks, pipes, or other metallic objects. Locating rebar in concrete or detection of voids beneath concrete or asphalt is also a popular GPR application.

GPR operates on the principle that electromagnetic waves emitted from a transmitter antenna are reflected from buried objects having different electrical properties than the host material. The signals detected at the receiver antenna are recorded and provide a detailed cross section of the subsurface that is similar in appearance to a seismic reflection record. The depth of penetration of the radar pulse is controlled by site conditions and the frequency of the antenna chosen.

2.6.1 - Ground Penetrating Radar cont.

Figure 2.1 - Ground Penetrating Radar Being Demonstrated in a Non- Environmental Remediation Work Area. (Photo courtesy of Enviroscan, Inc.)

Limitations of GPR

Exploration depth can be limited by soil or water with high conductivity. Detection depends upon a dielectric contrast between the subsurface feature and the surrounding material.

GPR can be a very effective tool for location of subsurface structures, especially shallow obstructions. Although GPR has been applied at greater depths, it is generally considered to be more effective down to approximately 10 to 15 feet below the ground surface in most lithologies. Resolution is degraded with depths exceeding 20 to 30 feet. For utility locating, depth is usually limited to 10 feet or less to ensure safe drilling operation. Transducers exist that can penetrate to greater depths, but these use a lower frequency. Lower frequency means lower resolution, and narrow objects like utilities cannot be seen.

Some things to consider when evaluating GPR:

- Closely spaced survey lines are required to locate small objects,
- A relatively smooth surface is also necessary, and
- As with most utility locating technologies, GPR is not as effective where the ground surface is paved with highly reinforced concrete due to interference from the presence of the metal rebar. Interference is also prevalent if surface structures are immediately adjacent to the area.

Recent advances in radar antennae and computer software have made GPR more effective in difficult situations.

Limitations of GPR cont.

It is important to note the depth limitations of GPR when clearing horizontal or directional drilling boreholes. Horizontal drilling technology is usually used at depths greater than 20 feet below the surface which is beyond the detection limits for GPR. An option for clearing horizontally drilled boreholes is use of a template and water jet to clear the horizontal run to the required depth. This is a relatively extreme option and will only be justified in cases where utilities may be present.

2.6.2 - Pipe Tracing Transmitter and Receiver

A pipe and cable locator and tracer can be used to detect and trace metallic utilities, utility tracing wires, or warning tapes. In pipe and cable tracing mode, the transmitter can be coupled by direct contact (conductively) to exposed portions of a metallic pipe, cable, or wire; or by simple proximity (inductively) to a subsurface metallic utility with known location and orientation. The transmitter remains stationary and energizes or excites the metallic utility to be traced with a signal that can be traced at the ground surface using the mobile receiver wand or probe.

Figure 2.2 - A Pipe Tracing Transmitter/Receiver Being Demonstrated in a Non-environmental Remediation Work Area (Photo courtesy of Enviroscan, Inc.)

Limitations of Pipe Tracing Transmitter and Receiver

To use the transmitter in the most effective manner, all metallic pipes to be traced must be available for connection directly to the transmitter. The inductive mode is not as effective. Also, the detection is limited to metallic objects and is not useful for plastic, ceramic, or fiberglass utilities.

2.6.3 - Electromagnetic Utility Tracing Receiver

The electromagnetic technique locates buried materials having a high conductance. Alternating electromagnetic waves generated at the surface are induced into the ground during the survey. When the waves pass through a conducting body, they induce an alternating electrical current in the conductive materials. These currents become the source of secondary magnetic fields, which can be detected at the surface. The strength of the field is directly proportional to the average conductivity of the subsurface materials. Typical electromagnetic applications include:

- Location of:
    - buried pipes,
    - tanks,
    - drums and other metallic objects,
    - sludge wastes,
    - leachate plumes,
    - salt water intrusions,
    - acid mine drainage, and
    - other ground water contamination problems.

Other applications include quick and economical site assessment of areas with variable bedrock topography, such as those found in karst terrain, clay layer mapping, fault detection, or mine and quarry siting.

Figure 2.3 - An EM Tracer Being Demonstrated in a Non-environmental Remediation Work Area. (Photo courtesy of Enviroscan, Inc.)

Limitations of this technique that can adversely affect the electromagnetic measurements include:

- Power lines
- Metal fences
- Metal debris, and
- Utilities

2.6.4 - Deep Focused Sensing Metal Detector

A deep focused metal detector acts as a pipe and cable locator and tracer to detect and trace metallic utilities, utility tracing wires, or warning tapes. In pipe and cable search mode, the instrument is essentially a deep-sensing metal detector that detects any highly electrically conductive material (metals) by creating an electromagnetic field with a transmitting coil. A receiving coil at a fixed separation from the transmitter measures the field strength. As the instrument is swept along the ground surface, subsurface metallic bodies distort the transmitted field. The change in field strength or orientation is sensed by the receiver and triggers an audible alarm and deflection of an analog meter. The instrument can nominally detect a 2-inch metal pipe to a depth of 8 feet and a 10-inch metal pipe to a depth of 14 feet.

Figure 2.4 - A Deep Focused Metal Detector Being Demonstrated in a Non-environmental Remediation Work Area. (Photo courtesy of Enviroscan, Inc.)

This technique's effectiveness is limited to metallic objects. It is not useful for plastic, ceramic, or fiberglass utilities.

2.6.5 - Vibrocator

Vibrocators are used to detect and trace fluid-filled, non-metallic utilities (for example, PVC or concrete water lines). A vibrocator system involves a low-frequency pressure wave generator (called a *transonde*), which is attached to a faucet, hydrant, or other available fitting. The transonde produces a continuous vibration or throbbing in the pipe. This vibration can be detected at the ground surface with a sensitive geophone or ground motion detector tuned to the transonde-generated frequency.

2.6.5 - Vibrocator cont.

Figure 2.5 - A Vibrocator Being Demonstrated in a Non-environmental Remediation Work Area. (Photo courtesy of Enviroscan, Inc.)

There are two limitations of this technology. One is that all non-metallic pipes to be traced must be available for connection directly to the transmitter. The second is that excessive energy imparted to the pipe may cause damage to the pipe.

2.7 - Training Workers for Borehole Clearing Tasks

The following are considered to be minimum levels of training for individuals performing the tasks associated with clearing a borehole:

- 40-Hour OSHA HAZWOPER training (required for HAZWOPER sites).
- Some level of internal training and prior drilling experience regarding safe locations in which to drill.

Specific drilling tasks may require more experience and training for the:

- Individual who makes the decision that the location is acceptable to drill,
- Quality Assurance (QA) Point Person.

A senior-level project team member should consult with the field personnel during the final location of the borehole.

2.8- Obtaining Required Permits

Determine the permits required for drilling activities under applicable local, state, and federal laws. Prepare the permit applications and proper documentation for submittal to permitting agencies or third parties. Examples of the various permits that may be required include, but are not limited to, the following:

- Work permits for agencies,
- Hot work permits for the facility,
- Work permit for the facility,
- Excavation permits for the facility, and
- Site work permits may also be required as mandated by site policies and procedures.

2.9 - Borehole Protection Steps

The following steps are recommended to reduce the potential for encountering subsurface utilities during drilling:

- Conduct a site walkthrough and verify utility location checklist is complete,
- Review proposed locations and the site with on-site personnel and obtain other historical information,
- Locate boreholes a safe distance (at least 5 feet) perpendicular from utility mark-out lines,
- Carefully break surface cover if present,
- Clear location to a depth of the utility window BGS (varies from client to client and location to location) and at least 120% of the borehole diameter, and

Proceed with caution when advancing the drill or probe.

2.10 - The Clearance Process

The goal of the entire clearance process is to verify absence of subsurface structures to avoid damage to property, the environment and injury to workers or others.

The first step in the clearance process is to contact the local area *ONE CALL* Utility Locate Service or, if inside a facility, the appropriate facility personnel. The local one call utility locator service must be contacted well ahead of the project, especially if directional drilling is planned. The service should be informed of the type of equipment to be used, and should be asked to space locator marks close together. This will allow the team to visualize sudden shifts or turns in the utility's path.

The clearance process is influenced by two geometric planes: vertical and horizontal. Considerations for completing the clearance process are:

1. Consider the depth and diameter of clearance.

    - When drilling vertically, the utility window profile depth must be considered. This can certainly vary with the amount of development in an area. The depth to clear will vary with the client, and may go until refusal is reached. Often the deeper utilities are high-pressure pipelines or high voltage power cables, which are very dangerous and warrant extreme caution.

- In all cases, it is preferable to clear a hole to about 120% of the diameter of the largest tool used for drilling, so as not to miss structures that might be just slightly tangential to the borehole. For instance, if a 10-inch hollow stem auger is being used to drill, a cleared area 12 inches in diameter should be used. The cutting head is often the largest diameter tool used for drilling and the cleared footprint should be 20% larger than the cutting head.
- When *angle* drilling, clearance should consider 120% of borehole length, along with the utility window profile. If possible, it is recommended to at least clear intended areas where the drill string will enter and exit the ground, and to use any means possible to positively identify the location and depth of any utilities that will be crossed in the boring process. The same vertical and horizontal considerations described for the vertical drilling should be used for angled or horizontal drilling.

2. In addition to completing all locates and completing clearance of subsurface locations along the path of the drilling head, additional excavations can be completed as described below:

    - If possible, excavate small areas to visually monitor the drill bit. A buried drill bit makes it impossible to tell a utility has been struck. Verify the drill bit remains at least 5 feet away from the utility. Keep the hole open until the drill bit has been pulled back and the drilling is complete.
    - Carefully excavate to expose utilities so the drill bit path can be monitored.

3. Calibrate the drill bit and locating device at the beginning of the project. Remember, the locating device can monitor the drill bit on the initial pass, but cannot monitor the backream head.

4. Workers should stay at least 5 feet (to 10 feet if space is available) away when boring parallel to buried utilities. Carefully excavate to expose utilities so the drill bit path can be monitored.

2.11 - Clearance Methodologies

Before drilling within 10 feet of an underground utility, the utility depth must be verified. Flags and locator marks indicate the direction the utility is running, but not how deeply it is buried. The only way to be sure of utility depth is to carefully expose and examine the utility line.

Clearance methodologies can be broken into two major categories:

- Those that can involve direct contact in order to reveal a subsurface structure, and
- Those that attempt to avoid the contact.

Direct contact is not universally acceptable. The following methods should be pursued only by experienced personnel. Proper hand-digging tools and techniques will protect both the workers and the utility.

- A blunt-nosed shovel is used to loosen the soil and a regular shovel is used to remove the soil. A pickax or a pointed spade should never be used. Do not stab at the soil or stomp on the shovel with both feet.
- Work with a gentle prying action and dig at an angle, so the shovel will slide along the surface of the wire, conduit, or pipe. Or, dig to the depth the utility is expected to be, but off to the side. Then, use a prying motion to break away soil as you approach the utility laterally.

2.11 - Clearance Methodologies cont.

Proper hand-digging tools and techniques must be used to safely verify the depth of any buried utilities that must be crossed or are located in close proximity to the work. Several types of direct contact methods include:

- Hand augers,
- Post hole diggers,
- Steel rods, and
- Hand digging tools.

A backhoe or similar machine may be used to uncover a utility. Clearly, the use of heavy equipment can produce severe damage to underground structures if not carefully performed. Due to hard soil structure or dense strata, use of hand tools to locate buried utilities may be precluded. In these instances, the clearance procedure requires excavation equipment. Extra measures must be taken to locate and identify buried utilities prior to excavation to protect against injury.

Methods that avoid direct contact:

- Air knifing or water jetting, and
- Vacuum soil excavation or wet vacuuming.

Air knife technology uses compressed air to break soil structure and allow for removal of the soil while reducing the potential for direct contact between buried utilities and the air knife operator. The compressed air essentially insulates the operator from directly contacting the buried utility. Compressed air, typically 90 to 100 psig, is converted to a supersonic jet while flowing through a nozzle especially designed for the purpose. Several nozzles are commercially available.

Figure 2.6 - Using an Air Knife (Photo courtesy of ATC Associates, Inc.)

2.11 - Clearance Methodologies cont.

As the stream leaves the nozzle, it expands concentrically, since it is surrounded by atmospheric air. This high velocity air penetrates the ground to a depth of about a foot, creating a momentary cavity of about a foot in diameter, in which the soil structure is crumbled.

Hard clays and other very hard soils will be slow during the first several inches of depth, and will produce increased scatter. But somewhat deeper, where the soil has usually retained greater moisture, the scatter will reduce, and the excavation rate will improve.
Both dry and wet applications of these technologies can be performed. Both methods have inherent problems associated with compromising the borehole for collection of environmental samples. Typically, dry air knifing and vacuum extraction are preferred where soil samples must be collected in the top 5 feet of profile. Water jetting or wet vacuuming may also compromise future collection of groundwater samples, so is usually selected for boreholes advanced for remediation wells only.

SECTION 3 - MOBILIZATION, SET UP, AND DEMOBILIZATION

This section applies to mobilization and demobilization for the following types of site operations: air knifing, air vacuuming, drilling, using geoprobes, and hand-augers. This section does not cover safety related to site mobilization in passenger vehicles.

3.1 - Performing Pre-Mobilization Tasks

3.1.1 - Inspections and Maintenance

- It is important to ensure vehicles are road worthy (that is, that they have been properly maintained and inspected) before using them on public roadways or project sites. Federal, state, and local laws require that vehicles be properly maintained and safe to operate upon our highways. It is the responsibility of the owner or operator to ensure that:
    - All drivers are properly licensed for the equipment that they are to be driving and that they are trained in safe driving procedures.
    - Equipment is inspected prior to being moved and any deficiencies corrected prior to moving the equipment.
    - Complete annual inspections of vehicles is performed.
    - All drivers should have in their possession the Federal Motor Carrier Safety Regulations Pocketbook**.** These regulations require that no motor vehicle be driven unless the driver thereof has satisfied him or her self that the following parts and accessories are in good working order, nor will any driver fail to use or make use of such parts and accessories when and as needed:
        - Service brakes, including trailer brake connections
        - Parking (hand) brake
        - Steering mechanism
        - Lighting devices and reflectors
        - Tires
        - Horn
        - Windshield wiper or wipers
        - Rear-vision mirror or mirrors
        - Coupling devices
        - Seat belts

The above is a representative list of items that must be checked prior to moving a vehicle. These and other items are included in Attachment 3.A - *Pre-Mobilization Checklist / Drilling Safety Guidance Document.*

Perform a final examination to verify that the vehicle and load are safe to be moved. Know the height, width and weight of the load. Verify that any needed permits are obtained or will be obtained en route to the drill site.

Verify that all necessary traffic-control devices for each site to be visited that day are loaded in the vehicles before they leave the office.

- For contract traffic-control services, verify that they are scheduled to be at the site with all needed equipment.

3.2 - Loading and Unloading a Truck Mounted Drill Rig

When loading or unloading a drill rig on a trailer or a truck, follow these precautions:

- Select an area of level ground for loading and unloading
- Have a spotter guide the driver off of the trailer or truck.
- Before using a ramp, verify the brakes of the drill rig are in working order
- Ensure that any ramps used are designed for this purpose and provide a sturdy and solid enough base to bear the weight of the drill rig with carrier including tooling.
- Verify that when the drill rig is on the trailer, the weight of the drill rig, carrier and tools are centered on the centerline of the trailer. In addition, some of the trailer load should be transferred to the hitch of the tow vehicle. Refer to the trailer recommendations for weight distribution provided by the manufacturer.
- Verify the drill rig is secured to the towing vehicle with ties, chains, or load binders that can handle the required weight.

3.3 - Physically Accessing the Equipment and Vehicles

Use proper mounting and dismounting techniques when climbing into and from vehicles or equipment. Some tips are:

- Face the equipment and use the hand and footholds provided – maintain three points of contact with the equipment
- Do not jump off equipment.
- Use vehicle ladders to access truck beds.
- Do not climb on tires.

3.4 - Traveling to the Site

3.4.1 - Driver Requirements

All drillers and drivers must:

- Be properly licensed and operate vehicles in compliance with federal, state, and local regulations
- Be aware that every car, truck, tractor, and drill rig has its own handling characteristics; every new driver should learn these characteristics in the company of an experienced driver.
- Every employee should be qualified on each type of vehicle and equipment the employee will operate prior to operating the vehicle or equipment unsupervised.
- Every employee knows the dimensions of any equipment he or she is driving, including the required overhead clearance, and the width, length and weight of the rig. The driver also knows the load limits for highways and bridges, and verifies that the vehicle is not exceeding those limits.

NOTE: Service stations and other facilities frequently have canopies and electrical service lines that are too low for a drill rig to clear, extreme caution must be used in these areas.

3.4.2 - Road Travel and Vehicle Safety

Perform a pre-trip vehicle inspection and obey state and federal DOT guidelines. Check vehicle maintenance records to assure any needed maintenance has been performed. Pre-operate equipment before leaving for the site and be familiar with operator's manual. Leave early, practice defensive driving, and observe the speed limit.

- Drill rigs are top-heavy:
    - Maneuver highway ramps or tight curves at a slow and safe speed, avoid quick lane changes.
    - Allow a safe distance between you and the vehicle ahead and use your turn signals.
    - Know the traveling height of your equipment.
    - Secure any load(s) properly.
    - Inspect trailer and hitch, safety chains, wiring connectors, lights, and brakes, if applicable.
- While traveling to and from the site observe the following:
    - Move disabled vehicle off the road and set out flares and reflectors or cones, and leave trouble lights on and flashing.
    - Never work under a vehicle unless steps have been taken to prevent it from rolling. In addition to setting the parking brake, use chock blocks or other methods to secure the vehicle to prevent movement.
    - Never leave mobile equipment unattended unless the controls are placed in gear or the Park position and the parking brake is set. When parked on a grade, chock the wheels or turn them into the bank.
    - Allow for mast overhang when cornering or approaching other vehicles or structures.
    - Do not operate trucks 1-ton and above unless equipped with automatic backup alarms.
    - Wear seatbelts at all times as driver or passenger when the vehicle is in motion

3.4.3 - Transporting Drill Rigs

When transporting a drill rig onto and off of a drilling site, follow these procedures:

- Verify all measurements of the drill rig with carrier including the traveling height (overhead clearance), width, length, and the highway and bridge load, width and overhead limits. Allow adequate margins, it is your responsibility to verify they are not exceeded.
- Prior to moving a drill rig, check to verify that the brakes are in reliable working order.
- When cornering or approaching other vehicles or structures remember to allow room for the mast overhang.
- Keep in mind that the drill rig mast is often too tall to clear the canopies of service stations and other facilities, even in the travel position
- Monitor low hanging electrical lines, particularly at the entrances to drilling sites, restaurants, motels, or other commercial sites.
- When traveling on a street, road, or highway, the mast of the drill rig must be completely lowered.
- If the rig is being left unattended, remove all ignition keys.
- Passengers are not allowed to ride on the drill rig
- Use caution when driving equipment with a high center of gravity, such as a portable drill rig. Allow for the increased and higher weight by making turns slowly and allowing for a greater stopping distance than normally needed.
- Always know where your helper or driller is. Never move the drill until they are accounted for.
- Establish, learn, and use the proper signals when moving a drill rig.
- Never move the drill rig with the mast up- even short distances.

3.4.4 - Entering the Site

It is the responsibility of the owner or operator or the vehicle or rig to ensure that the drill site is safe to enter and that it is safe to begin work. Such inspections often include the following:

- Are high voltage overhead power lines or any other utility lines present in the immediate area? A safe distance of thirty or more feet laterally to either side of the overhead utility should be observed when setting up in the vicinity of overhead lines. This distance may need to be adjusted, depending on the hazards involved, size of mast on the drill rig, and other considerations.
- Have all underground utilities been identified?
- Is there a danger of being struck by other moving vehicles?
- Is there a danger because of possible instability of high walls, banks, pits, rivers, and other related items?
- Are poisonous plants, animals, or insects in the area of the drill site?
- Is the site designated as a Hazardous Waste Site or have other hazards been identified or suspected, such as H_2S, Methane, or other chemicals? If so, are proper procedures for working in these environments in place, including proper training of employees and certification of safety equipment?
- Is there a danger of lightning strikes? This subject must be addressed regardless of time of year or current weather conditions.
- MSDS sheets must be on hand for all materials and chemicals brought to the site.

3.5 - Confirmation Activities for Clearances and Borehole Positioning

3.5.1 - Permits

Copies of all necessary permits will be provided to the Lead Driller or Acting Lead Driller, and any further information relevant to the drilling operation.

It is the driller's responsibility to verify the necessary permits have obtained and it is safe to drill.

Based on either site conditions or the planned ground disturbance activities, to ensure the safety of all on-site personnel and subsurface structure integrity, consideration should be given to locking out selected site utilities or temporarily shutting down a portion of or the entire facility.

3.5.2 – Markings

- Complete utility location prior to drilling [One Call: 811 or your local utility locating service] and coordinate with the drilling contractor and site personnel.
- Mark locations in white.
- Field verify utility locations.
- Document all utility locates on a plot plan or other map of the site.
- Observe the area for indications of utilities.
- Hand dig if questions remain or if required by the property owner.
- Refer to your specific *Utility Clearance and Isolation* procedure.

3.5.3 - Site Communication and Safety Review

Verify all new drill rig workers are informed of safe operating practices and emergency procedures on and around the drill rig and provide each new drill rig worker with a copy of the organization's drilling operations safety manual and, when appropriate, the drill rig manufacturer's operations and maintenance manual. The safety supervisor should assure that each new employee reads and understands the safety manual. If applicable, the emergency shut off/kill switch location and use should be reviewed with all crew members as well as visitors to the site.

If the site poses a chemical safety hazard, review potential signs and symptoms of exposure, routes of exposure, and protective measures to be used to minimize or prevent exposures (such as protective clothing and monitoring).

3.5.4 - Walk Through and Visual Inspection

Upon arriving at the drill site, verify that it is safe to enter and set up on the site. As mentioned earlier, it is important to:

- Look for overhead and underground power and other utility lines.
- If present, verify that the rig is being set up a safe distance from these lines.
- Investigate and note all overhead obstructions.
- Check boring locations for proximity to any overhead lines.
- Maintain required clearance from electrical lines. Refer to section 4 – *Drilling Operations* for more detail. High-tension lines require greater clearances.
- Consider having lines in the work area covered to provide a greater safety margin
- If necessary, contact someone to verify that these lines are safe to work near (that they have been de-energized provided that they were supposed to have been deenergized).
- Assume a line is energized until you have verified it isn’t.
- If in doubt, do not raise the mast - ASK!

Examine the actual location where the drill is to be set. If possible, it is best to have a level and clean area. Remove rock and other debris that may interfere with the drilling operation or pose safety hazards.

Be sure to follow the instructions contained in the site health and safety plan. This includes the wearing of special chemical protective clothing, air purifying respirators or self-contained breathing apparatus before moving into location.

Walk the line the rig is to travel in order to delineate any soft or wet ground. Look for field tile washouts, hidden ditches or drop-offs, boulders, debris, or other potential obstacles.

3.6 - Preparing for Drilling

3.6.1 - Preparing the Site

Prior to drilling, adequate site clearing and leveling should be performed to accommodate the drill rig and supplies and provide a safe working area. Drilling should not be commenced when tree limbs, unstable ground, or site obstructions cause unsafe drilling conditions. Housekeeping should be done to ensure a clear area for all site personnel.

Prior to move-in, the site should be adequately cleared and leveled to accommodate the drilling equipment and supplies, and to minimize fire hazards.

Evaluate the drilling site prior to setting the leveling jacks, especially if the location is on water saturated, frozen, or loose, caving soil. Do no set up on sloped ground. If necessary, build up solid, compacted earth where the jacks will contact the ground.

Job site should be on level ground (recommended no more than 5% grade), with solidly compacted soil to support the drill rig and auxiliary equipment. If it is necessary to work on a slope, the rig should be backed perpendicular to the slope so at least the rig is level left to right and the driller's platform is closer to the ground.

If it is necessary to drill within an enclosed area, verify that exhaust fumes are conducted out of the area. Exhaust fumes can be toxic and some cannot be detected by smell.

3.6.2 - Traffic Control

Traffic control devices may consist of items such as:

- Traffic cones
- Flags
- Caution tape
- Other devices such as signs, barricades, amber flashing lights, or fencing

It is recommended that each work area be cordoned off with traffic cones or other traffic control devices as appropriate to site-specific conditions. To increase visibility to vehicular traffic, it is recommended that every other cone have a flag inserted through its middle. Caution tape should be used to join all of the traffic control devices so that no one can easily walk through the work area. It is also recommended that work vehicles be used to shield field personnel from traffic hazards when practical. In addition, high-visibility clothing should be worn by workers.

3.6.3 - Considerations for Retail Service Stations and Other Onsite Locations

As there are no lanes marked out for traffic flow through most of these sites, and there are typically numerous entry points onto them, field personnel are vulnerable to traffic from all sides. In order to minimize the risk of being struck by a vehicle while performing tasks on site, field personnel may consider the following guidelines when developing work site traffic control plans:

- Review the site-specific Health and Safety Plan (HASP) for safety and any special traffic control details for the site you will be working on and the tasks you will be performing.
- Wear the appropriate PPE for the work to be performed as indicated in the HASP.
- Assess the work location for potential traffic exposure. Stay alert at all times since vehicular traffic is often continuous and uncontrolled on these sites. Evaluate all possible directions from which traffic may approach including the possibility of vehicles backing up. Never assume any potential pathway to be safe. Attempt to set up the work area on site with field personnel facing toward the highest potential for traffic while they work.
- Conduct a site pre-job safety meeting and complete the Daily Site Checklist, if included in the HASP, and sign-off on both the checklist and the HASP.
- Using the traffic control devices, establish your work zone as per the specifications detailed within the HASP.
- Perform all work to be completed within the work zone before breaking down the traffic control system.
- Clear the work area and break down the traffic control system.

3.6.4 - Working in or Near Active Roadways

Traffic control in these areas should be managed through development of an appropriate traffic control plan. A traffic control plan specific to the work site should be developed and included in the HASP, prior to performing work in these areas. Local and state requirements should also be consulted for possible permitting or additional traffic control requirements prior to performing any work in these areas.

3.6.5 - Establishing Work Areas Using Monitoring or Barricades

The field supervisor will designate the work zone based on site constraints before drilling begins. Preferably, the geotechnical workstation should be set up outside of the immediate drilling work area a distance of at least 1.5 times the mast height away from the drill.

- When possible, an exclusion zone with a radius of at least one mast length shall be created around the rig. Unauthorized personnel shall be kept clear of this zone.
- Post No Smoking signs around work area
- Establish designated smoking area away from work area
- Monitor air concentrations using direct-reading, real-time instruments such as OVM and colorimetric detector tubes
- Define and secure all work areas with safety cones, safety tape, construction fence, other barriers, or signs as appropriate.

3.6.6 - Establishing Site Security

Confirm required security is in place and as dictated by the site or HASP prior to beginning drilling operations. This may involve security personnel, physical barriers, or both.

3.6.7 - Storage and Material Handling

The key for a safe and smooth startup is to organize the work area prior to commencing drilling operations:

- Do not attempt to commence drilling before everything is unloaded and organized. Drilling will progress smoothly and accidents will be less likely if the driller takes the time to properly set up and organize first.
- The first requirement for safe field operation is that everyone understands and fulfills the responsibility for maintenance and housekeeping on and around the drill rig.
    - Suitable storage locations should be provided for all tools, materials, and supplies so that tools, materials, and supplies can be conveniently and safely handled without hitting or falling on a member of the drill crew or a visitor. Store items so that the work can proceed in an orderly fashion, with sufficient room in the work area to move about without tripping over supplies or equipment. Do not store equipment in places that would interfere with escape routes in an emergency.
    - Avoid storing or transporting tools, materials, or supplies within or on the mast of the drill rig.
    - Establish a suitable location for storage of tools, equipment and supplies so those items can be safely and conveniently stored and located when needed. Keep all tools supplies and equipment in their proper places.
    - Every crewmember must inspect their work site upon arrival to verify that equipment is in safe condition and the job site is in proper order. Return the job site to proper order prior to proceeding with work.
    - Drill rod, casing, augers and similar tools should be stacked orderly on racks to prevent sliding, rolling, spreading, or falling. When stationed on the ground prior to use, these tools may need to be chocked to prevent inadvertent or unanticipated rolling.
    - Work areas, platforms, walkways and other access-ways should be kept free of obstructions such as materials and tools, and substances such as debris, grease, ice, and mud, in order to minimize the tripping, slipping and falling hazards around the drill rig.
    - All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, visitors or animals from stepping or falling into the hole.
    - Use approved cleaning solvents instead of flammable liquids as cleaning agents on or near a drill rig.
    - Never use compressed air for the purpose of cleaning clothes.
    - All trash should be placed in bags and stored in areas outside of the immediate work area.
    - All controls, meters, dials, and operational and warning lights should be kept free of dirt, grease, and mud.
    - Keep all flammable liquids in proper containers and stored away from heat and spark sources.
    - All drilling fluids must be contained and disposed off-site
    - Pipe, drill rods, casing, augers, and similar drilling tools should be orderly stacked on racks or sills to prevent spreading, rolling, or sliding.
    - Penetration or other driving hammers should be placed at a safe location on the ground or be secured to prevent movement when not in use.
    - Work areas, platforms, walkways, scaffolding, and other access-ways should be kept free of materials, debris, and obstructions and substances such as ice, grease, or oil that could cause surfaces to become slick or otherwise hazardous.

3.6.8 - Fire Prevention

Fire prevention must be addressed prior to commencing any job. Failure to prevent a fire on a job site could result in severe injury or even death of employees. In addition to the potential for loss of life, severe equipment damage can result along with damage to surrounding areas. It is therefore the responsibility of the owner, operator, driller, helper, and anyone else involved in the drilling operation to take proper steps to reduce the possibility of a fire. Such steps should include:

- When possible, the surrounding area should be cleared of materials that are readily combustible, such as weeds, grass.

NOTE: Some areas are environmentally sensitive. This type of clearing may not be allowed.

- No smoking policies should be observed when working on drilling operations.
- Fire extinguishers of the appropriate size and type for the particular fire hazard involved must be present on the drill site. It is recommended and required on some jobs, that a fire extinguisher be present in every vehicle involved with the drilling activities.

NOTE: Operators must verify that fire extinguishers are serviced at appropriate intervals and that an inspection is performed on the fire extinguishers at least monthly. Such inspections and servicing must be documented.

- Only onsite personnel, trained in basic fire fighting techniques and in the proper operating procedures associated with the use of fire extinguishers, should respond to fires.

The best method, of course, is to prevent the fire entirely. Proper storage of fuels and good maintenance of hoses, and equipment on the rig will prevent many fires. A proactive approach is by far better than the best reactive solution to any problem.

3.6.9 - Safety Equipment

Safety equipment to consider includes but is not limited to traffic cones, PPE, barricades, barrier tape, signage, A fire extinguisher, blood borne pathogen kit, and first aid kit should be kept or available on site. Telephone access is essential. Identify the location of the nearest available telephone and, unless specifically forbidden by the site owner, ensure the team has access to a cell phone (unless prohibited). If the team is planning to use a cell phone, check for adequate signal strength upon arrival at the site. Refer to section 4.8 for additional information about safety equipment.

3.7 - Moving People and Equipment at the Site

Navigating across the site requires special attention. Many safety incidents occur in and around moving vehicles and equipment. The following guidelines will help eliminate some common dangers.

3.7.1 - Placing the Equipment

Figure 3.1 – Placing Equipment

The following safety suggestions relate to off-road movement:

- Never drive onto an off-road site or move a drill rig without first walking the route to check for depressions, rocks, stumps, gullies and similar obstacles. Be aware that overhead clearance requirements can vary dramatically as the vehicle rocks up and down while driving over obstacles and rough terrain.
- Check the brakes of the drill rig carrier before traveling, particularly on rough, uneven, or hilly ground.
- Check the complete drive train of a carrier at least weekly for loose or damaged bolts, nuts, studs, shafts, and mounting.
- Discharge all passengers before moving a drill rig on rough or hilly terrain.
- Use caution when traveling side-hill. Conservatively evaluate side-hill capability of drill rigs because the arbitrary addition of drilling tools may raise the center of mass. When possible, travel directly uphill or downhill. Increase tire-pressures before traveling in hilly terrain (do not exceed rated tire pressure).
- Attempt to cross obstacles such as small logs and small erosion channels or ditches squarely, not at an angle.
- Use the assistance of someone on the ground as a guide when lateral or overhead clearance is close.
- After the drill has been moved to a new drilling site, set all brakes and locks. When grades are steep, block the wheels.
- Never move a drill rig with the mast up.
- Maintain eye contact with the operator when directing the rig on to a boring location.
- Always walk around the truck prior to backing to assure that the area behind the truck is clear of equipment and workers.
- Never back out of a site onto a highway, unless traffic control is provided.
- Always position the vehicle in the safest possible place at drilling locations
- When working in a lane-closure do not enter the lane closure until it is set up, do not work in an improperly set up lane closure.
- CDL holders required by DMV to wear corrective lenses must wear them at all times performing Safety sensitive duties.

- When overhead electrical power lines exist at or near a drilling site or project, consider all wires energized.
- Watch for sagging power lines before entering a site. Do not lift power lines to gain entrance. Call the utility and ask them to lift or raise the lines or de-energize (turn off) the power.
- Before raising the drill rig mast on a site in the vicinity of power lines, walk completely around the drill rig. Determine what the minimum distance from any point on the drill rig to the nearest power line will be when the mast is raised and while being raised. Do not raise the mast or operate the drill rig if this distance is less than 20 feet (6 m) or, if known, the minimum clearance stipulated by Federal, state, and local regulations.
- Keep in mind that both hoist lines and overhead power lines can be moved toward each other by the wind.
- If there are any questions concerning the safety of drilling sites in the vicinity of overhead power lines, call the power company. The power company will provide expert advice at the drilling site as a public service and at no cost.
- Watch for overhead obstructions. Never travel between borehole locations with the mast, or feed cylinders, in a raised position.
- Know the location(s) of any other heavy equipment moving or working on-site.
- Weekly, inspect the complete drive train of a carrier for loose or damaged bolts, nuts, studs, shafts, and mountings.
- When travel takes you off road and into hill terrain, use the front axle (for 4x4, 6x6, etc. type vehicles or carriers). If equipped with multiple speed transfer case, operate in low range. Always refer to the manufacturer's recommendations.

3.7.2 - Loading and Unloading Rigs

When loading or unloading a drill rig on a trailer or a truck, follow these precautions:

- Verify you are on level ground for loading and unloading
- Have someone on the ground guiding you.
- Before using a ramp, verify the brakes of the drill rig are in working order
- Ensure that any ramps used are designed for this purpose and provide a sturdy and solid enough base to bear the weight of the drill rig with carrier including tooling.
- When the drill rig is on the trailer, verify the weight of the drill rig, carrier and tools are centered on the centerline of the trailer. In addition, some of the trailer load should be transferred to the height of the towing vehicle. Refer to the trailer recommendations for weight distribution provided by the manufacturer.
- Verify the drill rig is secured to the towing vehicle with ties, chains, or load binders that can handle the required weight.
- Inspect the trailer tires before loading or unloading. A flat tire will cause the rig and trailer to lean and equipment could come off the trailer.
- When traveling on the road, be sure the rig's slide base is in fully, that the rig is completely on the trailer, in the proper position, and secured.
- Skidding the rig off the trailer and to boring locations requires forethought and caution. Do not ride the skids when moving the rig. Avoid potential rollovers by skidding the rig perpendicular up a slope, not parallel or at a shallow angle to the slope.
- Provide a secure base and use cribbing of the appropriate size to level the rig.
- Secure the rig to the pavement, floor, or ground with anchor bolts, frost augers, chains, cables, or as appropriate.

3.7.3 - Start Up

Precautions for Setting up and Blocking the Drilling Rig

It is the driller's responsibility to verify the rig is properly set up. The stability of the drilling rig is critical to assure safe drilling operations. Some things to consider when setting up are provided below. Refer to section 4 – TITLE for more detailed information.

- Whenever possible, the driller should choose a dry, level, and reasonably smooth drilling site. Verify the rig's parking brake is engaged and that the wheels which will remain on the ground are blocked. Blocking the rig will help to provide a more stable drilling structure by distributing the weight of the rig evenly. If the rig is equipped with jacks or outriggers, they will be extended from the rig to the ground, raising the rig partially or entirely off the ground. Proper blocking of the rig will prevent differential settling which could result in the rig toppling sideways. Blocks should be placed between the jack swivel and the ground to provide more support area under the pad.
- All drill rig personnel and visitors should be instructed to stand clear of the drill rig immediately prior to and during starting of an engine.
- Before start-up, check that all brakes are set, all gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers or air controls are in the correct position, and the cathead rope is not on the cathead.
- Follow all guidelines provided by manufacturers with regards to starting up engines.
- Check for warning or lockout tags on the controls. Do not start any engine without having the tag removed by the person responsible for the install.
- Prior to lowering the leveling jacks, we recommend that a timber or plank be placed beneath the jack. By performing this function, it will be less likely that the jacks will sink into the ground. Even on asphalt, jacks could possibly, over time, sink down to the point that the rig might not remain level. Insure that the rig is level and everything is secured prior to raising the mast. Before the mast is raised, the rig must be leveled and stabilized with the leveling jacks.
- Verify before drilling is started with a particular drill, that the operator (who may be the safety supervisor) has had adequate training and is thoroughly familiar with the drill rig, its controls, and its capabilities.
- Inspect the drill rig when it first arrives onsite and then at least daily for structural damage, loose bolts and nuts, proper tension in chain drives, loose or missing guards or protective covers, fluid leaks, damaged hoses, damaged pressure gauges, and pressure relief valves.
- Check and test all safety devices such as kill switches at least daily and preferably at the start of a drilling shift. Drilling should not be permitted until all kill switches and warning systems are working correctly. Do not wire around, bypass, or remove an emergency device.
- Verify all gauges, warning lights, and control levers are functioning properly and listen for unusual sounds on each starting of an engine.
- Verify nothing is loose on the mast that would fall when the mast is raised to its upright position. When the mast is raised, take measures to secure it properly.

3.8 - Shut Down - Temporary (Daily) and Permanent

3.8.1 - Temporary Shut Down

- Inspect equipment at the start of each shift (pre-op) and at the end of each shift (post-op).
- Correct all major defects and safety defects prior to the start of work.
- All air and water lines and pumps should be drained when not in use if freezing weather is expected. If appropriate, the rig should be winterized at the end of each day.
- All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors, or animals from stepping or falling into the hole.
- For remote, idled, or access controlled sites, clearance holes can be left open, however, use hazard cones, fencing or other methods to identify the hazard.

3.8.2 - Demobilization

- Refer to the pre-travel inspection and safe driving procedures outlined in Section 1 and 2 when demobilizing.
- When loading equipment prior to demobilization, be especially alert to potential back injuries. Use proper lifting techniques including getting help if necessary.
- Verify any waste materials have been removed from the site or properly contained, labeled and scheduled for pickup.
- All open boreholes should be covered and protected or backfilled adequately and according to local and state regulations on completion of the drilling project.

SECTION 4 - DRILLING OPERATIONS

4.1 - Rig Set-up

The drilling contractor is responsible for ensuring that the rig is properly set-up. This includes such tasks as stabilizing the rig, clearing the location of overhead obstructions that may contact the mast as it is being raised or is in the fully raised position, and raising the mast. Each task is discussed in greater detail below.

4.1.1 - Drill Rig Stabilization

Rig stability is essential for conducting safe drilling operations. Components to assuring proper stabilization include rig placement (or location), use of hydraulic leveling jacks, use of blocking (or cribbing), and use of wheel chocks. Specific items to consider include the following:

Rig Placement

- To the extent possible, situate the rig on dry, level (recommended no more than 5% grade), and stable compacted ground surface.
- To the extent possible, avoid rough terrain and sites that do not allow sufficient space for worker access and egress to and from rig and associated support equipment.
- Carefully evaluate the drilling site prior to setting the leveling jacks, especially if the location is on water saturated, frozen, or loose, caving soil.
- Avoid situating rig on sloped ground. If necessary, build up solid, compacted earth where the jacks contact the ground.
- Rig is to be backed perpendicular to slope so at least the rig is level left to right, and the driller's platform is closer to the ground.
- The jacks from left to right should be as level as possible to prevent the rig from moving during operation.
- When setting up drilling fluid discharge, ensure it is channeled away from the rig to avoid soil erosion under jacks and cribbing.
- Avoid situating rig where overhead obstructions, such as tree limbs, canopies, overhead power lines, and piping racks, create unsafe drilling or tool handling conditions.
- Engage the emergency brake once the rig has been positioned.

Jacks

- Lower or extend leveling jacks and outriggers to raise the rig partially, or in some cases entirely, off the ground and to minimize the potential for the rig to tip over once the mast is raised.
- Do not position hands on or near jacks as jacks are being lowered or raised.
- Maintain jacks in lowered position as long as mast is raised.
- Non-skid jack pads are recommended for unimproved terrain or slopes.
- Be sure to monitor all rig jacks during setup and operation (front center and/or rear).
- Jacks should be inspected throughout drilling operations to identify changing ground conditions.

Blocking and Cribbing

- Blocking and cribbing is designed to distribute the weight over a larger surface area. When drilling on non-compacted soil, use blocks of sufficient strength to support the weight of the rig and to provide a more stable drilling structure. The larger the blocks (length, width, and height) the more evenly distributed the rigs weight will be and the potential for differential settling will be minimized. Blocks will more evenly distribute the rig's weight and will prevent differential settling.
- Recheck the status of blocking and cribbing at the beginning of each shift to evaluate stability.
- Locate blocks between the jack swivel and ground.
- Re-level drill rig if settling occurs after initial set-up.

Wheel Chocks

- If the rig is positioned on an incline and leveling of ground is impossible or impractical:
    - Chock the wheels of the rig remaining in contact with the ground.
    - Chock wheels of all support equipment and trailers.
    - It is highly recommended that wheel chocks be used even if the rig is on level ground.

4.1.2 - Overhead Hazards

Contact with overhead obstructions when raising the rig mast can result in property damage, injury, and, most importantly, loss of life. The most frequent cause of job-related death in the drilling industry is electrocution caused by contact of the drill rig with overhead power lines. Additionally, contact with overhead power lines can result in electrical shock and electrical burns. Drilling should not commence without first determining the risk posed by obstructions such as tree limbs, protruding objects and structures, and overhead power lines. The proposed drilling location should be inspected by the drilling contractor prior to setting-up the rig to ensure that all such obstructions have either been removed or that the risk of contacting such obstructions has otherwise been mitigated. Specific items to consider include the following:

Structures

- Prior to raising mast, review location for the presence of overhead structures, such as canopies, trees, or piping racks.
- Maintain sufficient horizontal space (approximately 10 ft) between overhead structures and rig to allow for mast to go past vertical when being raised.

Overhead Power Lines

- Contact the power company for expert advice on drilling in the vicinity of overhead power line(s) at a specific location and to determine if the power line(s) can be de-energized during drilling operations. Never assume a line is de-energized - ASK! If in doubt, do not raise the mast.
- Inspect location for sagging power lines before making entry with rig. Never lift power lines to gain entry to location.
- Note location of overhead utilities on all boring location plans and site work plans. Whenever possible, locate borings to avoid any possibility of contact with power lines. Walk completely around the rig to determine what the distance will be between the nearest power line and the mast as it is being raised and in the raised position
- When drilling near overhead power lines is unavoidable, allow sufficient space between the mast and the overhead lines. Because of the difficulty in estimating distances from the ground and the

effects of wind on the power lines and hoist lines of the mast, it is advisable to maintain a 20-foot clearance.

- Post signs on ground level to alert workers to the presence of overhead utilities.
- Never raise the mast of the rig without a designated spotter.
- Except where electrical distribution and transmission lines have been de-energized and visibly grounded at point of work or where insulating barriers, not a part of or an attachment to the equipment or machinery, have been erected to prevent physical contact with the lines, equipment or machines shall be operated proximate to power lines only in accordance with the following per 29 CFR 1926.550(ii):
    - For lines rated 50 kV or below, minimum clearance between the lines and any part of the crane or load shall be 10 feet,
    - For lines rated over 50 kV, minimum clearance between the lines and any part of the crane or load shall be 10 feet plus 0.4 inch for each 1 kV over 50 kV, or twice the length of the line insulator, but never less than 10 feet,
    - In transit with no load and boom lowered, the equipment clearance shall be a minimum of 4 feet for voltages less than 50 kV, and 10 feet for voltages over 50 kV, up to and including 345 kV, and 16 feet for voltages up to and including 750 kV.
- Unless a more conservative spacing requirement is stipulated by state or local regulations, use the following table as minimum spacing guidance:

TABLE 4.1 - Spacing Guidelines for Electrical Service

Nominal Voltage (Phase to Phase)	Minimum Required Clearance (feet)
≤ 50,000	10
Over 50,000 to 75,000	11
Over 75,000 to 125,000	13
over 125,000 to 175,000	15
over 175,000 to 250,000	17
over 250,000 to 370,000	21
over 370,000 to 550,000	27
over 550,000 to 1,000,000	42

Adapted from Code of Safe Drilling Practices, California Dept. of Transportation, Division of Engineering Services, Revised April 30, 2004

- Because of the difficulty in estimating distances from the ground and the effects of wind on the power lines and hoist lines of the mast, it is advisable to maintain at least a 20-foot clearance.
- Confirm with the power company that overhead power lines have been de-energized prior to drilling.
- Never drive the drill rig from hole to hole with the mast in the raised or partially raised position.

If contact between rig and power line occurs:

Assume the entire rig to be electrified. Do not attempt to enter or leave the rig or touch any part of it. Although people in the rig may not be affected, anybody touching the rig while in contact with the ground is in danger of being electrocuted.

Have someone call the power company and the local fire rescue squad immediately for assistance.

Do not touch any person who may be in contact with the current.
If a rescue is attempted, use a dry, clean rope or a dry, unpainted wood pole to remove the victim. Do not touch the victim until he has been removed from the current.
If the victim is unconscious when released from the current, check his breathing and pulse and, if needed, begin CPR immediately.

- Under most circumstances, the operator and other personnel on the seat of the vehicle should remain seated and not leave the vehicle. Do not move or touch any part, particularly a metallic part, of the vehicle or the drill rig.
- If you are on the ground, stay away from the vehicle and the drill rig, do not let others get near the vehicle and the drill rig, and seek assistance from local emergency personnel, such as the police or fire department.

4.2 - Raising the Mast

Once the rig has been properly stabilized and the location cleared of overhead obstructions, the rig mast can be raised. Specific items to consider include the following:

Starting the engine

- Start all engines in accordance with the manufacturer's manual.
- All drilling rig personnel and visitors should be instructed to stand clear of the drilling rig immediately prior to and during starting of an engine.
- Check for warning or lockout tags on the engine controls. If a warning or lockout tag is attached to the switch, do not start the engine until the warning tag has been removed by the person who installed it.
- Verify all gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers are in the correct non-actuating positions, and the cathead rope is not on the cathead before starting a drilling rig engine.

4.2.1 - Jump Starting an Engine with a Dead Battery

Use the following procedure when jump starts are necessary:

NOTE: do not connect the negative clamp to the negative (-) terminal of the discharged battery.

1. Connect one of the positive (+) cable clamps (red) to the positive terminal of the discharged battery.
2. Connect the positive clamp (red) from the other end of the jumper cable to the positive (+) terminal of the good battery.
3. Connect the clamp from the negative jumper cable (black) to the negative (-) terminal of the good battery.
4. Connect the negative cable clamp (black) on the other end of the jumper cable to the engine block or other good engine metal surface on the vehicle with the discharged battery. Do not connect the negative clamp to the negative (-) terminal of the discharged battery. This may trigger a spark and result in explosion of the gases surrounding the battery, causing injury.

Raising the Mast

- Before raising the mast, look up to check for overhead obstructions.
- Remove all loose objects, such as equipment and tools from the mast and inspected for damaged parts
- Raise the mast only after the leveling jacks are down. Do not raise the jacks until the mast has been lowered completely.
- Before raising the mast, all drill rig personnel (with exception of the operator) and visitors should be cleared from the areas immediately to the rear and the sides of the rig. No other work should be performed in the vicinity of the mast while it is being raised or lowered.
- Only qualified personnel may raise or lower the mast.
- Raise the mast a few inches in order to check brakes.
- Never drive the drill rig from hole to hole with the mast in the raised or partially raised position.

Securing Mast

- Secure or lock the mast in upright position according to the drilling manufacturer's recommendations.

4.3 - Auger Drilling

Auger drilling uses direct power to rotate (screw) flighted augers into the ground. Drill rigs must have kill switches in operable condition. Familiarize yourself with their location and operation. At least two persons must be present when operating the rig. Do not wear loose clothing, jewelry, hair, or equipment near the auger

The operator and tool handler should establish a system of responsibility for the series of various activities required for auger drilling, such as connecting and disconnecting auger sections, and inserting and removing the auger fork. The operator must assure that the tool handler is well away from the auger column and that the auger fork is removed before starting rotation.

Be aware of the following hazards which may be unique to this type of drilling:

- Clean the auger's male and female ends with a wire brush. Do not clean out bolt holes with your fingers. When applicable, couple the rig to the next auger while that auger is on the ground, then allow the machine to pick it up and place it on the down-hole string. Idle the machine down before engaging the rotation.
- Only use the manufacturer's recommended method of securing the auger to the drill drive coupling. Do not touch the coupling or the auger with your hands, a wrench, or any other tools during rotation.
- Whenever possible, use tool hoists to handle auger sections.
- Never place hands or fingers under the bottom of an auger section when hoisting the auger over the top of the auger section in the ground, or over other hard surfaces such as the drilling rig platform.
- Never allow feet to get under the auger section that is being hoisted.
- Prepare to start an auger boring with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear, and the engine running at low RPM.
- Use low-profile auger pins.
- Apply an adequate amount of down pressure prior to rotation to seat the auger head below the ground surface.
- Look at the auger head while slowly engaging the clutch or rotation control and starting rotation.
- When rotating augers, stay clear of the rotating augers and other rotating components of the drilling rig. Never reach behind or around a rotating auger for any reason whatsoever.
- Slowly rotate the auger and auger head while continuing to apply down pressure. Keep one hand on the clutch or the rotation control at all times until the auger has penetrated about 1 foot or more below the ground surface.
- If the auger head slides out of alignment, disengage the clutch or hydraulic rotation control and repeat the hole starting process.
- An auger guide can facilitate the starting of a straight hole through hard ground or a pavement.
- Never place your hands between the drill rig and an auger, even when attempting to free damaged or bound sampling equipment from the auger.
- Use a long-handled shovel to move auger cuttings away from the auger. Never use hands or feet to move cuttings away from the auger. It is preferable to move cuttings while the auger is inactive.
- Augers should be cleaned only when the drill rig is in neutral and the augers have stopped rotating.
- After loosening the top auger from the down-hole string, allow the machine to pick up the auger off of the string and set it on the ground, then uncouple from the machine.
- Care should be taken to ensure augers are properly stored and secured when not in use and during transport.

4.3 - Auger Drilling cont.

When using screw together augers consider the following:

- When coupling augers, idle the machine down while screwing together the augers and remove the auger catcher before rotating the auger string.
- When uncoupling augers, clean off the area where the pipe wrench jaws will engage the bottom auger.
- Drillers should remove their hands from the rotation lever or clutch handle while allowing the helper to place the wrench in the proper position. The helper should loosely hold on to a rope attached to the end of the pipe wrench to maintain tension. After breaking the auger, drillers should remove their hand from the rotation lever or clutch handle while allowing the helper to remove the wrench and put the auger catcher in place.

When using bolt-together augers, consider the following:

- Do not use bolts with excessively rounded heads or worn out threads.
- Do not use a worn out socket or breaker bar.
- Pull on the breaker bar to tighten bolts. Do not push.
- Drillers should remove their hands from the rotation lever or clutch handle while auger bolts are removed and the auger catcher is positioned.
- If the top auger will not disengage from the string, strike the auger with a hammer on the thick area of the female coupling end.
- Do not strike the flights, bolt holes, or the body (tube) of the auger.
- If the auger cap bolt will not loosen by hand, tap it with a hammer or use the breaker bar and socket.
- If the top cap will not disengage from the auger, strike the cap with a hammer.

When using solid stem flight augers, consider the following:

- Place the C-pin so the movement of cuttings up the flights will not disengage it.
- Drillers should remove their hands from the rotation lever or clutch handle while allowing the helper to remove the C-pin and put the auger catcher in place.
- When hoisting a string of augers from the borehole, use the proper top adapter that will not allow the string to become disengaged from the hoist line.

4.4 - Rotary Drilling

The term *mud rotary* means direct rotary drilling using mud slurry or water circulation to remove cuttings and keep the borehole wall stabilized. Be aware of the following hazards which may be unique to this type of drilling:

- Lifting heavy equipment (such as drill rods, flight augers)
- Rotating equipment and parts, flight augers, and
- Slippery or dangerous work areas caused by messy mud pits or troughs (workers could fall in), keep work area clear.
- Water swivels and hoisting plugs should be lubricated and checked for frozen bearings before use.
- Do not hold on to the discharge hose, or allow it to coil around your feet, while the tools are rotating.
- When unscrewing a side-mount water swivel from the drill string, be sure the string is sitting on the bottom of the borehole. Do not hold on to the back-up wrench while tools are rotating.
- Use the proper size wrench to makeup and breakout joints of casing. Put yourself in a stable position and pull, do not push, on the wrench.
- Keep hands away from the bottom of the bit assembly when removing it from, or inserting it into, the casing or boring. Set the assembly on the ground and remove it from the overshot - do not allow it to hang from the wire line.
- Use full grip circle wrenches to assemble and disassemble core barrels.
- Keep hands away from the bottom of the core barrel or inner tube when removing it from, or inserting it into, the casing, augers, or drill rods.

Air rotary is direct rotary drilling using high pressure air circulation to remove cuttings and keep the bit cool. Be aware of the following hazards which may be unique to this type of drilling:

- Rotating/lifting equipment,
- High pressure air lines,
- Air discharge of cuttings at high velocity (use a cover to control discharge of cuttings),
- Heavy drill rods being lifted,
- High noise levels, wear hearing protection,
- Space limitations (large drill rig and support vehicle), and
- Dust generation in dry formations (move upwind and use a cover or water spray for dust control).

4.4 - Rotary Drilling cont.

Listed below are general rotary (air and mud) drilling hazards:

- Do not brake drill rods during their lowering into the hole with drill rod chuck jaws.
- Drill rods should not be held or lowered into the hole with pipe wrenches.
- If a string of drill rods is accidentally or inadvertently released into the hole, do not attempt to grab the falling rods with your hands or a wrench.
- In the event of a plugged bit or other circulation blockage, high pressure in the piping and hose between the pump and the obstruction should be relieved or bled down before breaking the first tool joint.
- When drill rods are hoisted from the hole, they should be cleaned for safe handling with a rubber or other suitable rod wiper. Do not use your unprotected hands to clean drilling fluids from drill rods.
- If work must progress over a portable drilling fluids (mud) pit, do not attempt to stand on narrow sides or cross members. The mud pit should be equipped with a rough surface or cover panels of adequate strength to hold drilling rig personnel.
- Drill rods should not be lifted and leaned unsecured against the mast. Either provide some method of securing the upper ends of the drill rod sections for safe vertical storage or lay down the rods in a safe area.
- Drill rod chuck jaws should be checked periodically and replaced when necessary.
- The capacities of hoists and sheaves should be checked against the anticipated weight of the drill rod string plus other expected hoisting loads.
- Only the operator of the drill rig should brake or set a manual chuck so that rotation of the chuck will not occur prior to removing the wrench from the chuck.

4.5 - General Drilling Safety

4.5.1 - Training

- Employees working in the proximity of an operating drilling rig and the support equipment required to complete wells should be thoroughly familiar with the operational hazards involved.
- Prior to commencing investigative work, all employees must review the Site-Specific HASP and the hazards surrounding a drill operation. Document this by having the employees read and agree with the provisions of the Site-Specific HASP and then by having them sign an acknowledgement form.

4.5.2 - Housekeeping On and Around the Drill Rig

Good housekeeping is a proactive approach to keeping the job-site clean which in-turn reduces accidents and injuries. A clean work environment adds to drilling speed and efficiency. Customers like it when you keep and leave a work-site clean because it shows professionalism. Together, good housekeeping improves working conditions and safety practices. Every crewmember should inspect the work site upon his arrival to assure that equipment is in safe condition and the job site is in proper order. Return the job site to proper order prior to proceeding with work.

NOTE: The right time to clean-up is immediately after a mess is made.

Housekeeping means cleaning-up, *which is an ongoing part of drilling*, rather than an occasional activity. Follow these suggestions to make your housekeeping efforts more efficient:

- Identify where to unload equipment and supplies
- Put materials in a convenient place where they can be safely handled without hitting or falling on anyone
- Find a safe place for tools you pick up, not on the edge of a truck bed
- Drill rods, casing, augers, and similar tools should be orderly stacked on racks to prevent sliding, rolling, spreading, or falling
- Place fire extinguishers and first aid kits in easily accessible locations
- Decide on a location for trash collection: All trash should be placed in bags and stored in areas outside of the immediate work area.
- Determine a steam cleaning site that reduces the mess
- Every crew member is responsible for site clean-up
- Good housekeeping can eliminate most trip hazards

NOTE: When you are not given a task to do, *clean-up something*.

4.5.2 - Housekeeping On and Around the Drill Rig cont.

The first requirement for safe field operation is that everyone understands and fulfills the responsibility for maintenance and housekeeping on and around the drill rig.

- Suitable storage locations should be provided for all tools, materials, and supplies so that tools, materials, and supplies can be conveniently and safely handled without hitting or falling on a member of the drill crew or a visitor, without creating tripping hazards, and without protruding at eye or head level.
- Avoid storing or transporting tools, materials, or supplies within or on the mast of the drill rig.
- Pipe, drill rods, casing, augers, and similar drilling tools should be stacked orderly on racks or sills to prevent spreading, rolling, or sliding.
- Penetration or other driving hammers should be placed at a safe location on the ground or be secured to prevent movement when not in use.
- Work areas, platforms, walkways, scaffolding, and other access ways should be kept free of materials, debris, and obstructions and substances such as ice, grease, or oil that could cause surfaces to become slick or otherwise hazardous.
- Keep all controls, control linkages, warning and operation lights, and lenses free of oil, grease, and ice.
- Do not store gasoline in any portable container other than a self-closing, non-sparking, red container with flame arrester in the fill spout and having the word *gasoline* clearly visible. The container must also comply with all other hazard communication requirements.
- Dirty or contaminated pipe, drill rods, augers, or sampling equipment, should be moved away from the work area to prevent possible exposure to non-protected personnel and also to prevent cross-contamination of clean materials.
- Wastewater and drilling fluids must be properly contained and labeled and stored out of the operational area.
- The use of additional footing safeguards (mats) should be evaluated on a case-by-case basis.
- Remove and dispose of empty bags or other containers, which have held drilling mud, cement or other dust producing materials.
- Do not leave items such as hand tools, rakes, shovels, or other small equipment left lying on the ground to pose a trip hazard.
- Welding gas cylinders should be stored in an upright and secured position. Protective caps should be in place when the cylinders are not in use.
- Never use compressed air for cleaning clothes.
- All unattended boreholes must be adequately covered or otherwise protected to prevent personnel, site visitors, or animals from falling into the hole. All open boreholes should be covered, protected, or back filled adequately and according to local and state regulations or customer requirements upon completion of the drilling project.
- Walk around, not over, obstacles. Carefully choose a walking path to avoid ruts and steep slopes. Walk around freshly placed fill, gravel, or rip-rap. Keep your eyes on the path.
- Avoid storing or transporting tools, materials, or supplies within or on the mast of the drill rig.

4.5.3 - Equipment Inspection

- Inspect equipment at the start of each shift (pre-op) and at the end of each shift (post-op).
- Correct all major defects and safety defects prior to the start of work.

4.5.4 - General Inspection Routine

- Inspect drilling equipment, cranes, winches, generators and compressors prior to use - correct any identified problem before proceeding with work
- Verify that the emergency shutoff switch works
- Verify that preventative maintenance has been conducted
- Wear proper PPE: Hardhat, safety glasses with side shields, and steel-toed boots as a minimum
- Conduct tailgate safety meetings and facilitate a safe work culture
- Pre qualify drilling subcontractors
- Verify that Drillers and Helpers have proper training and experience
- Refer to company specific *Drilling Safety Guidelines*, *Subcontractor Health and Safety Requirements*, and *Behavior Based Safety* procedures.

4.5.5 - Set-up

- **See details below for set-up precautions related to proximity to power lines.**

4.5.6 - Start-up

All Drillers will:

- All personnel should know location and use of emergency shut-down/kill switch.
- Identify potential pinch points and hazards which could injure fingers and toes.
- Traffic barricades should be positioned.
- Operate as a team in which every crewmember is responsible for their own safety and that of each of the other crewmembers.
- Know their individual duties so that work can progress smoothly, efficiently and safely.
- Stay alert with their minds on their jobs.
- Stay observant for safety problems and correct them as they occur or report the problem to the lead worker.
- Use all required and recommended safety equipment.
- Refrain from engaging in practical jokes/horseplay around the drilling rig and work site.
- Get proper rest and nutrition so that they report to work in a physically and mentally fit condition.
- Never work under the influence of alcohol or drugs, whether legal or illegal.
- Pass an operational capability test administered by the employee's supervisor or supervisor's representative on each type of equipment the employee will operate on state business prior to operating the equipment unsupervised.
- Always use the buddy system whenever working near areas of vehicular traffic, public roads or public property.
- Remove cuttings with a long-handled shovel, not your hand or foot.

4.5.7 - Drilling

Considerations during general operation**:**

No visitors are permitted in the vicinity of the work area without proper protective clothing and authorized permission.
Only personnel necessary to achieve drilling objectives should remain within the exclusion zone. All others should remain outside the exclusion zone.
Effective communication (hand signals), especially under high noise conditions, is essential to safety. Clarify use of hand signals.
If the operator of the rig must leave the area of the controls, he operator should shift the transmission controlling the rotary drive and the feed control to neutral.
All crew members should be familiar with basic controls of the rig, including how to stop the engines, align the kelly with the borehole, raise and lower the drive head, raise and lower hoists, and chuck or unchuck the rods.
Do not climb the rig mast while equipment is running. Shut down/lock out equipment and use full body safety harness if climbing mast is necessary.
The operator of a drilling rig should only operate the rig from the position of the controls.
The operator should shut down the drilling engine before leaving the vicinity of the drilling rig.
Drilling should always proceed cautiously, especially at depths less than ten feet.
Operation of drilling equipment should be limited to qualified personnel.
Do not exceed the manufacturers' technical specifications for items such as speed, force, torque, pressure, and flow.
If drilling in an enclosed area, make certain the exhaust fumes are vented from the work site.
If drilling with air, direct the exhaust and cuttings away from the workers.
Never operate the drill rig with any of the machinery guards removed.
Drill rods and sampling barrels should never be left unsecured, leaning against or balanced across the drill rig.
Never exceed the pipe and rod racks design maximum load.
Always make provisions to prevent stock from accidental rolling.
When core is being extruded from a core barrel, hands should be kept out of line of the end of the barrel.
Attach safety chains or cables swivel, air, and other pressure hoses.
When cranking pumps or other motors keep head well back of the crank area to avoid being hit when motor turns over.
Fugitive dust control is to be used during dry drilling, especially in potential areas of naturally occurring asbestos.

4.5.7 – Drilling cont.

- When adding and removing drill rod:
    - Only the drill operator will brake or set the chucks, to eliminate the possibility of engaging the transmission prior to removing the chuck wrench.
    - Do not use the chucks as a brake on a string of drill rods that are being lowered into a hole. Braking the drill string with the chuck will result in metal slivers on the drill rod and consequent hand injuries, and could result in losing the drill rod down the hole.
    - Check the chuck jaws periodically and replace them as necessary.
    - Never place hands on wrenches where they can get trapped between the wrench and the drill rig.
    - Ensure that wrenches are removed from rods before starting to drill.
    - Do not take hold of the male thread end of drill rod. Watch for sharp burrs on rods and casing, and file sharp edges off rods when necessary.
    - Do not use extension leverage (cheaters) on pipe wrenches to break drill rod. If extension leverage is needed, the wrong tool is being used.
    - Clean drill rods with a rubber wiper or other suitable device when being removed from a hole.
    - Allow drilling fluids to drain from drill rods into the mud pit before setting the rod to the side, to minimize the amount of mud around the work area.
    - The operator knows the capacity of the hoist and mast, and the weight of the drill rod, to prevent the hoist capacity from being exceeded.
    - The drill rig operator must exercise care to lower the hoist slowly while the drill rod is being carried away from the hole.
    - There should be at all times at least three wraps of hoisting line on the hoist drum to prevent a line load from being applied directly to the fastening clamp.
    - Do not guide or hold onto moving wire line work cables with bare hands.

4.5.8 - Adding and Removing Drill Rods

When adding and removing drill rod:

Only the drill operator will brake or set the chucks, to eliminate the possibility of engaging the transmission prior to removing the chuck wrench.

Do not use the chucks as a brake on a string of drill rods that are being lowered into a hole. Braking the drill string with the chuck will result in metal slivers on the drill rod and consequent hand injuries, and could result in losing the drill rod down the hole.

Check the chuck jaws periodically and replace as necessary.

Never place hands on wrenches where they can get trapped between the wrench and the drill rig.

Ensure that wrenches are removed from rods before starting to drill.

Do not take hold of the male thread end of drill rod. Watch for sharp burrs on rods and casing, and file sharp edges off rods when necessary.

Use of extension leverage (like a cheater pipe) on pipe wrenches to break drill rod should be avoided whenever possible. If extension leverage is needed, the wrong tool is probably being used. In rare instances where extension is required, use extreme caution to avoid slippage and possible injury.

Clean the drill rod with a rubber wiper or other suitable device when being removed from a hole.

Allow drilling fluids to drain from drill rods into the mud pit before setting the rod to the side, to minimize the amount of mud around the work area.

Do not guide or hold onto moving wire line work cables with bare hands.

4.5.9 - Positioning Pipe and Casing

When positioned in the mast, drill pipe or casing should be secured until attached and in the drilling position

If work stops during positioning of drill pipe or casing into the mast, lower any suspended load to the ground or lay it down on the support vehicle. The following are general field practices that apply to all drilling operations regardless of method:

- Direct water discharge hoses away from leveling blocks

4.5.10 - Pressurized Systems

- No repair or maintenance will be performed on pressurized systems unless all pressure has been relieved
- Extreme caution will be used when opening any valve
- All relief valves will be installed so that any discharge will be directed away from workers and equipment
- Any extensions necessary for proper venting of relief valves will be secured against whipping and incorporate whip checks

4.5.11 - Most Common Injuries

- Slipping and falling
- Getting dirt in the eye while steam cleaning or while hitting auger and rods with hammer
- Cutting fingers from handling augers and heavy objects
- Injuring back from improper lifting

4.5.12 - Near Losses, Incidents and Injuries and Treatment

- No matter how minor, all near losses, incidents, and injuries will be reported to a supervisor immediately.

4.5.13 - First Aid Kits/Fire Extinguishers

- Each rig will be equipped with a fully supplied, approved first aid kit and an ABC fire extinguisher of suitable size for the fire hazard to be encountered at the job site.

4.5.14 - Underground utilities

- Complete utility locates prior to drilling [One Call: 811 or your local utility locating service] and coordinate with the drilling contractor and site personnel.
- Mark locations in white
- Field verify utility locations
- Document all utility locates on a plot plan or other map of the site.
- Observe the area for indications of utilities
- Hand dig if questions remain or if required by the property owner
- Refer to your specific *Utility Clearance and Isolation* procedure

4.5.15 - Environmental Contamination (if applicable)

- Before Visqueen or other plastic is laid down, the site will be cleared of trip hazards, obstacles or debris such as rocks, sticks, ruts and holes.
- Contain cuttings in drums or plastic sheeting
- Wear proper PPE and minimize contact with soil, sediment, groundwater, or other contamination.
- Work upwind of the boring
- If unusual soil discoloration or odors are encountered, stop work, evacuate area and contact the safety manager. The approach will need to be re-evaluated and a PPE upgrade may be required
- Follow all provisions of the Health and Safety Plan

4.5.16 - Working on Streets or Highways

- Follow state and local laws concerning traffic control signage, cones, and barricades.
- Do not work before sun-up, after sundown, or any time visibility is poor.
- Position support vehicle(s) between the work area and oncoming traffic.
- Use safety strobe lights on all vehicles and equipment.
- Wear appropriate reflective safety vests.
- Use radios when flagging.

4.5.17 – Operating the Drilling Rig

- Only employees will operate the drilling rig or handle equipment associated with drilling operations, including winches, augers, drive rods, ropes, and cables. Technicians, field personnel and any visitors must be aware of the location of the emergency shut-down/kill switches and operation of these devices, and the devices must be in safe working condition prior to the start of the project and thereafter.
- The Technician should never leave the controls of the drilling rig while the tools are rotating unless all employees are clear of rotating equipment.
- During drilling operations the Well Technician at the controls must be aware of the Assistant Technicians position and actions at all times. Operation of the winches and or rotary actions should only occur once the Well Technician has visually or verbally confirmed that the Assistant Technician is all clear. During assembly operations (auger attachment or rodding connection) no mechanical operations should occur until body position or hand placement is confirmed to be in a non-pinch or crush position.
- Only employees necessary to run the rig are allowed in close proximity, except during essential sampling and other activities.
- Technicians will not reach into or near pinch points, the borehole, or the rotating equipment, unless the drilling rig has been shut down.

4.5.18 - Working on the Mast - General Repairs

- Drillers should not climb the mast to make repairs if the mast can be lowered. If the mast cannot be lowered to make repairs, workers may use a ladder or may climb the mast if proper fall protection, such as a harness and attached lanyard, is available. Fall protection devices, in the form of a harness and lanyard, will be used where workers are 6 feet or greater in height (if a ladder or personal lift is not available). No one should climb the mast to make repairs while the drilling rig is operating
- During general repairs or maintenance actions Technicians must also consider extra caution with respect to hand tools and potential slippage actions. Keep tools clean and free of grease and oils, plus thoroughly clean any bolt heads or parts before wrenching. These actions may prevent slippage and possible hand injuries. Where possible, leather gloves should be worn (cotton gloves may be worn where dexterity is an issue).

4.5.19 - Special Precautions for Drilling in Landfills

In addition to the usual physical hazards of drilling, employees drilling in landfills may experience an increased hazard from methane gas. Methane, a decomposition product of organic materials is a very flammable gas, which may accumulate in the borehole or in the general work area. To help reduce the hazards due to the presence of methane while drilling in landfills, the following procedures should be implemented:

- No smoking within 75 feet from the drilling area.
- The drilling rig should be equipped with a spark-arresting muffler; a diesel engine can sometimes be preferred.
- All ignition sources should be at least 75 feet from the borehole and, if possible the rig should be located upwind of the borehole,
- Monitor methane concentrations as frequently as possible using a Combustible Gas Indicator (CGI).
    - The frequency of monitoring must be established in the Site-Specific (HASP).
    - The meter should be kept near the rig.
    - Results of the monitoring data should be entered into the field log,
    - Calibrate the CGI against a reference gas at least weekly.
- **All work will stop if gases are detected at 10 percent or greater of the lower explosive limit (LEL)** in the hole being drilled.
- Under such circumstances it may become necessary to inert, ventilate, or flood the borehole with water during drilling to reduce the risk of down-hole explosions.

4.5.20 - Lighting

Lighting around a drilling operation should be sufficient to provide illumination at all times. See the table below for guidance.

Table 4.2 - Minimum Illumination Intensities in Foot-Candles

Foot-Candles	Area of Operation
5 Foot-Candles	General construction area lighting.
3 Foot-Candles	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas.
5 Foot-Candles	Indoors: warehouses, corridors, hallways, and exit ways.
5 Foot-Candles	Tunnels, shafts, and general underground work areas: (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading)
10 Foot-Candles	General construction plant and shops (batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts and active store rooms, mess halls, and indoor toilets and workrooms.)
30 Foot-Candles	First aid stations, infirmaries, and offices.

NOTE: The above are minimum requirements. Many circumstances, including weather, may warrant higher lighting values.

4.6 – Electrical Safety

4.6.1 - Supplying Power to the Job Site

Drilling projects sometimes require around the clock operations and, therefore, require temporary electrical lighting. In general, all wiring and fixtures used to provide electricity for drilling operations should be installed by qualified personnel in accordance with the National Electrical Code (NFPA70 1999) with consideration of the American Petroleum Institute's recommended practices for electrical installations for production facilities (API RP 500B). Lights should be installed and positioned so that the work area and operating positions are well lighted without shadows or blind spots. The following are specific recommendations for land based drilling operations:

- Before working on an electrical power or lighting system, lockout the main panel box with your own lock and keep the key on your person at all times.
- Install all wiring using high quality connections, fixtures, and wire. Be sure that the wiring is insulated and protected with consideration for the drilling environment.
- Do not use makeshift wiring and equipment.
- Place all lights positioned directly above working areas in cages or similar enclosures to prevent loose or detached lamps or vapor tight enclosures from falling on workers.
- Install lights so as to eliminate glare or blind spots on tools, ladders, walkways, platforms, and the complete working area.
- Locate and guard electrical cables to prevent damage by drilling operations or by the movement of personnel, tools, or supplies.
- Use only three prong, U blade, grounded type plug receptacles and have adequate current carrying capacity for the electrical tools that may be used.
- Use only electrical tools that have three prong, U blade, ground wire plugs, and cords.
- Do not use electrical tools with lock on devices.
- Provide adequate grounding for all electrical welders, generators, control panels, and similar devices.
- Provide secure protective enclosures on control panels, fuse boxes, transformers, and similar equipment.
- Avoid attaching electrical lighting cables to the mast or other components of the drill rig. If this must be done, use only approved fasteners. Do not string wire through the mast.
- Do not use poles used to hold wiring and lights for any other purpose.
- Turn power off before changing fuses or light bulbs.
- Require all workers in a drilling area illuminated with electrical lighting to wear safety head gear that protects the worker's head, not only against falling or flying objects, but also against limited electrical shock and burns according to ANSI Z89.1 and Z89.2.
- Allow only trained, designated personnel to operate electrical equipment.
- Do not permit unqualified field personnel to work on or near electric lines or devices.

4.6.2 - Safe Use of Electricity

Electrical shock can occur if equipment is maintained improperly or operated unsafely. Care and common sense minimizes danger and reduces the chance of fire resulting from electrical faults.

Figure 4.2 – Lockout Tagout Reminder

- Do not work on electrical parts unless you are sure they are disconnected
- Never splice, connect, or handle live circuits
- Verify test flow or possible leaks will not spray water into any electrical enclosures such as starters, control boxes, or connection boxes during testing
- Verify all electrical equipment is properly grounded

4.6.3 - Reacting to Contact with Electricity

Figure 4.3 – High Voltage Warning Sign

- If a drill makes contact with electrical wires, it may or may not be insulated from the ground by the tires of the carrier. Under either circumstance, the human body, if it simultaneously comes in contact with the drill rig and the ground, will provide a conductor of the electricity to the ground. Death or serious injury can be the result.

4.6.4 - Electrical Equipment

Get permission from the owner's representative before utilizing electrical outlets on-site. Do not operate electrical equipment in standing water or excessively wet conditions.

4.7 - General Equipment Safety

4.7.1 Safe Use of Hand Tools

With a vast number of hand tools that are likely to be used on a drill rig or during repair, the best rule of thumb is to use a tool only in the manner for which it was intended. Keep cutting tools sharp. If an accident occurs, treat all cuts and scratches immediately with simple first aid measures to prevent infection, which can occur in a matter of hours. Some other guidelines are:

Inspect tools prior to use
Use tools for their intended use only
Do not use damaged tools
Pull, do not push wrenches - verify there is a good grip
Never use excessive force on a tool. If excessive force is required, the wrong tool is being used.
Keep all tools clean and orderly stored when not being used.

- Do not leave tools on ladders or other overhead working spaces.
- Do not leave tools on the ground.

Never throw or drop tools. Use hoists or hand lines to raise or lower tools.
Always use non-sparking tools in areas of potentially explosive materials or atmosphere.

Hand Tools

As many different types of hand tools may be used on or around a drill rig and in repair shops, there are an equal number of instructions for proper use. *Use the tool for its intended purpose* - is the most important rule.

The following suggestions apply to safe use of several hand tools that frequently are used on and around drill rigs:

- When a tool becomes damaged, either repair it before using it again or get rid of it.
- Do not use tools with split or defective handles or worn parts. If a tool becomes damaged, repair it before using it again or replace it.
- When using a hammer, any kind of hammer for any purpose, wear safety glasses and require all others around you to wear safety glasses.
- When using any kind of chisel or punch, for any purpose, wear safety glasses and require all others around you to wear safety glasses.
- Keep all tools cleaned and stored appropriately when not in use

Hammers

Use only hammers that are in good condition with handles firmly attached. Repair or replace hammers with defective handles or mushroomed heads. If the head has mushroomed, dress it prior to using it. When repairing a handle, never use nails as a substitute for a wedge.
Always grip the handle close to the end. Choking the grip near the head is less accurate and effective.
Set nails with a light blow to minimize the possibility of finger injuries.
Always use a hammer with a flat face to drive nails, never use a machinist's hammer for this purpose.
Never pound objects with the hammer's handle.
To prevent flying metal splinters, never strike a hardened object such as a wrench or another hammer with anything but a rawhide or soft-metal hammer.

Wrenches

- Keep all pipe wrenches clean and in good repair. Use a wire brush frequently to clean the jaws of pipe wrenches. An accumulation of dirt and grease can cause wrenches to slip.
- Use a wrench of adequate size, a larger wrench is safer than using a cheater pipe.
- If using an adjustable wrench, note that the fixed jaw is stronger than the movable one.
- If possible, pull on a wrench using your arm muscles rather than push on it.
- Maintain good footing, one foot bracing behind the other, when using a wrench. Remove sharp objects from the area in case of a fall.
- Position your hands so they will not be crushed or smashed if the nut or joint releases.
- Never apply a wrench to moving machinery.
- Never use a wrench as a hammer.
- Wire brush the jaws of pipe wrenches frequently, and replace worn jaws periodically.
- Use wrenches - not pliers - on nuts.
- Never use pipe wrenches in place of a rod holding device.
- Replace hook and heel jaws when they become visibly worn.
- When breaking tool joints on the ground or on a drilling platform, position your hands so that your fingers will not be pinched between the wrench handle and the ground or the platform if the wrench should slip or the tool joint suddenly let go.
- When using a wrench on a tight nut: first use some penetrating oil, use the largest wrench available that fits the nut, when possible pull on the wrench handle rather than pushing, and apply force to the wrench with both hands when possible and with both feet firmly placed. Do not push or pull with one or both feet on the drill rig or the side of a mud pit or some other blocking-off device. Always assume that you may lose your footing -- check the place where you may fall for sharp objects.
- Never use a cheater bar on an aluminum pipe wrench

Screwdrivers

Always use a screwdriver that closely fits the screw slot.
Never use a screwdriver with a worn, chipped, or broken tip.
Never use a screwdriver as a substitute for a chisel or pry bar.
Keep cutting tools sharp.
If an accident occurs, treat all cuts and scratches immediately with simple first aid measures to prevent infection, which can occur in a matter of hours.

Pinch points

Never place your hand or other body parts under auger or in holes in the auger
Attach one flight at a time
Stand clear of outriggers
Wear leather gloves
Identify any and all places where moving equipment could trap a body part and act to eliminate the hazard.

Power Tools

- Always read the owner's manual of the tool that you are using to learn the correct application and the limitation of the tool.
- Lubricate tools as recommended by the manufacturer.
- Properly ground power tools.
- Never operate power saws or grinders without safety guards.
- Never run power tools in damp or wet locations.
- Always have proper lighting when using power tools.
- Do not abuse the cord - never carry a tool by its cord, or yank the cord to remove the plug from a receptacle.
- Secure the work with clamps to allow both hands to be free to operate the tool.
- Remove adjusting keys and wrenches prior to starting the power tool.
- Keep the work area clean and free of clutter that can interfere with the work or get caught in the power tool.
- Do not overreach, keep good footing and balance when using power tools.
- Do not carry plugged-in tools with your finger on the start switch.
- Disconnect all tools from power source when not in use and when servicing.

4.8 - Personal Protective Equipment

4.8.1 - Individual Protective Equipment

Certain personal protective equipment (PPE) must be worn because of the physical hazards posed by the drilling operation. For most geotechnical, mineral, and groundwater drilling projects, individual protective equipment must include a safety hat, safety shoes, safety glasses, and close fitting gloves and clothing. The Site-Specific Health and Safety Plan will dictate other PPE and precautions necessary to address site related hazards and risks. All protective equipment is provided by the respective employer(s).

Hard Hats

Hard hats must be worn by everyone working or visiting at or near a drilling site (worn with the brim in front, only). All hard hats must be kept clean and inspected each working day to assure they are in good repair with the headband and crown straps properly adjusted for the individual drill rig worker or visitor. A hard hat is the number one piece of safety equipment. They should be worn on all drilling sites, shop or yard areas where work might be performed under heavy objects, or where there is the possibility of injury from falling objects. A hard had protects you from falling objects. For your protection, OSHA regulations allow government inspectors to assess fines for not wearing hard hats.

Safety Shoes or Boots

Safety shoes or boots should be worn by all drilling personnel and all visitors to the drill site that observe drilling operations within close proximity of the drill rig. All safety shoes or boots must meet the requirements of ANSI.

Gloves

All drilling personnel should wear gloves for protection against cuts and abrasions that could occur while handling wire rope or cable and from contact with sharp edges and burrs on drill rods and other drilling or sampling tools. All gloves must be closefitting and not have large cuffs or loose ties that can catch on rotating or translating components of the drill rig.
Where possible, leather gloves should be worn (cotton gloves may be worn where dexterity is an issue).

Gloves should be worn when work activities involve handling the drilling equipment, sampling devices or even when servicing the drill unit. The type of glove will be dependent upon the task being performed and potential for chemical or other contaminants. At a minimum leather gloves should be worn when assembling tooling or servicing and repairing the drill unit. If dexterity is an issue (small bolts or screws), cotton or nitrile gloves maybe adequate.

Eye Protection

- All drilling personnel should wear safety glasses. General prescription glasses and sunglasses are not safety glasses. All safety glasses must meet the requirements of ANSI.
- Use safety glasses whenever using a hammer, chisel, power tool or any other tool that can cause particles to fly.

Hearing Protection

- Hearing protection devices such as ear plugs and ear muffs should be worn as required when the noise exposure is 85 dBA or greater over an 8-hour workday. Although noise levels vary with the type of drilling equipment used, potentially hazardous noise levels are likely to be generated during split-spoon sampling and air drilling. Typically, speech at normal conversational levels becomes difficult at 2 to 3 feet when noise levels are in excess of 85 dBA.
- When appropriate, each drill rig worker must wear noise-reducing hearing protection that meets the requirements of ANSI.

Fall Protection

- Fall protection is required when working at heights of greater than 6 feet (guard rails or a personal fall arrest system). Establish a good solid footing and that walking and working surfaces are as clean and dry as possible.
- Work to be done above three feet on the mast should require use of a safety harness, or the mast must be lowered. At a minimum fall protection must be used in accordance with applicable regulatory or client requirements. The most stringent being applicable.

Clothing

The clothing of the individual drill rig worker is not generally considered protective equipment, however, the worker's clothing should be comfortable but must be close fitting, without loose ends, straps, draw strings, belts or otherwise unfastened parts that might catch on some rotating or translating component of the drill rig. Rings and jewelry must not be worn during a work shift. In addition to loose clothing, hair should be tied back, as loose long hair can catch in mechanical equipment. All jewelry, including rings must be removed before beginning each shift. All personnel should wear clothing appropriate for the weather conditions.

High Visibility Clothing

High visibility clothing is required when working in environments that are regulated by Department of Transportation and or when working on active roadways or other high traffic areas such as service stations. It is also required for night work operations.

Other Protective Equipment

For some drilling operations, the environment or regulations may dictate that other protective equipment be used. The requirement for such equipment must be determined jointly by the management of the drilling organization and the safety supervisor. Such equipment might include face shield, respirator, and insect repellent. When drilling is performed in chemically or radiological contaminated environment, special protective equipment, and clothing may, and probably will, be required. The design and composition of the protective equipment and clothing must be determined jointly by the management and the client who requests the drilling services, and under some circumstances, with the concurrence of a health and safety professional.

4.9 - Weather and Night Work

4.9.1 - Weather Considerations

Cold

Extended exposure to windy, cold weather can lead to frostbite, hypothermia, and possibly death. The cold stress equation is as follows:

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURY & ILLNESS

The Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA) offer the following steps for recognizing, evaluating, and controlling cold stress:

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Drink warm, sweet beverages (sugar water, sports-type drinks). Avoid drinks with caffeine (coffee, tea, or hot chocolate) or alcohol, which cause dehydration. Eat warm, high-calorie foods like hot pasta dishes.
- Dress appropriately, layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (i.e., polypropylene).
- Take frequent breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Workers are at greater risk when they have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension, they take certain medications (check with a doctor, nurse, or pharmacy to see if any medications being taken have adverse affects while working in cold environments), or they are in poor physical condition, have a poor diet, or are older.
- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.
- All air and water lines and pumps should be drained when not in use if freezing weather is expected. If appropriate, the rig should be winterized at the end of each day.
- Take breaks as necessary to warm up.

Heat

- During hot weather take frequent breaks and drink plenty of fluids.
- Dress appropriately for the conditions expected.
- Maintain a supply of drinking water.
- Take breaks as needed to cool off.

Inclement Weather

- Drilling operation should be terminated during an electrical storm, and the complete crew should move away from the drill rig.
- Although drilling operations can proceed through a wide range of weather conditions, operations must cease if weather conditions are severe enough to create a safety hazard.
- Safety hazards from weather may include, but are not limited to, low visibility for approaching traffic, inability for the driller's to see, grasp, or handle equipment, and rough seas while working on the barge. Other conditions can create safety hazards, and can be decided in the field.
- The Driller has the responsibility to determine if the severity of the conditions warrants stopping the drilling operation.
- If performing tasks during inclement weather, work deliberately and adjust the work procedures to address the changed conditions.
- Stay away from the drill during electrical storms.

Lightning

Because of the high potential for lightning strike on the mast of a drilling rig, drilling must cease when thunder and lightning storms approach and are within 5 miles. Workers should take shelter away from the rig during the potential for lightening. If possible, the mast should be lowered prior to the advancement of thunder and lightning storms. A minimum of 20 minutes should be allowed after a lightning strike before drilling resumes.

4.9.2 - Night Work Safety

Schedule night work in advance to allow employees to adjust their schedules and avoid unnecessary fatigue.
Wear required protective clothing:
Orange or lime-green vests with reflective strips, and
White coveralls.
Use sufficient illumination.
Traveling public must be able to identify all locations where employees are grouped together and engaged in work activities.
The lighting must be oriented so that the traveling public is not temporarily blinded.

- The intensity of the illumination should not be any brighter than that necessary to perform the work.

4.10 - Wire Rope, Hoists and Cat Head Safety

This section concerns rotating equipment, catheads, wire ropes, and hoists (the part of the drilling rig which may cause serious injuries), and drilling techniques most commonly used during auger and rotary drilling:

- Use tools only for the job for which they were intended.
- Stay clear of cables while lifting equipment or while drilling rig is under heavy strain.
- Do not ride on hook, ropes, or other traveling lines of the rig.
- When moving or hoisting stabilizers or drill collars, tag lines should always be used. A helper should not use his hands to hold or control heavy tooling. Instead, he should loop a rope around it and hold onto both ends of the rope.
- Inspect pulley sheaves for wear and cable and rope positioning.

4.10.1 - Wire Rope Safety

Worn or misused wire rope is potentially one of the most dangerous pieces of equipment on any drilling rig. When a wire rope breaks, it is typically under significant tension and therefore has a tendency to snap back, like a rubber band. Be constantly aware of the condition of wire rope, which is used to hoist drill pipe or other heavy object. Wire rope used for such purposes and has begun to fray or unravel, or which has a number of breaks, should be removed from service and replaced prior to mobilization. This also applies to hemp rope, which is used to hoist the hammer during split-spoon sampling. See the chart below.

 **Mechanical damage due to rope movement over sharp edge projection while under load.**	 **Typical wire fractures because of bending fatigue.**
Localized wear due to abrasion on supporting structure. Vibration of rope between drum and jib head sheave. 	 **Wire fractures at the strand, or core interface, as distinct from crown fractures, caused by failure of core support.**
Narrow path of wear resulting in fatige fractures, caused by working in a grossly oversize groove, or <u>over small support rollers.</u> 	**Strand core protrusion because of torsional unbalance created by drop ball or other shock loading application.** 
Two parallel paths of broken wires indicative of bending through an undersize groove in the sheave. 	 **Break up of IWRC resulting from high stress application. Note nicking of wires in outer strands.**
 **Severe wear, associated with high tread pressure. Protrusion of fiber main core.**	 **Typical example of localized wear and deformation created at a previously kinked portion of rope.**
 **Severe wear in Lang Lay, caused by abrasion or cross-over points on multi-layer coiling application.**	 **Multi strand rope bird-caged due to torsional unbalance. Typical of build up seen at anchorage end of multi-fall crane application.**
 **Corrosion of severe degree caused by immersion of rope in chemically treated water.**	 **Protrusion of IWRC resulting from shock loading.**

Figure 4.1 – Types of Wire Rope Wear

4.10.1 - Wire Rope Safety cont.

Listed below are guidelines regarding wire ropes and hoists:

- Always wear the appropriate gloves when handling wire ropes.
- Minimize shock loading on wire rope, apply loads smoothly and steadily.
- Protect wire rope from sharp corners or edges.
- Do not guide wire ropes onto cable drum with your hands.
- Discard cable when kinked or frayed.
- Thoroughly inspect all wire ropes that have not been used for a period of a month or more.
- Install all connections and end fittings, which consist of spliced eyes and various manufactured devices, according to the manufacturer's specifications.
- If a ball bearing type hoisting swivel is used to hoist drill rods, inspect and lubricate swivel bearing daily to assure that the swivel freely rotates under load.
- If a rod slipping device is used to hoist drill rods, do not drill through or rotate drill rods through the slipping device, do not hoist more than 1 ft. (0.3 m) of the drill rod column above the top of the mast, do not hoist a rod column with loose tool joints, and do not make, tighten, or loosen tool joints while the rod column is being supported by a rod slipping device. If drill rods should slip back into the borehole, do not attempt to break the fall of the rods by hand or by tensioning the slipping device.
- Most sheaves on drill rigs are stationary with a single part line.
- Never increase the number of parts of line without first consulting with the manufacturer of the drill rig.
- Wire ropes must be properly matched with each sheave. If the rope is too large, the sheave will pinch the wire rope. If the rope is too small, it will groove the sheave. Once the sheave is grooved, it will severely pinch and damage larger sized wire ropes.
- Following the installation of a new wire rope, first lift a light load to allow the wire rope to adjust.
- Use replacement wire ropes that conform to the drill rig manufacturer's specifications.
- Apply loads smoothly and steadily to minimize shock loading of a wire rope.
- There should be at all times at least three wraps of hoisting line on the hoist drum to prevent a line load from being applied directly to the fastening clamp

DANGER!
Do not subject a cable to *shock load*. Rapidly engaging and disengaging the hoist while attached to a load puts an enormous strain on the cable and may lead to catastrophic failure.

4.10.1 - Wire Rope Safety cont.

All wire ropes and fittings should be visually inspected prior to and during use and thoroughly inspected at least once a week for:

- abrasion
- broken wire
- wear
- reduction in rope diameter
- reduction in wire diameter
- fatigue, corrosion
- damage from heat
- improper reeving
- jamming, crushing
- bird caging
- kinking,
- core protrusion
- damage to lifting hardware

Wire ropes should be replaced when inspection indicates excessive damage. End fittings and connections consist of spliced eyes and various manufactured devices. All manufactured end fittings and connections should be installed according to the manufacturer's instructions and loaded according to the manufacturer's specifications.

Figure 4.2 – Wire Rope Warning Sign

4.10.2 - Hoist Safety

DANGER!
Drill rig hoists and masts are designed for *vertical* lifting of drilling tools only. Do not attempt to lift something away from the borehole as damage to the cable, sheave, or structural failure may occur.

Listed below are guidelines regarding wire ropes and hoists:

- Replace damaged safety latches on safety hooks before using.
- Always use proper lifting devices.
- Use tool handling hoists only for vertical lifting of tools (except when angle hole drilling).
- Do not use tool handling hoists to pull on objects away from the drill rig, however, drills may be moved using the main hoist of the drill if the wire rope is spooled through proper sheaves according to the manufacturer's recommendations.
- When stuck tools or similar loads cannot be raised with a hoist, disconnect the hoist line and connect the stuck tools directly to the feed mechanism of the drill.
- Do not use hydraulic leveling jacks for added pull to the hoist line or to the feed mechanism of the drill.
- When attempting to pull out a mired down vehicle or drill rig carrier, only use a winch on the front or rear of the vehicle and stay as far as possible away from the wire rope. Do not attempt to use tool hoists to pull out a mired down vehicle or drill rig carrier.
- Avoid sudden loading in cold weather.
- Never use frozen ropes.
- Replace faulty guides and rollers.
- Know the working load of the equipment and rigging being used and the weight of the load being lifted. Never exceed these limits.
- Periodically inspect and test hoist clutches and brakes.
- Know and do not exceed the rated capacity of mast hooks rings, links, swivels, shackles, and other lifting aids.
- Never conduct any hoisting operations when the weather conditions are such that hazards to personnel, the public, or property are created.
- Never use a hoist line to ride up the mast of a drill rig.
- The drill rig operator must exercise care to lower the hoist slowly while the drill rod is being carried away from the hole.

4.10.3 - Sheaves

Inspect and lubricate sheave wheels, shafts, and pins often. Use the proper sheave diameter and width to match the hoist line that runs over it.

- Most sheaves on drill rigs are stationary with a single part line.
- Replace worn sheaves or worn sheave bearings.

4.10.4 - Cat Head Safety

The following safety procedures should be employed during cathead operation:

- Only drilling personnel familiar with cathead operation should be allowed to operate equipment.
- Keep the cathead clean and free of rust and oil and grease.
- The cathead should be cleaned with a wire brush if it becomes rusty.
- Check the cathead periodically, when the engine is not running, for rope-wear grooves. If a rope groove forms to a depth greater than 1/8 inch (3 mm), the cathead should be replaced.
- Always use a clean, dry, sound rope. A wet or oily rope may grab the cathead and cause drill tools or other items to be rapidly hoisted to the top of the mast.
- Should the rope grab the cathead or otherwise become tangled in the drum, release the rope and sound an appropriate alarm for all personnel to rapidly back away and stay clear. The operator should also back away and stay clear. If the rope grabs the cathead, and tools are hoisted to the sheaves at the top of the mast, the rope will often break, releasing the tools. If the rope does not break, stay clear of the drill rig until the operator cautiously returns to turn off the drill rig engine and appropriate action is taken to release the tools. The operator should keep careful watch on the suspended tools and should quickly back away after turning off the engine.
- Do not operate the cathead in rain.
- The rope should always be protected from contact with all chemicals. Chemicals can cause deterioration of the rope that may not be visibly detectable.
- Never wrap the rope from the cathead (or any other rope, wire rope, or cable on the drill rig) around a hand, wrist, arm, foot, ankle, leg, or any other part of your body.
- Always maintain a minimum of 18 inches of clearance between the operating hand and the cathead drum when driving samplers, casing, or other tools with the cathead and rope method. Be aware that the rope advances toward the cathead with each hammer blow as the sampler or other drilling tool advances into the ground.
- Never operate a cathead (or perform any other task around the drill rig) with loose, unbuttoned, or otherwise unfastened clothing or when wearing gloves with large cuffs or loose straps or lacings.
- Do not leave a cathead unattended with the rope wrapped on the drum.
- Position all other hoist lines to prevent contact with the operating cathead rope.
- When using the cathead and rope for driving or back-driving, verify that all threaded connections are tight and stay as far away as possible from the hammer impact point.
- The cathead operator must be able to operate the cathead standing on a level surface with good, firm footing conditions without distraction or disturbance.
- Never use more wraps of the rope than are required to hoist the load. Extra laps can lead to the rope feeding on to the drum by itself resulting in entanglement.

4.10.4 - Cat Head Safety cont.

- Use extreme caution when returning to the rig and while turning off the engine.

DANGER!
If the cathead rope becomes entangled, immediately release the rope, sound an alarm to notify other personnel in the area, and quickly move a safe distance away from the area in a direction perpendicular to the orientation of the drill rig.

4.11 - Health and Hygiene

4.11.1 - Personal Hygiene Requirements

The Site-Specific HASP should identify exclusion zone requirements and decontamination needs. Often a break area outside the restricted work areas will be established with a hand and face washing facility. Before eating, drinking, or smoking, all employees should thoroughly wash their hands and face. To help limit the potential for ingestion of contaminants, eating, drinking, chewing, or smoking is not allowed when working in the immediate vicinity of the drilling rig or in any restricted work areas (exclusion and decontamination zones).

4.11.2 - Chemical Hazards

- Review material safety data sheets
- Follow manufacturer’s instructions for use, handling and storage
- Use recommended protective equipment
- Label all containers

4.11.3 - Dust

- Minimize generation of dust from soil, sand or bentonite.
- Stay out of visible dust clouds.
- Wet materials if necessary to eliminate visible dust.

4.11.4 - Noise

- Wear hearing protection when operating or working near the rig.

4.11.5 - Ambient Air Monitoring

Vapors

Approach areas where vapors are suspected from the upwind direction and stay upwind or crosswind from potential sources of vapors (use flagging, wind socks, or similar devices to indicate wind direction).

4.11.6 - A Sample Hazard Communication and Chemical Safety Program

Attachment 4.A represents a sample hazard communication and chemical safety program document from the fictional MAKEHOLE Drilling Company. It may be used as an example for developing customized plans for environmental remediation drillers.

Safety Sensitive Employees

All safety sensitive employees are *prohibited* from the following conduct:

- **Alcohol**
  - Perform safety sensitive functions while under the influence of alcohol.
  - Operate a commercial vehicle while possessing alcohol. This includes the possession of medicines containing alcohol (prescription or over-the-counter), unless the packaging seal is unbroken.
  - Use alcohol while performing safety-sensitive functions.
  - Perform safety-sensitive functions within four (4) hours after using alcohol.
  - Use alcohol for eight (8) hours after an accident requiring a post-accident alcohol test or until a post-accident is administered, whichever occurs first.
  - Refuse to submit to a post-accident, random, reasonable suspicion, or follow-up alcohol test

- **Drugs or Controlled Substances** (include marijuana, cocaine, amphetamines, opiates and phencyclidines)
  - Perform a safety-sensitive function when the driver uses any controlled substance, except when the use is under the instructions of a physician who has advised the driver that the substance does not adversely affect the driver's ability to safely operate a commercial vehicle.
  - Refuse to submit to a post-accident, random, reasonable suspicion, or follow-up drug test.

NOTE: Any CDL holder who has engaged in prohibited conduct will be immediately removed from the performance of any safety-sensitive function related to a commercial vehicle, including driving, and may not perform any safety-sensitive functions until certain evaluations have been met.

4.12 - Materials Handling

4.12.1 - Proper Lifting

Back injury is a common drilling injury. Improper lifting causes lower-back pain even for those who are strong and in good condition. Almost 65 percent of workers have back pain at some point during their working career.
Think through the process - How can you move the material or equipment and still minimize total weight, distance traveled, and frequency of movement? Be sure of your footing. When possible, let the drill rig do the work or use other mechanical devices to lift and move materials. Ask others to help with awkward or heavy items and equipment. Offer to help someone else with lifting. Stretch and warm-up muscles before lifting. Use proper lifting techniques. Move heavy objects with the aid of handcarts whenever possible.

Proper lifting takes the hazard out of moving heavy objects. Ask someone who knows how to demonstrate the following procedures. Then use them whenever you lift something either at work or at home:

- Establish you can lift the load safely or ask for help
- Use a mechanical lifting device if available
- Inspect route to be traveled making sure of sufficient clearance
- Look for any obstructions or spills
- Inspect the object to decide how it should be grasped
- Look for sharp edges, slivers, or other things that might cause injury
- Do not move any object that will obstruct your field of vision when transporting the load.

Before lifting a relatively heavy object:

1. Approach the object by bending at the knees,
2. Keeping your back vertical and un-arched while obtaining a firm footing.
3. Grasp the object firmly with both hands.
4. Stand slowly and squarely while keeping your back vertical and un-arched.

NOTE: Lift with the muscles in your legs, not the muscles in your lower back. If the object is in excess of 50 pounds, request assistance.

4.12.2 - Heavy Materials, Drums and Containers - Lifting and Moving

- Do not lift or move heavy containers without assistance
- Do not lift or move awkward loads without assistance.
- Use proper bending and lifting techniques by lifting with arms and legs and not with back
- If possible, use powered lift truck, drum cart, or other mechanical means
- Take breaks if feeling faint or overexerted
- Spot drums in storage area prior to filling
- Wear appropriate PPE including leather gloves and steel-toed boots

4.12.3 - Drum Handling

- If a hoist is used to load drums, only lifting attachments specifically designed for drum lifting should be used. Do not use makeshift lifting attachments.
- Use only the proper tools and equipment to move, load or unload drums.
- Drums should be lined with a clear plastic before any material is placed in them.
- All drums should be placed into spill containment basins. If basins are not available, drums should be stored or placed on edge in such a manner as to avoid the accumulation of rainwater on the lids. The exterior of drums should be wiped clean before being stored to eliminate run off contaminants due to rain.
- Use chemical and leather gloves will to protect hands from cuts caused by mill burrs or rough edges.
- Avoid pinching or crushing hands or fingers between other drums or objects while moving.
- Before drums are pulled over on their sides, all caps and bungs should be secured and there should be sufficient clearance for hands and feet.
- When opening closed drums that have been exposed to heat from the sun or other sources, personnel should stand clear and open slowly until any pressure is relieved.
- All fluid and material containers should be clearly labeled to avoid improper use.
- Hazardous materials should be labeled and handled accordingly.
- Hazardous waste drums must be labeled in accordance with applicable federal and state regulations.
- Position hands and fingers to avoid pinching, smashing, or crushing when closing drum rings
- Do not lift or move heavy containers without assistance
- Use proper bending and lifting techniques by lifting with legs and avoid lifting with the back.
- If possible, use powered lift truck, drum cart, or other mechanical means
- Designate an appropriate drum storage area

4.13 - Forklift Operations

NOTE: Do not operate a forklift or any other equipment unless you have completed the appropriate training for that forklift or other equipment. Doing so may be grounds for disciplinary action.

4.13.1 - Forklift and Forktruck Operations

- Only drivers and operators authorized by the employer and trained in the safe operations of industrial trucks and forklifts or industrial tow tractors are permitted to operate such vehicles. Devise methods to train operators in safe operation of powered industrial truck and forklifts.
- Stunt driving and horseplay are prohibited.
- No riders are permitted on vehicles unless provided with adequate riding facilities.
- Employees may not ride on the forks of lift trucks.
- Employees may not place any part of their bodies outside the running lines of an industrial truck and forklift, or between mast uprights or other parts of the truck where shear or crushing hazards exist.
- Employees are not allowed to stand, pass, or work under the elevated portion of any industrial truck and forklift, loaded or empty, unless it is effectively blocked to prevent it from falling.
- Drivers will check the industrial truck and forklift at least once per shift, and if it is found to be unsafe, report the matter immediately to your supervisor. Do not put the vehicle in service again until it has been made safe. Check for the proper functioning of tires, horn, and any other warning devices, lights, battery, controller, brakes, steering mechanism, cooling system, and the lift system for fork lifts (forks, chains, cable, and limit switches).
- No industrial truck and forklift will be operated with a leak in the fuel system.
- Industrial trucks and forklifts will not exceed the authorized or safe speed, always maintaining a safe distance from other vehicles, keeping the truck under positive control at all times and observe all established traffic regulation. For trucks traveling in the same direction, a safe distance may be considered to be approximately 3 truck lengths or preferably a time lapse-3 seconds-passing the same point.
- Do not pass trucks traveling in the same direction at intersections, blind spots, or dangerous locations.
- Slow down and sound the horn at cross aisles and other locations where vision is obstructed. If the load being carried obstructs forward view, travel with the load trailing.
- Look in the direction of travel and do not move a vehicle until certain that all persons are in the clear.
- Industrial trucks and forklifts will not be driven up to anyone standing in front of a bench or other fixed object of such size that the person could be caught between the truck and object.
- Grades will be ascended or descended slowly.
  - When ascending or descending grades in excess of 10 percent, loaded trucks should be driven with the load upgrade.
  - On all grades the load and load engaging means should be tilted back if applicable, and raised only as far as necessary to clear the road surface.
  - Motorized hand and hand-rider trucks should be operated on all grades with the load-engaging means downgrade.
- Carry the forks as low as possible, consistent with safe operations.

4.13 - Forklift Operations cont.

NOTE: When the operator is over 25 feet (7.6 meters) from or out of sight of the industrial truck and forklift, the vehicle is *unattended* and (A) above should apply.

- When leaving a industrial truck or forklift unattended, either:
  - The power will be shut off, brakes set, the mast brought to the vertical position, and forks left in the down position. When left on an incline, block the wheels, or
  - The power may remain on provided the brakes are set, the mast is brought to the vertical position, forks are left in the down position, and the wheels will be blocked, front and rear.
- When the operator of an industrial truck and forklift is dismounted and within 25 feet (7.6 meters) of the truck which remains in the operator's view, the load engaging means will be fully lowered, controls placed in neutral, and the brakes set to prevent movement. Exception: Forks on fork-equipped industrial truck and forklifts may be in the raised position for loading and unloading if the forks are raised no more than 42 inches above the level where the operator and loaders are standing and the power is shut off, controls placed in neutral and the brakes set. If on an incline, the wheels will be blocked.
- Vehicles will not be operated on floors, sidewalk doors, or platforms that will not safely support the loaded vehicle.
- Prior to driving onto trucks, trailers and railroad cars, check their flooring for breaks and other structural weaknesses.
- Cross railroad tracks diagonally, wherever possible. Parking closer than 8 ½ feet from the centerline of railroad tracks is prohibited.
- Do not load trucks in excess of their rated capacity.
- Do not move a loaded vehicle until the load is safe and secure.
- Take extreme care when tilting loads. Tilting forward with the load engaging means elevated is prohibited except when picking up a load. Elevated loads will not be tilted forward except when the load is being deposited onto a storage rack or equivalent. When stacking or tiering, backward tilt will be limited to that necessary to stabilize the load.
- Place the load-engaging device in such a manner that the load will be securely held or supported.
- Take special precautions in securing and handling of loads by trucks equipped with attachments, and during the operation of these trucks after the loads have been removed.

Every employee who operates an industrial truck and forklift will be instructed in the following procedures and in any other practices dictated by the work environment. Such information will be provided at the time of initial employment. Copies of these instructions, printed in a language understood by the majority of the employees, will be conspicuously posted at a place frequented by the drivers.

4.13.2 - Employee Operating Instructions

- Securely fasten your seat belt.
- Where possible, avoid operating the forklift/industrial truck near ditches, embankments, and holes.
- Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces.
- Stay off slopes too steep for safe operation.
- Watch where you are going, especially at row ends, on roads, and around trees.
- Do not permit others to ride.
- Operate the forklift/industrial truck smoothly-no jerky turns, starts, or stops.
- Hitch only to the drawbar and hitch points recommended by forklift manufacturers.
- When forklift is stopped, set brakes securely and use park lock if available.

Every employee who operates an industrial truck or forklift will be required to check the industrial truck or forklift prior to operation each day and if it is unsafe report the matter immediately to a foreman or mechanic and will not use the industrial truck or forklift again until it has been made safe.

Employees are prohibited from stunt driving or horseplay while operating an industrial truck or forklift.

No repairs will be performed on any agricultural or industrial trucks, forklifts or tractors until arrangements have been made to reduce the probability of injury to repairmen or others caused by sudden movement or operation of such equipment or its parts.

4.14 - Fire Protection

4.14.1 - Fire on the Rig

Always carry an approved Class ABC fire extinguisher on the drill rig that meets the requirements of DOT regulation 49 CFR 393.95. The fire extinguisher should be located to permit visual determination of whether it is fully charged and is readily accessible for use

- Learn how to use fire extinguishers and know where they are located on the drilling rig and support vehicles.

- Remember the four letter word ***PASS*** and the fire is controllable, you can put a fire out successfully.

  P **- PULL** the pin
  A **- AIM at** the base of the fire standing approximately eight feet from the fire
  S **- SQUEEZE** the handle
  S **- SWEEP** the fire by moving the extinguisher back and forth as you aim at the base of the fire until it is out.

- Fire Extinguishers will be inspected monthly for condition and expiration date and tag with the date of annual inspection and inspector's name. If the tag is not located on the extinguisher, replace it with one that is properly tagged.
- Place the fire extinguisher in an easily accessible location within 10 ft of drilling of drilling rig.

4.14.2 - Other Fire and Explosion Precautions

- Do not refuel an engine while it is running or while it is still hot.
  - Use a funnel when refueling from a can.
  - No Smoking while handling or dispensing fuels.
  - Fuels should be handled, transported, and stored in approved, properly marked containers.
  - Store fuels away from equipment exhaust.
  - Do not store fuels inside a building.
- Flammable and combustible materials are typically present at drilling sites.
  - These materials include gasoline, diesel fuel, polyethylene, wood, weeds, and others.
  - To help prevent these materials from igniting, employees should first and foremost ensure that all sources of ignition (such as matches or lighters) have been identified and maintained at a safe distance from flammable and combustible materials.
- Smoking, open flames, or spark producing equipment should not permitted within 75 feet of drilling rigs, open wells, gasoline-driven pumps, or fuel storage areas.
- Flammable liquids (includes empty and full cans) should not be stored or left within 50 feet of drilling rigs, pumps, or other related machinery.
- Containers used for fuel will be bonded and grounded during dispensing to prevent the discharge of static electricity.
- Safety fuel containers must be returned to a designated safe storage area after fueling is completed.

4.15 - Rig Inspections and Maintenance

Drilling contractors are responsible for maintaining the drilling rig in proper working condition. Conducting routine inspection of the rig and associated support equipment and performing all required maintenance are key components to ensuring proper working condition. Specific items to consider when performing inspection and routine maintenance are discussed in greater detail below.

Inspections

The drilling contractor should inspect the drill rig when it first arrives onsite and at least daily thereafter for structural damage, loose bolts and nuts, proper tension in chain drives, loose or missing guards or protective covers, fluid leaks, damaged hoses, or damaged pressure gauges and pressure relief valves. Daily inspections should include the following:

- Inspect and test major systems to ensure proper operating condition and to identify signs of excessive wear.
  - Kill Switches
  - Protective Guards
  - Cable Systems
  - Leveling Jacks and Outriggers
  - Drill Controls
  - Hydraulic Lines
  - Connections, fittings, and valves
  - Exhaust Systems
  - Brake Systems
- Immediately notify Senior Driller of any equipment or safety device in need of repair.
- Correct all identified equipment and safety device defects prior to drilling.

4.15 - Rig Inspections and Maintenance cont.

An example checklist is included as Attachment 4.B - *Drill/Direct Push Type Rig Inspection Checklist*.

Maintenance

The drilling contractor should maintain logs, documenting all preventative maintenance performed on a given rig. Any maintenance determined to be necessary once the rig has arrived on location should be completed prior to drilling. Maintenance activities should never be performed while drilling. Specific items to consider when performing maintenance include the following:

General

- Never use gasoline or other flammables to perform cleaning duties around the rig.
- Place all transmissions, gearboxes, hydraulic valves, and hoist levers in neutral before initiating repairs.
- Have all preventative maintenance, or other scheduled maintenance, completed as recommended.
- Shut down the drill rig and remove the positive cable from the battery to clean, repair or lubricate fittings, unless the adjustment requires the rig to be running. The operator and lubricator must coordinate their efforts to successfully perform the maintenance safely.
- While performing maintenance, either remove or tag the key to prevent accidental starting of the rig.
- Apply grease and oil only through oil and grease inlets.

- Always chock wheels, lower leveling jacks, and set hand brakes prior to working under a drill rig.
- Whenever possible, reduce operating systems to a zero energy state, that is, release all pressure from hydraulic, drilling fluid and air pressure systems, prior to performing maintenance. Use extreme caution when opening drain plugs, pressure caps, valves, and removing hoses and hydraulic lines.
- Never weld or cut on or near a fuel tank.
- Replace all caps, plugs, clamps, cables and guards prior to returning the rig to service.
- Never modify any part of the mast without permission from the equipment shop.
- If it should become necessary to drain oil, fuel, hydraulic fluid or any other industrial fluid in the field, never allow the fluid to drain onto the ground. The fluid must be containerized and disposed of in an appropriate manner according to site-specific requirements. Avoid spillage.
- All cab areas should be clean and free of loose materials, equipment, tools, and unsecured personal items.

4.16 - Decontamination

Decontamination procedures are used to remove or neutralize contaminants that have accumulated on personnel, samples, tools or equipment and to ensure the protection of personnel from permeating substances, chemicals, and infectious agents. Decontamination reduces or eliminates transfer of these contaminants to clean areas, prevents the mixing of incompatible substances, and minimizes the likelihood of sample contamination. Various decontamination methods will physically remove, inactivate by chemical detoxification, disinfection, sterilization, or remove contaminants by both physical and chemical means. In many cases, gross contamination can be removed by physical means.

4.16.1 - Typical Cleaning Methods

Typical cleaning methods work by either dissolution or by forcing the contaminant off a surface with pressure. In general, less of the equipment surface is removed using non-abrasive methods.

- High-Pressure Water - using a high-pressure pump, an operator controlled directional nozzle, and high-pressure hose. Operating pressure usually ranges from 340 to 680 psig, which relates to flow rates of 20 to 140 lpm.
- Steam Cleaning - using water delivered at high pressure and high temperature in order to remove accumulated solids or oils.
- Mechanical - using brushes with metal, nylon, or natural bristles or utilizing appropriate tools to scrape, pry, or otherwise remove adhered materials.
- Dissolving - using chemicals to dissolve surface contaminants as long as the solvent is compatible with the equipment and protective clothing. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products. Halogenated solvents are generally incompatible with protective clothing and are toxic.
- Surfactants reduce adhesion forces between contaminants and the surface being cleaned and prevent reposition of the contaminants. Non-phosphate detergents dissolved in tap water is an acceptable surfactant solution.
- Disinfection and Sterilization - using chemical disinfectants to inactivate infectious agents. Standard sterilization methods are impractical for large equipment and personal protective clothing.

4.16.2 - Personnel and Equipment Decontamination Plan

As part of the site-specific health and safety plan, a personnel and equipment decontamination plan should be developed and set up before any personnel or equipment enters the areas of potential contamination. These plans should include:

- Number and layout of decontamination stations,
- Decontamination equipment needed,
- Appropriate decontamination methods,
- Procedures to prevent contamination of clean areas,
- Methods and procedures to minimize worker contact with contaminants during removal of protective clothing,
- Methods and procedures to prevent cross-contamination of samples and maintain sample integrity and sample custody, and
- Methods for disposal of contaminated clothing, equipment, and solutions.

Revisions to these plans may be necessary for health and safety when the types of protective clothing, site conditions, or on-site hazards are reassessed based on new information.

4.16.3 - Standard Materials and Equipment

The following are standard materials and equipment that may be used as a part of the decontamination process:

- Appropriate protective clothing,
- Air purifying respirator (APR),
- Field log book,
- Non-phosphate detergent,
- Selected high purity, contaminant-free solvents,
- Long-handled brushes,
- Drop cloths (plastic sheeting),
- Trash containers,
- Paper towels,
- Galvanized tubs or equivalent (baby pools),
- Tap water,
- Contaminant-free distilled or deionized water,
- Metal or plastic container for storage and disposal of contaminated wash solutions,
- Pressurized sprayers, water,
- Pressurized sprayers, solvents,
- Trash bags,
- Aluminum foil,
- Sample containers,
- Safety glasses or splash shield, and
- Emergency eyewash bottle.

Specific decontamination materials and equipment will be specified in the site-specific HASP.

4.16.4 - Field Sampling Equipment Cleaning Procedures

The general equipment cleaning steps that may be followed for general field sampling activities are provided below:

1. Physical removal
2. Scrub with non-phosphate detergent plus tap water.
3. Tap water rinse.
4. 10% nitric acid (required during sampling for inorganics only).
5. Distilled or deionized water rinse.
6. Solvent rinse (required during sampling for organics only).
7. Total air dry (required during sampling for organics only).
8. Triple rinse with distilled or deionized water.

4.16.4 - Field Sampling Equipment Cleaning Procedures cont.

This procedure can be expanded to include additional or alternate solvent rinses that will remove specified target compounds if required by site-specific work plans or as directed by a particular client.

Table 4.2 - Decontamination Solvents Table

Solvent	Soluble Contaminants
Water	Low-chain compounds Salts Some organic acids and other polar compounds
Dilute Bases • Detergent • Soap	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents (note: some solvents can degrade or permeate protective clothing) • Alcohols (methanol) • Ethers • Ketones • Aromatics • Straight-chain alkanes (hexane) • Common petroleum products (fuel oil, kerosene)	Non-polar compounds (such as some organic compounds)

Special considerations for solvents:

- Solvent rinses are not necessarily required when organics are not a contaminant of concern.
- An acid rinse is not necessarily required if analysis does not include inorganics.
- Always reference appropriate analytical procedure for specific decontamination solutions required for adequate removal of the contaminants of concern.
- Sampling equipment that requires the use of plastic or Teflon tubing should be disassembled, cleaned, and the tubing replaced with clean tubing, if necessary, before commencement of sampling or between sampling locations.
- The use of distilled or deionized water may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte-free distilled or deionized water.
- The use of an untreated potable water supply may not be an acceptable substitute for tap water.

4.16.5 - Preventing the Spread of Contamination

Several procedures can be established to minimize contact with waste and the potential for contamination including:

- Employing work practices that minimize contact with hazardous substances (avoid areas of obvious contamination, avoid touching potentially hazardous substances),
- A specified area will either be available or can be constructed where fluids generated during decontamination can be captured for disposal.
- Use of remote sampling, handling, and container-opening techniques,
- Covering monitoring and sampling equipment with plastic or other protective material,
- Use of disposable outer garments and disposable sampling equipment with proper containment of these disposable items,
- Use of disposable towels to clean the outer surfaces of sample bottles before and after sample collection, and
- Encasing the source of contaminants with plastic sheeting or over packs.

4.16.6 - Hazards of Decontamination

Due to the presence of water, chemicals, solvents, heat, pressure, and heavy equipment, decontamination activities can be very dangerous. The following are safety items to be considered during equipment decontamination.

Proper procedures for dressing prior to entrance into contaminated areas will minimize the potential for contaminants to bypass the protective clothing. Generally, all fasteners (zippers, buttons, and snaps) should be used, gloves and boots tucked under or over sleeves and pant legs, and all junctures taped, which should be detailed in the site health and safety plan.

- Only properly trained personnel should operate cleaning equipment.
- Use PPE as directed in the health and safety plan, which may include safety glasses with face shield, goggles, poly-coated Tyvek®, aprons, gloves (nitrile, neoprene, or leather), steel toed boots, chemical resistant rubber boots, and respirators to prevent physical contact with potential contaminants and debris.
- Be aware of the slipping hazards of wet or dry plastic inside the decontamination area.
- When drill rods are hoisted from the hole, they should be cleaned for safe handling with a rubber or other suitable rod wiper. NEVER use unprotected hands to clean drilling fluids from drill rods.
- Practice good housekeeping at all times, keeping the decontamination area free of slip, trip, or fall hazards.
- Do not allow eating, smoking, drinking, chewing, or any hand-to-mouth contact in decontaminant areas.
- Monitor affects of heat or cold stress or overexertion in the decontamination area.
- Monitor air concentrations using direct-reading, real-time instruments such as organic vapor monitors (OVMs) and Draeger tubes.
- Establish action levels or limits for ambient air concentration, explosive atmosphere, O_2 deficient atmosphere, and make sure these action levels are understood by decontamination personnel.

4.16.6 - Hazards of Decontamination cont.

- Monitor air concentrations using direct-reading, real-time instruments such as OVM and Draeger tubes.
- Upgrade PPE as necessary (safety glasses with splash shields or goggles, respirators, neoprene gloves, and slicker suit or laboratory apron).
- Stay upwind (use flagging or similar device to indicate wind direction)
- Avoid blocking traffic and stay out of the way of drilling activities.
- Set up near a water supply and keep natural drainage in mind to reduce run-off and clean up.
- Position equipment so over-spray does not get on vehicles or private property.
- Allow for adequate ventilation because exhaust fumes can be lethal.
- Do not operate near anything flammable where a spark or open flame could start a fire or explosion.

4.16.7 - Wastewater and Decontamination Fluids

- Reference MSDS of decontamination solutions for incompatibilities with site contaminants, skin or inhalation hazards, or flammable properties.
- Avoid decontamination chemicals/solutions that permeate, degrade, or damage personal protective equipment.
- Adhere to all Federal, State, and local agency laws, codes, and regulations when handling, transporting, and storing of wastewater, drilling fluids and decontamination fluids.
- The material being removed from drill sites must be packaged, moved, stored, treated, and disposed of in a manner that prevents its release into the environment.
- Drums and containers used to transport drilling waste will meet the appropriate US Department of Transportation (DOT), OSHA, and EPA regulations for the materials that they contain. Appropriate manifest and chain of custody documentation should be used and the waste generator should maintain records as required by applicable regulations.
- Drums and containers used to contain and store drilling wastes and other hazardous materials must be appropriately labeled in accordance with federal and state regulations.
- Drums and containers will be inspected as required by regulations.
- Drum and container integrity will be assured prior to being moved.
- If leakage or spillage occurs, it will be cleaned up immediately. If necessary, the waste material will be transferred to another container to minimize leakage and appropriate measures taken to prevent reoccurrence.
- The drums will have exterior contamination removed at the worksite prior to transportation.
- Blocking devices to plug flow paths to create a collection point for filtration and protection of material entering drain inlets or contaminating drill sites are to be used if necessary (such as waddles, sand bags, or plastic dams).

4.16.8 - Steam Cleaning/Pressure Washing

- The steam cleaner flame may not be intrinsically safe.
- Check hose for possible weakness or potential break points prior to use.
- Avoid pointing any cleaning wand toward body and never use steam, high pressure water, or compressed air for the purpose of cleaning clothes because injury can occur from contact with a high-pressure stream, water, or air.
- Be aware of heat and hot water from steam cleaner.
- Burns can occur from contact with hot equipment or water
- Wear appropriate eye protection as foreign objects may enter eyes due to splashing.
- Be aware of slip/trip hazards while walking on wet surfaces.
- Avoid contact of skin with hazardous rinsing agents (solvents or acids)
- Keep hoses, troughs, and support equipment in good condition.
- Do not spray inside vehicle cab.
- Avoid spraying painted surfaces to keep from removing paint.
- When shutting down steam cleaner, press spray gun release lever for two minutes or until cool water flows out
- Drain hoses and debris into storage containers.

4.16.9 - Health and Safety Hazards of Sampling

Soil and groundwater sampling present various hazards. Besides the usual physical hazards of normal drilling activities and hazards that the individual sites pose, chemical, biological, radiological, and explosive hazards are added when drilling and sampling from monitoring wells. Drilling and sampling activities expose workers to various chemicals that were placed in the ground, either accidentally or intentionally and extreme caution must always be taken when performing these activities in areas of known or suspected waste sites. Not only should workers be aware of the hazards that individual chemicals pose, but of the potential effects of mixtures or chemical interactions because the combination of substances at a waste site may have a more powerfully adverse effect on human health than they would individually. Some of the most significant hazards identified when sampling in known or suspected hazardous waste areas are:

- Exposure to chemicals or waste
- Strains
- Sprains
- Cuts
- Pinch points
- Slips trips, falls.

Sampling procedures are highly complex and must be tailored to fit the chemical being monitored, the hydrogeologic situation, and the design of the monitoring wells. Detailed descriptions of groundwater and soil sampling techniques can be found in publications by the Environmental Protection Agency (Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, EPA 542-S-02-001, EPA-540-S-95-504), ASTM (D5088-02), National Ground Water and National Drilling Associations as well as various scientific journals.

4.16.10 – Work Area Monitoring

Before sampling in areas of potential contamination, it is important to understand what potential physical or chemical hazards the site may pose in addition to the chemical hazards of the materials and preservatives being brought onsite for the purpose of sampling. Historical land use, waste manifests, environmental site assessments, surveys, as built drawings or any other historical documentation may be used to help provide site information. Once a site is ready to be sampled or drilled, the real or potential dangers from fire, explosion, airborne contaminants, radiation, or oxygen deficient atmospheres may need to be monitored. The following details hazards and the equipment used to identify those hazards. Action limits should be set prior to entering the field based on the known or suspected contaminants that may be encountered onsite.

- Combustible Gases -- The atmosphere in any location capable of containing or generating a combustible concentration of gases should be monitored with a combustible gas meter. Actions should be taken in response of the meter reaching a defined percentage of the lower explosive limit (LEL); 25% is often used to cause an immediate evacuation of the site.
- Oxygen Deficiency -- A location capable of containing or generating an oxygen deficiency either by depletion or displacement should be monitored with an oxygen meter. Any reading less than 19.5% oxygen will result in the use of self-contained breathing apparatus (SCBA).
- Organic Vapors and Gases -- The atmosphere can be monitored with either a photoionization detector (PID) or a flame ionization detector (FID). When appropriate, cyanide gas and halogenated vapors will also be monitored. Any response above background concentrations may trigger an upgrade in PPE and respiratory protection. In addition, chemical specific Draeger tubes can also be used to identify presence of specific chemicals.

- Inorganic Vapors and Gases -- There are only a few direct reading instruments with the capability to detect and quantify non-specific inorganic vapors and gases. PIDs have a very limited capability in this area. If specific inorganics are known or suspected of being present, an attempt should be made to provide appropriate monitoring if possible. In the absence of a monitoring capability always assume a worse case scenario and upgrade the level of protection to a level that gives respiratory and skin protection that is appropriate to a worse case assumption.
- Radiation - When radiation may be encountered at a site, a Geiger-Mueller detector for beta and gamma radiation should be used to monitor airborne levels.

Hazards

- Explosions from methane gas produced by the decay of organic materials in sanitary landfills. An explosion potential also exists in monitoring work involving hydrocarbon recovery.
- Toxic substances used in manufacturing pesticides, herbicides, solvents, paints, and other common products. Sometimes certain nontoxic chemicals placed in a disposal site will react with other chemicals to produce highly toxic chemicals.
- Biologic wastes from hospitals or medical laboratories at universities that contain bacteria and viruses.
- Chemical wastes that are corrosive, highly reactive, flammable, or explosive.
- Radioactive wastes from hospitals and industrial and university laboratories.
- Before attempting to conduct monitoring work at a waste site, the drilling contractor should learn exactly what types of wastes were handled there, provide the necessary protective clothing and training for personnel, and stress that any physical changes in a worker's health may be caused by contact with the waste. Always be prepared for worst case conditions.

Precautions

The following precautions should be assessed when sampling:

- Maintain good housekeeping practices, store sampling supplies, coolers, tools, and equipment orderly and out of the main traffic area to avoid unnecessary slip, trip, and fall hazards.
- Be aware of the electrical hazards associated with using groundwater-sampling pumps.
- Use ground fault circuit interrupters in wet or moist conditions.
    - Inspect wires for cuts, wearing and fraying. Remove these wires from service and mark DANGER DO NOT USE if faulty.
    - Follow manufacturer’s instructions when using generators.
    - Use intrinsically safe electrical equipment in areas suspected to have flammable or explosive hazards.
- Be aware of biological hazards when revisiting wells for sampling. Often wasps, bees, ants, spiders and other insects and animals take up residence inside or around monitoring wells. Be aware of these potential hazards as wells caps are opened.
- Request MSDSs for sample preservatives as well as site constituents. Wear appropriate chemical gloves when handling samples as preservatives often contain acidic or corrosive chemicals.
- When using bailers for groundwater sampling, consider the following:
    - Use caution and proper lifting techniques when utilizing larger bailers as they are extremely heavy and awkward when full of sampling liquid.
    - Use increased level of PPE, Tyvek, respirator (if necessary), goggles, splashguard, gloves, chemical resistant boots, or booties to protect skin and eyes from contact with contaminated liquids.

4.16.10 – Work Area Monitoring cont.

- When moving equipment consider the following:
  - Avoid wearing loose or baggy clothing.
  - Wear appropriate PPE including leather gloves.
  - Wear appropriate PPE including gloves, goggles, Tyvek suit, respirator, rubber boots, or splashguard when handling contaminated materials as detailed in the health and safety plan.
  - Upgrade PPE as site conditions change and additional PPE is warranted.

- When handling sharp sampling tools:
  - Use correct tools for opening soil sleeves.
  - Cut away from body when opening sleeve or cleaning soil cores.
  - Always use a sturdy surface when cutting and handling soil cores.
  - Consider using a carrot peeler or metal putty knife in lieu of knifes while preparing and cutting soil samples.

Avoid sample cross contamination by:

- Decontaminating or disposing of sampling equipment between sampling locations.
- Double-checking sample labels to ensure accuracy and adhesion to containers.

When performing standard penetration test, consider the following:

- Split barrel samplers should be inspected daily for excessive wear to threads or bowing of split-tube halves.
- Keep the ball check free of debris to ensure proper operation.
- Keep hands away from the bottom of the sampler when removing it from, or inserting it into, the casing or augers.
- When using pipe wrenches to disassemble the sampler, put yourself in a stable position, and place hands and fingers such that they will not be smashed between the handle and the ground.
- Inspect 140 lb Safety Hammer daily for cracks or excessive wear to the hammer body, top bail, or threads. Do not hold on to the sampling rods while operating the hammer
- Do not use hands to manipulate the own hole hammer when transferring it to vertical use.
- Inspect inner workings of the automatic hammer regularly and lubricate lifting mechanism(s) often.

When conducting Shelby Tube Sampling, consider the following:

- Use the correct size socket-head bolts.
- Keep the ball check free of debris to ensure proper operation.
- Pull, do not push, the pipe wrench while turning the sampling rods to break the sample free while down hole.
- Do not use the machine to turn the rods.
- Keep hands away from the bottom of the sampler when removing it from, or inserting it into, the casing or augers.
- When removing a tube from the head, do not suspend the sampling rods from a slip ring.

4.16.10 – Work Area Monitoring cont.

Consider the following when using all types of core barrels:

- Use full grip circle wrenches to assemble and disassemble core barrels.
- Keep hands away from the bottom of the core barrel or inner tube when removing it from, or inserting it into, the casing, augers, or drill rods.

When using a sample extruder (hydraulic ram), consider the following:

- There are two extremely dangerous pinch points that can crush or sever extremities.
    - The first pinch point is located at the hydraulic ram, where the ram is inserted into the top of the Shelby tube. This is typically a tight fit and a potential pinch point.
    - The second pinch point area is where the Shelby tubes seats against the front plate.
- The Shelby tube often becomes unseated when retracting the hydraulic ram, which can cause the Shelby tube to be shoved up onto the ram header and split the metal at the top of the tube causing sharp metal fragments to be become high-speed projectiles or for the tube to bend abruptly and hit the person operating the extruder. To prevent this ALWAYS steady the Shelby tube by placing your hand on the mid-portion of the tube while retracting the ram.
- Use proper lifting techniques when moving this equipment.
- Only trained and qualified personnel should operate sample extruders
- Always use side shield safety glasses or goggles when operating the extruder and operate the extruder slowly.
- Be aware of pinch points and keep hands and clothing away from these areas.
- When extruding very moist soils, be aware of formation water spraying from the end of the Shelby tube.
- Inspect hydraulic fluid lines of the hydraulic extruder leading to and from the ram assembly for wear or cuts. If cuts occur, hydraulic fluid could be expelled from a line at high velocity.

SECTION 5 - WELL CONSTRUCTION, DEVELOPMENT, AND ABANDONMENT

5.1 - Introduction

Well construction consists of placing a well screen and casing (riser) into the open borehole. A drawing is provided as Attachment 5.A - *Simplified Well Construction Diagram*. The materials of construction can include screen and blank casing composed of polyvinyl chloride (PVC), low carbon steel, fiberglass, stainless steel, and other more exotic materials. Annular materials such as gravel or filter pack (surrounding the screen), fine sand seal, (above the gravel pack), bentonite pellets, (above the fine sand seal) and a grouting material (impervious materials such as cement or high-solids bentonite grout) are placed in the annulus between the borehole and screen or riser casing, after the screen and casing are installed. Finally a surface completion consisting of a well pad, locking riser and protective bollards are installed to protect the above ground portions of the well.

Well development includes the operations, performed on the constructed well, which mitigate the formation damage caused by the drilling methods. Both chemical and physical techniques can be used during well development operations. Chemical methods include treating the well with specialty chemicals such as polyphosphates, acids and other specific compounds designed to increase the flow from the formation into the well. Physical methods may include, high pressure jetting of water into the well, surging, bailing, swabbing or even the introduction of dry ice or compressed air into the well to create a low pressure environment inside the well screen and casing.

Well abandonment activities are performed on extraction, injection and monitor wells when the well is no longer needed for its intended function. Wells can be abandoned by simply installing and impermeable material (grout) inside of the well, or requirements may dictate that the entire well must be removed from the ground (over drilling).

5.2 - Roles and Responsibilities

In most instances the consultant or owner determines the depth of the well and the precise location of the well materials. The data are then provided to the driller who physically installs the well materials into the borehole. Depending on the contractual arrangements, the driller or owner may purchase the well materials and transport the materials to the actual well site. Well development criteria are also provided to the driller by the owner or consultant. Finally, well abandonment parameters are many times determined by state and local regulations.

5.3 - Personal Protective Equipment (PPE)

The PPE requirements for well construction are similar to the protection worn during the drilling operations. At a minimum the following PPE is required:

- Hard hat
- Steel toed boots
- Gloves
- Safety glasses
- Hearing protection

Additional dermal and respiratory protection is dictated by the site-specific health and safety plan. The field personnel must remember that as the well materials are being added to the borehole, fluids are being displaced and may rise to the ground level in the borehole. Therefore, the PPE should mitigate potential exposure to the contaminants present in the subsurface or ground water.

PPE for well development must also be determined based on the chemicals used for well development and the potential for exposure to contaminated ground water.

5.4 - Waste containment

Two waste streams will be generated during well construction, subsurface materials such as soil and ground water and rubbish including, empty filter pack and cement bags, five gallon pails, boxes and bags from the well screen and casing along with other packing containers.

The soil cuttings and ground water should be contained in the same manner as the material generated during the drilling operations.

The rubbish and trash must be properly controlled in labeled containers during well construction. Placing the material in receptacles as they are used eliminates the potential for slips, trips, and falls caused by personnel movement around the well site.

Well development activities generate a rubbish waste stream (from packaging of the chemicals) and the ground water produced during pumping activities.

5.5 - Traffic

Many times the well is constructed in a high traffic area such as a retail service station. The traffic control plan developed for the drilling operations should also be used for the well construction, development, and abandonment phases of the project.

5.6 - Housekeeping of Bagged Material

Filter pack, transition sand, cement, and high solids bentonite grout are normally packaged in paper bags weighing between 50 lbs and 100 lbs. Many times the bagged material is stored on the project location in inclement weather conditions. Rain and sunlight can and will degrade the packaging material which leads to breakage and spillage of sand, gravel and grout material. Additionally, the bagged material must be stacked in a manner which is safe for personnel moving the sacks.

The following sections detail the steps used in well construction activities along with potential hazards of the operations.

5.7 - Transport Well Materials to Location

Prior to the movement of materials to the well location the following items will need to be considered:

- Distance from supply vehicle to the well location
- Weight, size and length of the materials
- Site terrain and pathways
- Method of movement and equipment to be used

5.7.1 - Well Casing and Annular Materials

Movement of the well casing material (PVC, Stainless) and annular materials (filter pack, seal materials and cement or grout) may involve the use of manual or mechanical handling methods such as:

- Forklift
- Manually (PVC screen and casing, individual bags of gravel, sand and grout)

5.7.2 - Potential Hazards for Moving Well Materials

Potential hazards include:

- Manual lifting of heavy bags and awkward lengths of pipe
- Slips trips and falls
- Pinch points
- Obstructions (overhead and pathway)
- Long lengths of piping
- Traffic

5.8 - Install Screen and Casing

Prior to installation of well screen and casing into the borehole the following items should be considered:

- Type of screen and casing PVC (manual installation) steel and stainless steel (rig installation)
- Weight of casing string (rig capacity)
- Overhead obstructions and clearance
- Connection type (threaded, welded)

Potential Hazards for Screen and Casing Installation include:

- Manual screen slotting
- Manual lifting of awkward lengths or heavy pipe
- Pinch points
- Obstructions (overhead and pathway)
- Connections
    - Torque
    - Pinch Points
    - Pipe length and weight
    - Hand Tools - pipe wrenches

5.9 - Install Annular Materials

Prior to the installation of annular materials the following should be considered:

- Weight of bagged materials (typically 50 - 100 lbs)
- Package shape, bags, pails
- Dust and chemical issues (minimization of dust generation)
- Distance from the staging area or off-load location to the well

Potential Hazards of annular material installation include:

- Silica and other dust (Avoid skin and eye contact; Wear respiratory protection)
- Pressurized lines during grout mixing and placement
- Opening bags
- Knives, box cutters, hammers, screw driver
- Trash obstacles

5.10 - Develop the Well

In most cases, well development activities are performed by a separate rig and crew - not by the drilling rig and crew. Therefore the development rig crew must consider the same operational safety checks as the drilling rig. Refer to previous sections of this guide for information about:

- Pre-Mobilization Tasks
- Traveling to Site
- Confirmation Activities
- Preparation and Set Up
- Moving People and Equipment to Site
- Rig Set Up
- Raising the Mast

Prior to well development the following should be considered:

- Methods
- Physical
    - Swab
    - Bail
    - Airlift
    - Overpump
- Chemical
    - Acid
    - Mud thinners (polyphosphates, liganosulfates)
- Fluid containment - drums tanks
    - Labeling
    - Long term storage
    - Hauling

5.10.1 - Potential Hazards of Well Development

- Pinch points
- Tool lengths
- Moving cables
- Contaminated fluids
- Acids and polyphosphates
- Electricity
- Noise
- Pressurized lines

5.11 - Surface Completion

Prior to well surface completion the following should be considered:

- Type of completion - flush mount, above grade, locking
- Bollard location and clearances

5.11.1 - Potential Hazards of Surface Completion:

- Traffic control
- Mixing concrete
- Heavy vaults and boxes
- Striking underground utilities
- Vault settlement - trip hazard, surface water intrusion

5.12 - Abandoning Wells

Prior to well abandonment the following should be considered:

- Rig mobilization and rig up - from *Section 4 – Drilling Operations*
- Method
    - Over drill
    - Abandon in place

5.12.1 - Potential Hazards of Over Drill

- All previous sections of the guideline apply.

5.12.2 - Potential Hazards of Abandon in Place

- Silica and other dust – Skin and eye contact must be avoided and respiratory protection worn.
- Pressurized lines during grout mixing and placement
- Opening bags – knives, box cutters, hammers, screw drivers may be unsafe if not used properly
- Trash obstacles
- Fluid containment
- All pipe handling safety guidelines apply

Each job location has site-specific parameters that govern the means and methods for well installation, development and abandonment activities. The drilling method and drill rig will dictate the specific hazards involved. Daily tailgate meetings and job safety analysis should be developed for the specific tasks based on the drilling method and rig, type of well materials, or location of material staging area.

Specific job safety analysis for well construction may include:

- Proper lifting techniques
- Loading and unloading of forklift or truck beds
- Hand tool usage
- Drum handling

Attachment 5.B - *Typical Job Safety Analysis for Equipment Loading and Unloading* is included as an example.

REFERENCES AND RESOURCES

- Federal Motor Carrier Safety Regulations Pocketbook
- American Iron and Steel Institute *Wire Rope Users Manual*
- American Public Works Association: http://www.apwa.net/
- Common Ground Alliance: http://www.commongroundalliance.com/
- Gas Utility Manager: http://www.gasindustries.com/
- National Utility Locating Contractors Association: http://www.nulca.org/
- Underground Focus: http://www.undergroundfocus.com/

Code of Safe Drilling Practices, California Dept. of Transportation, Division of Engineering Services, April 30, 2004

Attachment 1.A - Typical Health and Safety Plan (HASP) Organization and Contents

NOTE: The list of topics offered below is presented as an example. It is not comprehensive or intended to be adequate for all project applications and work plans.

MAKEHOLE HEALTH AND SAFETY PLAN - TABLE OF CONTENTS

COVER - REVIEW SIGNATURE PAGE

EMERGENCY CONTACT SHEET

MAP TO HOSPITAL

PROCEDURES FOLLOWING AN INCIDENT

SECTION 1 - INTRODUCTION
- Purpose and Policy
- Organization of This Health and Safety Plan
- Site Description and History
- Scope of Work
- Project Team Organization

SECTION 2 - INCIDENT NOTIFICATION AND REPORTING
- Forms and Procedures

SECTION 3 - HAZARD ANALYSIS
- Hazards Analysis of Work Tasks
- Chemical Hazards
- Physical Hazards
- Traffic
- Vehicle Operation
- Avoiding Traffic
- Underground and Overhead Utilities
- Trip and Fall
- Fire and Explosion
- Heat Stress
- Cold Related Illness
- Environmental Biological Hazards

SECTION 4 - PERSONNEL PROTECTION AND MONITORING
- Medical Surveillance
- Site-Specific Training
- Personal Protective Equipment and Action Levels
- Monitoring Requirements
- Routine Monitoring
- Oxygen Monitoring

MAKEHOLE HEALTH AND SAFETY PLAN
TABLE OF CONTENTS

Attachment 1.B - Example JSA for Clearance Activities

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Pre-Ground Disturbance Clearance Activities			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other _As specified in HASP and JSA Job Step_____			

JOB STEP	POTENTIAL HAZARDS	PREVENTATIVE/CORRECTIVE ACTION	APPLIES TO PROJECT (Y/N)
All Pre-Ground Disturbance Clearance Activities including Site Inspection, Subsurface Features Mark-out, Removal of Surface Cover and Ground Clearance	Slips, Trips, Falls	Keep work area free of excess material and debris	
		Remove all trip hazards by keeping materials/objects organized and out of walkways	
		Keep work surfaces dry when possible	
		Wear appropriate PPE including non-slip rubber boots if working on wet or slick surfaces	
		Install rough work surface covers where possible	
		Stay aware of footing and do not run	
	Heat/Cold Stress	Take breaks if feeling faint or overexerted	
		Consume adequate food/beverages (water, sports drinks)	
		If possible, adjust work schedule to avoid temperature extremes	
	Biological Hazards: Insects, Snakes, Wildlife, Vegetation	Inspect work areas when arrive at site to identify hazard(s)	
		Use insect repellant if observe mosquitoes/gnats	
		Survey site for presence of biological hazards and maintain safe distance	
		Wear appropriate PPE including leather gloves, long sleeves and pants, and snake chaps as warranted by site conditions	
	Traffic (including pedestrian)	Notify attendant or site owner/manager of work activities and location	
		Use cones, signs, flags or other traffic control devices as outlined in the Traffic Control Plan	
		Set up exclusion zone surrounding work area using cones, signs, flags or other traffic control devices	
		Wear appropriate PPE including high visibility clothing such as reflective vest	
		Inspect area behind vehicle prior to backing and use spotter	
	Fire/Explosion	Post No Smoking signs around work area	
		Establish designated smoking area away from work area	

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Pre-Ground Disturbance Clearance Activities			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other _As specified in HASP and JSA Job Step_____			

JOB STEP	POTENTIAL HAZARDS	PREVENTATIVE/CORRECTIVE ACTION	APPLIES TO PROJECT (Y/N)
		Ensure type ABC, 20-lb, fully charged fire extinguisher on-site and within inspection period	
		As site conditions/activities warrant, establish Hot Work Permit including air monitoring using direct-reading, real-time instruments such as LEL/O meter	
		Stop work if hazardous conditions (explosive atmosphere) are identified	
Ambient Air Monitoring	Vapors	Approach area where vapors are suspected from upwind direction and stay upwind/crosswind of from potential sources of vapors (use flagging or similar device to indicate wind direction)	
	Ineffective Air Monitoring	Ensure personnel using have been trained on instrument use	
		Calibrate instrument prior to use	
Breaking-Up and Removing Asphalt/ Concrete Cover by Saw Cutting or with Heavy Equipment	Heavy Equipment Movement	Heavy equipment should be equipped with back-up alarm or use horn when backing	
		Do not allow personnel to stand within the swing radius of equipment booms/arms when equipment is in operation	
		Stay clear of operating equipment and heavy equipment when moving	
		When approaching heavy equipment, approach should be made from the front ensuring eye contact is made with operator	
	Suspended Loads	Do not walk under suspended loads	
		Wear appropriate PPE including hard hat	
	Ignition Sources	Ensure electrical equipment properly grounded	
		Apply water as necessary to address surface sparking potential	
		Equip heavy equipment with non-sparking bucket/blade	
	High Noise Levels	Hearing protection required when working around operating equipment if levels are suspected to be >85 dBA (if have to yell to person at a dist of 3 ft to be heard, likely exceeding 85 dBA).	
	Airborne Particulates and Debris	Use water as necessary to control dust in area	
		Wear appropriate PPE including face shield or safety glasses with side shields, dust mask, leather gloves and long sleeves	
	Heavy Material Lifting	Use heavy equipment to lift	
		Do not lift or move heavy materials (greater than 50 lbs) without	

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Pre-Ground Disturbance Clearance Activities			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other _As specified in HASP and JSA Job Step_____			

JOB STEP	**POTENTIAL HAZARDS**	**PREVENTATIVE/CORRECTIVE ACTION**	**APPLIES TO PROJECT (Y/N)**
		adequate assistance	
		Bend and lift with legs and arms, keeping back straight	
		Wear appropriate PPE including leather gloves, long sleeves and pants, and steel-toed boots	
	Impact to Subsurface Lines	Ensure all underground features have been identified in area per Subsurface Clearance Protocol (SCP) prior to start of activities	
	Equipment Rollover	If soil appears unstable, the soil should be assessed by a qualified professional engineer to ensure safe conditions with implementation of design control measures prior to start of work	
Soil Clearance using hand tools or heavy equipment (probe, auger, air knife rig, backhoe)	Heavy Equipment Movement	Heavy equipment should be equipped with back-up alarm	
		When approaching heavy equipment, approach should be made from the front ensuring eye contact is made with operator	
	Physical Injury from Managing Equipment	Take breaks if feeling faint or overexerted	
	Ignition Sources	Ensure equipment properly bonded and grounded	
		Use sufficient hose so that equipment does not have to be located in critical zone	
		Apply water as necessary to address sparking potential if equipment comes in contact with rocks/buried objects	
		Equip heavy equipment with non-sparking bucket/blade	
	High Noise Levels	Hearing protection required when working around operating equipment if levels are suspected to be >85 dBA (if have to yell to person at a dist of 3 ft to be heard, likely exceeding 85 dBA).	
	Airborne Debris	Wear appropriate PPE including leather gloves, long sleeves and pants, and face shield or safety glasses with side shields	
	Vapors and Airborne Particulates	Monitor air concentrations using direct-reading, real-time instruments such as OVM and Draeger tubes	
		Stop work if hazardous conditions (explosive atmosphere, O_2 deficient atmosphere) identified until precautions are taken	
		Wear appropriate PPE including dust masks and respirators	
		Stay upwind (use flagging or similar device to indicate wind direction)	
	Impact to	Ensure underground features in area have been identified to extent	

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Pre-Ground Disturbance Clearance Activities			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other _As specified in HASP and JSA Job Step_____			

JOB STEP	**POTENTIAL HAZARDS**	**PREVENTATIVE/CORRECTIVE ACTION**	**APPLIES TO PROJECT (Y/N)**
	Underground Lines/ Tanks	possible per SCP (line locators, drawing review,)	
		Wear insulating gloves or stand on insulating mat when advancing hand tools	
	Open Excavation	Personnel should stay at least two feet away from edge	
		Install orange construction fence or temporary chain link fence around excavated area if to be left unattended	
Solid Waste Management/ Disposal	Vapors and Airborne Particulates	Monitor air concentrations using direct-reading, real-time instruments such as OVM and Draeger tubes	
		Stop work if hazardous conditions (explosive atmosphere, O_2 deficient atmosphere) identified until precautions are taken	
		Wear appropriate PPE including safety glasses with side shields, dust masks and respirators	
		Stay upwind (use flagging or similar device to indicate wind direction)	
	Contaminated Materials and Container Pinch Points	Wear appropriate PPE including nitrile and leather gloves	
		Position hands/fingers to avoid pinching/smashing/crushing when closing drum rings	
	Heavy Materials and Container Lifting/Moving	Do not lift or move heavy containers without assistance	
		Use proper bending/lifting techniques by lifting with arms and legs and not with back	
		If possible, use powered lift truck, drum cart, or other mechanical means to move containers	
		Take breaks if feeling faint or overexerted	
		Spot drums in storage area prior to filling	
		Wear appropriate PPE including leather gloves and steel-toed boots	

Attachment 1.C - Example JSA for Drilling or Boring and Soil Sampling

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Drilling/Boring and Associated Soil Sampling			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_ Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other __Hearing protection and High Visibility Vest___X____			

JOB STEP	POTENTIAL HAZARDS	PREVENTATIVE/CORRECTIVE ACTION	APPLIES TO PROJECT (Y/N)
All Drilling/ Boring Activities	Slips, Trips, Falls	Keep work area free of excess material and debris	
		Remove all trip hazards by keeping materials/objects organized and out of walkways	
		Keep work surfaces dry when possible	
		Wear appropriate PPE including non-slip rubber boots if working on wet or slick surfaces	
		Install rough work surface covers where possible	
		Stay aware of footing and do not run	
	Heat/Cold Stress	Take breaks if feeling faint or overexerted	
		Consume adequate food/beverages (water, sports drinks)	
		If possible, adjust work schedule to avoid temperature extremes	
	Biological Hazards: Insects, Snakes, Wildlife, Vegetation	Inspect work areas when arrive at site to identify hazard(s)	
		Use insect repellant if observe mosquitoes/gnats	
		Open enclosures slowly	
		Survey site for presence of biological hazards and maintain safe distance	
		Wear appropriate PPE including leather gloves, long sleeves and pants, and snake chaps as warranted by site conditions	
	Traffic (including pedestrian)	Notify attendant or site owner/manager of work activities and location	
		Use cones, signs, flags or other traffic control devices as outlined in the Traffic Control Plan	
		Set up exclusion zone surrounding work area using cones, signs, flags or other traffic control devices	
		Wear appropriate PPE including high visibility clothing such as reflective vest	
		Inspect area behind vehicle prior to backing and use spotter	
	Fire/ Explosion	Post No Smoking signs around work area	

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Drilling/Boring and Associated Soil Sampling			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_ Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other __Hearing protection and High Visibility Vest ___X____			

JOB STEP	POTENTIAL HAZARDS	PREVENTATIVE/CORRECTIVE ACTION	APPLIES TO PROJECT (Y/N)
		Establish designated smoking area away from work area	
		Ensure type ABC, 20-lb, fully charged fire extinguisher on-site and within inspection period	
		As site conditions/activities warrant, establish Hot Work Permit including air monitoring using direct-reading, real-time instruments such as LEL/ O_2 meter	
		Stop work if hazardous conditions (explosive atmosphere) are identified	
Ambient Air Monitoring	Vapors	Approach area where vapors are suspected from upwind direction and stay upwind/crosswind of from potential sources of vapors (use flagging or similar device to indicate wind direction)	
	Ineffective Air Monitoring	Ensure personnel using have been trained on instrument use	
		Calibrate instrument prior to use	
Concrete Coring	Ignition Sources	Ensure electrical equipment properly grounded	
		Apply water as necessary to address surface sparking potential	
	High Noise Levels	Hearing protection required when working around operating equipment if levels are suspected to be >85 dBA (if have to yell to person at a dist of 3 ft to be heard, likely exceeding 85 dBA).	
	Airborne Particulates and Debris	Use water as necessary to control dust in area	
		Wear appropriate PPE including face shield or safety glasses with side shields, dust mask, leather gloves and long sleeves	
	Sharp Rough Materials	Wear appropriate PPE including leather gloves, long sleeves and pants, and steel-toed boots	
	Impact to Subsurface Lines	Ensure all underground features have been identified in area per SCP prior to start of activities	
Drill Rig Set-Up	Rig Roll Over	Do not move rig with mast raised	
		Cross all hills and obstructions head on	
		Set riggers prior to raising mast	
		If soil appears unstable, the soil should be assessed by a qualified professional engineer to ensure safe conditions with implementation of design control measures prior to start of work	
	Contact with Electric Lines	Position rig to avoid overhead utility lines by distance defined by voltage and local regulations	

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Drilling/Boring and Associated Soil Sampling			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_ Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other __Hearing protection and High Visibility Vest ___X____			

JOB STEP	POTENTIAL HAZARDS	PREVENTATIVE/CORRECTIVE ACTION	APPLIES TO PROJECT (Y/N)
	and Other Overhead Obstacles	Use a spotter when raising mast to confirm clearance of overhead lines and other obstructions	
	Rig Movement	Heavy equipment should be equipped with back-up alarm or use horn when backing - use spotter when available	
		Stay clear of operating equipment and rig when moving	
	Heavy Equipment Lifting/ Carrying	Use at least 2 people to lift and carry sections, use mechanical lift devices whenever possible, bend and lift with legs and arms, not back	
	Sharp or Elevated Equipment	Wear appropriate PPE including steel-toed safety boots, leather gloves and hard hat	
		Establish communication system between workers involved in moving/attaching sections	
Ground Disturbance: Auger/Boring Advancement	Faulty or Inappropriate Equipment	Qualified driller must inspect drill rig prior to use, if faulty or inappropriate, do not proceed until repaired or replaced	
		Inspect all hand tools prior to use, if faulty or inappropriate, do not proceed until repaired or replaced	
	Moving Equipment	Clear area of obstructions and communicate with all workers involved that drilling is beginning	
		Do not exceed manufacturer's recommended speed, force, torque, or other specifications. and penetrate the ground slowly with hands on the controls for at least the first foot of soil to minimize chance of auger kick-out	
		Stay clear of rotating auger	
		Use long-handled shovel to clear away cuttings when auger has stopped	
		Do not wear loose clothing	
		Wear appropriate PPE including leather gloves and steel-toed boots	
	Suspended Loads	Do not walk under suspended loads	
		When possible, remove overhead hazards promptly	
		Wear appropriate PPE including hard hat and steel-toed boots	
	High Noise Levels	Use hearing protection if within 20 feet of active drill rig	
	Vapors and Airborne	Monitor air concentrations using direct-reading, real-time instruments such as OVM and Draeger tubes	

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Drilling/Boring and Associated Soil Sampling			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_ Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other __Hearing protection and High Visibility Vest ___X____			

JOB STEP	POTENTIAL HAZARDS	PREVENTATIVE/CORRECTIVE ACTION	APPLIES TO PROJECT (Y/N)
	Particulates	Stop work if hazardous conditions (explosive atmosphere, O_2 deficient atmosphere) identified until precautions are taken	
		Wear appropriate PPE including face shield or safety glasses with side shields, dust masks or respirators, long sleeves and pants	
		Stay upwind (use flagging or similar device to indicate wind direction)	
	Impact to Subsurface Lines/Tanks	Only drill in areas where underground features have been identified and cleared per Subsurface Clearance Protocol (SCP) if hole has to be moved, clear new location first	
		Wear appropriate PPE including insulating gloves or stand on an insulating mat when in contact with drill rig	
		Ensure first aid responders are trained to deal with electric shock and flash burns	
Ground Intrusion: Split Spoon	Faulty Equipment	Inspect rope/cable/rod for wear, fraying, oils and moisture prior to use, do not use if faulty until repaired or replaced	
		Inspect cathead for rust and rope grooves prior to use, do not use if faulty until repaired or replaced	
	Moving Equipment	Do not wrap rope around any part of the hand or body	
		Maintain distance of at least 18-inches from in-running points on running/reciprocating equipment	
		Eliminate excess rope	
		Do not wear loose clothing	
		Wear appropriate PPE including leather gloves	
Soil Sampling	Contaminated Materials	Wear appropriate PPE including Nitrile gloves	
	Sharp Sampling Tools	Use correct tools for opening sleeves	
		When opening sleeve, cut away from body	
		Place soil core on sturdy surface prior to cutting	
	Vapors	Wear appropriate PPE including respirator if conditions warrant	
	Sample Cross Contamination	Decontaminate or dispose of sampling equipment between sampling locations	
		Double-check sample labels to ensure accuracy and adhesion to containers	

JOB SAFETY ANALYSIS FORM			
JOB TITLE/TASK: Drilling/Boring and Associated Soil Sampling			
PROJECT ID		PROJECT MANAGER:	
DATE:	REVISION:	HEALTH/SAFETY DIRECTOR:	
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE): _X_ Safety Glasses w/ Sideshields _X_ Steel-toed Boots _X_ Hard Hat _X_ Nitrile Gloves _X_ Leather Work Gloves _X_ Other __Hearing protection and High Visibility Vest ___X____			

JOB STEP	**POTENTIAL HAZARDS**	**PREVENTATIVE/CORRECTIVE ACTION**	**APPLIES TO PROJECT (Y/N)**
Solid/Liquid Waste Management/ Disposal	Vapors and Airborne Particulates	Monitor air concentrations using direct-reading, real-time instruments such as OVM and Draeger tubes	
		Stop work if hazardous conditions (explosive atmosphere, O_2 deficient atmosphere) identified until precautions are taken	
		Wear appropriate PPE including safety glasses with side shields, dust masks and respirators	
		Stay upwind (use flagging or similar device to indicate wind direction)	
	Contaminated Materials and Container Pinch Points	Wear appropriate PPE including Nitrile and leather gloves	
		Position hands/fingers to avoid pinching/smashing/crushing when closing drum rings	
	Heavy Materials and Containers Lifting/ Moving	Do not lift or move heavy containers without assistance	
		Use proper bending/lifting techniques by lifting with arms and legs and not with back	
		If possible, use powered lift truck, drum cart, or other mechanical means	
		Take breaks if feeling faint or overexerted	
		Spot drums in storage area prior to filling	
		Wear appropriate PPE including leather gloves and steel-toed boots	

Attachment 3.A - Pre-Mobilization Checklist / Drilling Safety Guidance Document

Check When Completed	Checklist of Items
	Participate in boring, utility, locate and walk site
	Verify equipment needs
	Verify equipment staging area(s)
	Verify sequence of onsite mobilizations
	Service brakes, including trailer brake connections
	Service Parking (hand) brake
	Service Steering mechanism.
	Service Lighting devices and reflectors
	Service Tires
	Service Horn
	Service Windshield wiper or wipers
	Service Rear-vision mirror or mirrors.
	Service Coupling devices
	Inspect the windshield for cracks, repair or replace as necessary
	Verify that an appropriate, permitted fire extinguisher is within the driver's grasp and that the extinguisher is properly secured.
	Verify supply of sufficient flares or reflectors which can be used in the event of a breakdown while on the highway.
	Verify that seat belts are in good working condition.
	Verify all windows function properly. Repair or replace as necessary
	Verify all doors lock and function properly. Repair or replace as necessary.
	Verify back-up alarms are installed and function properly. Repair or replace as necessary.
	Verify that all lug nuts are properly tightened and that the wheels appear to be in good condition. While performing this task, the driver should make certain that the spare tire is in good condition, properly inflated, and that a suitable jack and lug wrench are available.
	Verify the mast, jacks, deck (s), and tools are completely secured prior to moving the vehicle.
	Verify all tool boxes are closed and properly secured.
	Inspect all spools containing wire rope (cable) and verify they are secured and that the cables will not unwind while driving down the road.

Attachment 4.A - Sample Hazard Communication and Chemical Safety Program

MAKEHOLE Drilling Co. - Hazard Communication and Chemical Safety Program

Section 1 - Purpose

This document serves as the MAKEHOLE Drilling Hazard Communication Program. It provides detailed safety guidelines and instructions for receipt, use, and storage of chemicals at our jobsites by employees and subcontractors. Our goal is to provide all employees and affected personnel with the tools, knowledge and information necessary to protect their selves and co-workers from hazards encountered in the work place.

Section 2 - Scope

In general, employees do not handle hazardous chemicals as part of their normal work routine; however, employees work in facilities that manufacture, transport and store hazardous chemicals. Thus management has included a Hazard Communication and Chemical Safety Program for the purpose of MAKEHOLE employee awareness. Employees are instructed not to handle potentially hazardous chemicals and to alert proper facility officials in the event that a substance of unknown origin is spotted. In addition to hazardous substance training and right to know training, employees receive specific awareness training for Asbestos, Benzene, Hydrogen Sulfide and lead exposure.

Section 3 - Regulatory References

This Hazard Communication and Chemical Safety Program is intended to comply with the following OSHA requirements. 29 CFR 1910.1200,

Section 4 - Company Policy

A written Hazard Communication Program shall be developed, implemented and maintained at each work site. Company HS&E manager shall have full authority and responsibility for implementation and execution throughout operations. Business unit managers shall have full authority and responsibility for implementation and execution within their areas of control and senior site supervisors shall have full authority and responsibility for implementation and execution within their areas of control.

- All employees and affected personnel shall receive Hazard Communication and Chemical Safety Program training. In addition, employees and affected personnel shall receive training and information regarding hazardous chemicals and safety precautions specific to their assigned work sites.
- Employees shall not handle potentially hazardous chemicals unless they have been properly trained and instructed to do so.
- Employees shall immediately alert proper facility officials in the event that a substance of unknown origin is spotted.
- Employees shall immediately report all chemical spills, releases or exposures to their immediate supervisor or proper facility official.
- Each company operation and job-site shall establish emergency response and evacuation plans per company Emergency Preparedness Program.
- All containers shall have the appropriate label, tag or marking prominently displayed that indicates the identity, safety and health hazards.
- Each job-site shall have a copy of the Material Safety Data Sheet (MSDS) for each hazardous chemical present.
- A Master Chemical information List (CIL) shall be maintained by Manager of HS&E. Each site-operation

and jobsite may use this master or develop a subset CIL covering chemicals present at those specific jobsites.

- Non-routine tasks shall be evaluated by the Project Supervisor before the task commences, to determine all hazards present.

Section 5 - Responsibilities

- **Management**
  - Business unit managers have full authority and responsibility for the implementation and execution of this Hazard Communication and Chemical Safety Program, within his or her area of control.
  - Ensure compliance with this program.
  - Conduct immediate corrective action for deficiencies found in the program.
  - Maintain an effective Hazard Communication training program.
  - Make this plan available to employees or their designated representative

- **Shipping and Receiving**
  - Ensure all received containers are properly labeled and that labels are not removed or defaced.
  - Ensure all shipped containers are properly labeled
  - Ensure shipping department employees are properly trained in spill response
  - Ensure received Material Safety Data Sheets (MSDS) are properly distributed

- **Purchasing Agent**
  - Obtain, from the manufacturer, MSDS for chemicals purchased from retail sources

- **Safety Manager**
  - Manager of HS&E has full authority and responsibility for the implementation and execution of this Hazard Communication and Chemical Safety Program, company wide.
  - Develop and maintain a list of hazardous chemicals using the identity that is referenced on the MSDS
  - Monitor the effectiveness of the program
  - Conduct annual audit of the program
  - Monitor employee training to ensure effectiveness
  - Keep management informed of necessary changes
  - Ensure MSDSs are available as required
  - Monitor jobsites for proper use, storage and labeling of chemicals

- **Supervisors**
  - The senior site supervisor has full authority and responsibility for the implementation and execution of this Hazard Communication and Chemical Safety Program, within his or her area of control.
  - Comply with all specific requirements of the program
  - Provide specific chemical safety training for assigned employees
  - Ensure chemicals are properly used stored and labeled
  - Ensure only the minimum amount necessary is kept at work stations
  - Ensure up to date MSDS are readily accessible to all employees on all shifts

- **Employees**
  - Comply with chemical safety requirements of this program
  - Report any problems with storage or use of chemicals
  - Immediately report spills of suspected spills of chemicals
  - Use only those chemicals for which they have been trained

- Use chemicals only for specific assigned tasks in the proper manner

- **Subcontractors**
  - Comply with all aspects of this program
  - Coordinate information with the Project Supervisor
  - Ensure Subcontractor employees are properly trained
  - Notify the Project Supervisor before bringing any chemicals into client's property of facilities
  - Monitor and ensure proper storage and use of chemicals by subcontractor employees

Section 6 - HAZCOM Definitions

TERM	DEFINITION
Chemical	Any element, chemical compound, or mixture of elements or compounds.
Combustible liquid	Any liquid having a flash point at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flash points of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.
Compressed gas	Any compound that exhibits: • A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psig at 70 deg. F. • A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psig at 130 deg. F. regardless of the pressure at 70 deg. F. • A liquid having a vapor pressure exceeding 40 psig at 100 deg. F.
Container	Any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers.
Employee	A worker who may be exposed to hazardous chemicals under normal operating conditions or in foreseeable emergencies. Workers such as office workers or bank tellers who encounter hazardous chemicals only in non-routine, isolated instances are not covered.
Explosive	A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.
Exposure or exposed	An employee is subjected in the course of employment to a chemical that is a physical or health hazard, and includes potential (incidental or possible) exposure. Subjected in terms of health hazards includes any route of entry (for example, inhalation or ingestion)

TERM	DEFINITION
Flammable	A chemical that falls into one of the following categories: • Aerosol, flammable means an aerosol that yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening, • Gas, flammable means: –) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen (13) percent by volume or less, or – A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than twelve (12) percent by volume, regardless of the lower limit. • Liquid, flammable means any liquid having a flash point below 100 deg. F., except any mixture having components with flash points of 100 deg. F. or higher, the total of which make up 99 percent or more of the total volume of the mixture. • Solid, flammable means a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.
Flash point	The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.
Hazardous chemical	Any chemical this is a physical hazard or a health hazard.
Hazard warning	Any words, pictures, symbols, or combination appearing on a label or other appropriate form of warning which convey the specific physical and health hazard(s), including target organ effects, of the chemical(s) in the container(s). (See the definitions for *physical hazard* and *health hazard* to determine the hazards which must be covered.)
Health hazard	A chemical for which there is evidence that acute or chronic health effects may occur in exposed employees. The term *health hazard* includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, and neurotoxins, agents which act on the hematopoietic system and agents which damage the lungs, skin, eyes, or mucous membranes.
Identity	Any chemical or common name which is indicated on the material safety data sheet (MSDS) for the chemical. The identity used shall permit cross-references to be made among the required list of hazardous chemicals, the label and the MSDS.
Immediate use	The hazardous chemical shall be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

TERM	DEFINITION
Label	Any written, printed, or graphic material displayed on or affixed to containers of hazardous chemicals.
Material Safety Data Sheet (MSDS)	Written or printed material concerning a hazardous chemical which is prepared in accordance with OSHA Standard 1910.1200 requirements.
Mixture	Any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction.
Oxidizer	A chemical other than a blasting agent or explosive as defined in 1910.109(a) that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.
Physical hazard	A chemical that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.
Pyrophoric	A chemical that will ignite spontaneously in air at a temperature of 130 deg. F. or below.
Specific chemical identity	The chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.
Unstable (reactive)	A chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure, or temperature.
Use	To package, handle, react, emit, extract, generate as a byproduct, or transfer.
Water-reactive	A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.
Work area	A room or defined space in a workplace where hazardous chemicals are produced or used, and where employees are present.
Workplace	An establishment, job site, or project, at one geographical location containing one or more work areas.

Section 7 - Hazard Recognition

This Hazard Communication and Chemical Safety Program is primarily a hazard recognition program. Elements such as, product warning labels and material safety data sheets, detailed in the sections that follow provide useful tools and knowledge enabling employees to identify hazardous chemicals in the work place.

7.1 - General Chemical Safety

Assume all chemicals are hazardous. The number of hazardous chemicals and the number of reactions between them is so large that prior knowledge of all potential hazards cannot be assumed. Use chemicals in as small quantities as possible to minimize exposure and reduce possible harmful effects. The following general safety rules shall be observed when working with chemicals:

Read and understand the Material Safety Data Sheets.
Keep the work area clean and orderly.
Use the necessary safety equipment.
Carefully label every container with the identity of its contents and appropriate hazard warnings.
Store incompatible chemicals in separate areas.
Substitute less toxic materials whenever possible.
Limit the volume of volatile or flammable material to the minimum needed for short operation periods.
Provide means of containing the material if equipment or containers should break or spill their contents.

Task Evaluation

Each task that requires the use of chemicals should be evaluated to determine the potential hazards associated with the work. This hazard evaluation or JSA must include the chemical or combination of chemicals that will be used in the work, as well as other materials that will be used near the work.

Chemical Storage

The separation of chemicals (solids or liquids) during storage is necessary to reduce the possibility of unwanted chemical reactions caused by incidental mixing. Explosives should be stored separately outdoors. Use either distance or barriers (trays) to isolate chemicals into the following groups:

- Flammable Liquids - store in approved flammable storage lockers.
- Acids - treat as flammable liquids
- Bases - do not store bases with acids or any other material
- Other liquids - ensure other liquids are not incompatible with any other chemical in the same storage location.
- Restraints and Containment - Lips, strips, or bars are to be installed across the width of storage shelves to restrain the chemicals in case of earthquake or unexpected shock.
- Chemicals shall not be stored in the same refrigerator used for food storage. Refrigerators used for storing chemicals must be appropriately identified by a label on the door.

Container Labels

It is extremely important that all containers of chemicals are properly labeled. This includes every type of container from a 5000 gallon storage tank to a spray bottle of degreaser. The following requirements apply:

- All containers shall have the appropriate label, tag or marking prominently displayed that indicates the identity, safety, and health hazards. The name and address of the manufacturer or importer must also be provided.
- Portable containers which contain a small amount of chemical need not be labeled if they are used immediately that shift, but must be under the strict control of the employee using the product.
- All warning labels, tags, and markings must be maintained in a legible condition and not be defaced or removed. Facility weekly supervisor inspections shall check for compliance of this rule.

- Incoming chemicals are to be checked for proper labeling. The symbol below is an example of labeling used to rate the hazard of products in storage tanks. It is a National Fire Protection Association (NFPA) standard. Each square contains a number based upon the accompanying table.

7.2 - Rating Summary

Chemical (Blue)

4 - **Danger -** May be fatal on short exposure. Specialized protective equipment required
3 - **Warning -** Corrosive or toxic. Avoid skin contact or inhalation
2 - **Warning -** May be harmful if inhaled or absorbed
1 - **Caution -** May be irritating
0 - No unusual hazard

Flammability (Red)

4 - **Danger** Flammable gas or extremely flammable liquid
3 - **Warning** Flammable liquid flash point below 100° F
2 - **Caution** Combustible liquid flash point of 100° to 200° F
1 - Combustible if heated
0 - Not combustible

Reactivity (Yellow)

4 - **Danger** Explosive material at room temperature
3 - **Danger** May be explosive if shocked, heated under confinement or mixed with water
2 - **Warning** Unstable or may react violently if mixed with water
1 - **Caution** May react if heated or mixed with water but not violently
0 - **Stable** Not reactive when mixed with water

Special Notice Key (White)

W - Water Reactive
Oxy - Oxidizing Agent

Section 8 - Emergencies and Spills

Each operation and job-site shall establish emergency response and evacuation plans per company Emergency Preparedness Program. The required emergency response and evacuation plans shall include the following elements:

8.1 - Environmental Response Plan

Each location shall have an Environmental Response Plan that includes the following:

- Instructions on how to report an environmental spill.
- Location and phone number of the local company approved spill response contractor.
- In case of an emergency, implement the proper Emergency Action Plan:
    - Evacuate people from the area.
    - Isolate the area.
- If the material is flammable, turn off ignition and heat sources.
- Only personnel specifically trained in emergency response are permitted to participate in chemical emergency procedures beyond those required to evacuate the area.
- Call for Emergency Response Team assistance if required.

8.2 - Emergency Evacuation Plan (Fires and Other Emergencies)

Each location where personnel occupy a building shall have a Building Emergency Evacuation Plan that indicates the following:

- Instructions on how to report a fire or other emergency.
- A floor plan indicting each room, the available exits, fire extinguisher locations, fire alarms, evacuation route(s).
- A designated assembly point.
- Main electrical disconnects, main gas supply and water shut off valves, and hazardous material storage locations (for solvents, paints, fuels, pesticides - indicate quantities).

Each location where personnel are assigned to a client's facility shall have a Job Site Evacuation Plan that includes the following:

- Instructions on how to report a fire or other emergency.
- The alarm signal(s) and the all clear signal for the facility and the immediate work area.
- A site plan that indicates a primary and a secondary evacuation route, an assembly point, the location of fire alarms, fire extinguishers, and safety showers.
- Communication network to keep employees and supervising business unit appraised of job site status.
- Spills - Chemical spill or release reporting criteria varies by agency and type of spill.

Section 9 - Housekeeping

Housekeeping is a fundamental part of all safety programs but caution must be exercised not to create additional or more serious hazards by improperly handling, storing, and disposing of chemicals in the interest of housekeeping. The following housekeeping rules shall apply with regard to hazardous chemicals:

Maintain the smallest possible inventory of chemicals to meet immediate needs.
Periodically review stock of chemicals on hand.
Ensure that storage areas, or equipment containing large quantities of chemicals, are secure from incidental spills.
Rinse emptied bottles that contain acids or inflammable solvents before disposal.
Recycle unused laboratory chemicals wherever possible.
DO NOT Place hazardous chemicals in salvage or garbage receptacles.
DO NOT Pour chemicals onto the ground.
DO NOT Dispose of chemicals through the storm drain system.
DO NOT Dispose of highly toxic, malodorous chemicals down sinks or sewer drains.

Section 10 - Hazard Communication Program and Procedure

10.1 - Hazard Communication Plan

This written Hazard Communication Plan (HAZCOM) has been developed based on the OSHA Hazard Communication Standard and consists of the following elements:

Written Hazard Communication Program
Identification of Hazardous Materials
Product Warning Labels
Material Safety Data Sheets (MSDS)
Effective Employee Training

Multiple Jobsites

Each jobsite shall have a copy of the Hazard Communication Program, a list of all hazardous chemicals in company possession and a MSDS for each of those chemicals. In the event that crews are working in various locations, a primary location shall be designated for the location of the hazardous chemical information. In the event multiple jobsites are too remote to designate a primary location and still have timely and effective access to the information, a copy shall be carried with the crew. The onsite supervisor is responsible for notifying the client and other contractors of the particular hazardous chemicals used in our company's scope of work and obtaining the information from the client and other contractors regarding the hazardous chemicals that may be encountered in the work area.

Non-Routine Tasks are defined as working on, near, or with unlabeled piping, unlabeled containers of an unknown substance, confined space entry where a hazardous substance may be present and a one-time task using a hazardous substance differently than intended (example: using a solvent to remove stains from tile floors).

Steps for Non-Routine Tasks

Step 1: Hazard Determination
Step 2: Determine Precautions
Step 3: Specific Training and Documentation
Step 4: Perform Task

All non-routine tasks shall be evaluated by the Project Supervisor before the task commences, to determine all hazards present. Once the hazard determination is made, the Project Supervisor shall determine the necessary precautions needed to either remove the hazard, change to a non-hazard, or protect from the hazard (use of personal protective equipment) to safeguard the Employees present. In addition, the Project Supervisor shall provide specific safety training for Employees present or affected.

Subcontractors

All subcontractors working under our companies control are required to follow the requirements of this program. We shall provide subcontractors information concerning:

Location of MSDS
Precautions to be taken to protect subcontractor employees
Potential exposure to hazardous substances
Chemicals used in or stored in areas where they will be working
Location and availability of Material Safety Data Sheets
Recommended Personal Protective Equipment
Labeling system for chemicals

Multiple Employer Worksites

As industrial contractor company employees will often be assigned to jobsites where employees from multiple companies are working together or in close proximity. Many of these jobsites may have hazardous materials present, either being used by other employers, stored or transported through the area. In these facilities, jobsites or work areas where this company is a subcontractor or does not have total control of the procedures being used, company supervision shall identify and communicate to all employees in his or her area of control the following:

Methods of supplying or locations of MSDS provided by the primary employer or organization in control of the facility or worksite.
Methods the primary employer or organization in control of the facility or worksite will use to inform other employers and their employees of any precautionary measures required to protect employees during normal operations and emergencies.
Methods of notification, labeling, or warnings used by the primary employer or organization in control of the facility or worksite to inform other employers and their employees of material hazards in the work area.

Non-English Speaking Employees

Where non-English speaking employees are exposed to material hazards, a method, or methods shall be employed to communicate hazardous material information to these employees in their own language.

10.2 - Identification of Hazardous Materials

Some chemicals are explosive, corrosive, flammable, or toxic. Other chemicals are relatively safe to use and store but may become dangerous when they interact with other substances. To avoid injury and property damage, persons who handle chemicals in any area must understand the hazardous properties of the chemicals. Before using a specific chemical, safe handling methods and health hazards must always be reviewed. Supervisors are responsible for ensuring that the equipment needed to work safely with chemicals is accessible and maintained for all employees on all shifts.

10.3 - Product Warning Labels

In addition to the National Fire Protection Association (NFPA) standard illustrated in section 8.4 above, there are numerous other types of labeling schemes in use. Most combine symbols with text to communicate the hazards involved. Some even identify specific PPE requirements, body organs at risk if exposed, and emergency procedures.

10.4 - Chemical Information List and Material Safety Data Sheets

Chemical information List (CIL) is the list of all hazardous substances in a specific location. Every substance on the CIL shall have a Material Safety Data Sheet (MSDS) on file at the jobsite or local project/business unit office. Each supervisor is required to maintain a list such as this and forward copies of the added product MSDS to the Safety Manager for addition to the master Chemical Information List.

Chemical Information List by Product Name (*partial example*)

PRODUCT NAME	COMMON NAME	MANUFACTURER	MSDS CODE
2-26 Aerosol	2-26	CRC Industries	# 36001
40-600 Moisture Displacer	Moisture Displacer	Ideal Industries Lab	# 36660
40-620 HD Electric Motor Cleaner	Motor Cleaner	Ideal Industries Lab	# 36544
40-625 Red Insulating Varnish,	Varnish Ideal	Industries Lab	# 43145
40-630 Zinc Cold Galvanize	Cold Galv	Ideal Industries Lab	# 42282
40-680 All Purpose Cutting Oil	Cutting Oil	Ideal Industries Lab	# 38207
40-685 Penetrating Oil	Penetrating Oil	Ideal Industries Lab	# 26438
40-690 Gray Electric Equipment Paint	Gray Paint	Ideal Industries Lab	# 47720
40-695 Hand Cleaner	Hand Cleaner	Ideal Industries Lab	# 47237
40-700 Hornet/ Wasp Spray	Wasp Spray	Ideal Industries Lab	# 43821
40-705 Switch and Contact Cleaner	Contact Cleaner	Ideal Industries Lab	# 32850
40-705 Switch and Contact Cleaner With Lubricant	Contact Cleaner	Ideal Industries Lab	# 46498
40-720 Fluorescent Orange Marking Paint	Orange Paint	Ideal Industries Lab	# 45790
40-725 Cable Cleaner	Cable Cleaner	Ideal Industries Lab	# 36363

Material Safety Data Sheet (MSDS) Information

Each job-site shall have a copy of the Material Safety Data Sheet (MSDS) for each hazardous chemical present. A Material Safety Data Sheet, often referred to by its acronym MSDS, is a detailed informational document prepared by the manufacturer or importer of a hazardous chemical which describes the physical and chemical properties of the product. Information included in a Material Safety Data Sheet aids in the selection of safe products, helps employers and employees understand the potential health and physical hazards of a chemical and describes how to respond effectively to exposure situations. The employee responsible for the purchase of all hazardous chemicals is also responsible for obtaining the MSDS for those chemicals from the supplier and forwarding a copy to the Safety Manager. The Safety Manager shall add the chemical to the hazardous chemical list and forward copies to the onsite supervisors to update the worksite MSDS binder. The format of a Material Safety Data Sheet may vary but there is specific information that must be included in each sheet. It is useful to review this information to increase your ability to use a Material Safety Data Sheet. All Material Safety Data Sheets should include the following information:

Section 1: Chemical Product and Company Information - provides the chemical name on the label to the MSDS. Also listed is the name, address and the phone number of the company, manufacturer, or distributor who provides the chemical.

Section 2: Composition and Ingredients - identifies all hazardous ingredients, OSHA permissible exposure limits (PEL) and ACGIH (American Conference of Governmental Industrial Hygienists) Threshold Limit Values (TLV).

Section 3: Hazard Identification - information about the health effects of exposure. Description of the material appearance, potential symptoms and health effects, routes of entry and target organs.

Section 4: First Aid - Provides first aid procedures for each route of entry.

Section 5: Fire-Fighting - information on the explosive and fire properties, extinguishing agents and items and general fire-fighting information.

Section 6: Accidental Release - information on material spill response, containment and required spill response PPE.

Section 7: Handling and Storage - information about chemical storage and handling and measures to prevent over-exposure.

Section 8: Exposure Controls and Personal Protection - engineering controls and personal protective equipment to reduce chemical exposure.

Section 9: Physical and Chemical Properties - this section tells about the physical and chemical properties of the chemical. Characteristics include appearance, odor, physical state, pH, vapor pressure, vapor density, boiling point, freezing point, melting point, solubility in water and specific gravity or density.

Section 10: Stability and Reactivity - all potentially hazardous chemical reactions are identified in this section, including information on chemical stability, conditions to avoid, incompatibility, hazardous decomposition and hazardous polymerization.

Section 11: Toxicological Information - provides information such as acute data, carcinogen potential, reproductive effects, target organ effects, and other physiological aspects.

Section 12: Ecological Information - information concerning the environmental impact if a chemical is released into the environment.

Section 13: Disposal Considerations - information concerning proper chemical disposal, recycling and reclamation.

Section 14: Transport Information - shipping information includes the hazardous materials description, hazard class and the identification number (UN or NA numbers).

Section 15: Regulatory Information - provides information about applicable federal regulations. Examples include OSHA, TSCA (Toxic Substance Control Act), CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act), SARA Title III (Superfund Amendments and Reauthorization Act).

Section 16: Additional Information - provides other information about the chemical such as hazard ratings, preparation, and revisions of the MSDS, and label information. Manufacturers may withhold certain information as proprietary (such as hazardous ingredients) on a Material Safety Data Sheet if the information is considered a trade secret.

10.5 - Effective Training

All affected employees shall receive Hazard Communication and Chemical Safety Program training. In addition, employees shall receive training and information regarding hazardous chemicals and safety precautions specific to their assigned work sites.

Training Content

All new and affected employees shall receive safety orientation training covering the elements of the HAZCOM and Chemical Safety Program. This training shall consist of the following:

- Requirements of OSHA's standard 29 CFR 1910.1200.
- Detailed review of the Hazard Communication and Chemical Safety Program
- Location and availability of the written Hazard Communication Program
- Location and availability of the List of Chemicals used in the workplace
- Methods and observation used to detect the presence or release of a hazardous chemical in the workplace.
- The specific physical and health hazard of all chemicals in the workplace
- Specific control measures for protection from physical or health hazards
- Explanation of the chemical labeling system
- Location and use of MSDS
- Locations and operations in their work area where hazardous chemicals are present

Job Specific Training

Employees shall receive on the job training from their supervisor. This training shall cover the proper use, inspection, and storage of necessary personal protective equipment and chemical safety training for the specific chemicals they will be using or will be working around.

Personnel Training

All company personnel shall be trained in Hazard Communication and Chemical Safety Awareness.

Training Frequency

Hazard Communication and Chemical Safety Program training and re-training shall be provided as follows:

- **Initially** - on hire or upon assignment to tasks or locations where hazardous chemicals are used, stored or may present in some manner. Hazard Communication and Chemical Safety Awareness training shall be included in the Short Service Employee Program and shall be covered in first 180 days of service or prior to new employees assignment to locations where hazardous chemicals are used.
- **Annually** - prior to anniversary of pervious training. Hazard Communication and Chemical Safety Awareness training shall also be refreshed annually as part of the Toolbox Safety Meeting Program
- **Upon changes** - in the Hazard Communication and Chemical Safety Program.
- **Introduction of new hazards** - Whenever a new chemical, physical, or health hazard is introduced to the work site that has not been effectively covered by previous training.
- **Immediate On-the-Spot Training** - This training shall be conducted by supervisors for any employee that requests additional information or exhibits a lack of understanding of the safety requirements.

Section 11 - Reporting and Recordkeeping

Training - All training shall be recorded.

Reports

- All exposure incidents shall be reported.
  - Incident/Accident Report
  - All exposure events resulting in injury, illness or loss of consciousness of an employee shall be recorded as Incidents on an Incident/Accident Report.
- Spills
  - Spills or releases that meet the following criteria shall be recorded as Incidents on an Incident/Accident Report
  - Oil based fluids spilled on land or water in excess of five (5) gallons
  - Chemical based fluids or products spilled on land or water in excess of (5) gallons or five (50) pounds whichever is less.
- Near Miss Reports
  - Failures in containment, control methods, or isolation, not resulting in employee injury, illness, or exposure, shall be recorded as near miss events on a Near Miss Report.

Record Control and Retention

Records associated with this program shall be handled in the following manner:

Custodian - Manager of HS&E shall be the custodian of the Master Chemical Information List (CIL) required by OSHA's 29 CFR 1910.1200.

Incident/Accident records - shall be handled per the Incident Reporting and Record Keeping Program.

Availability - A copy of this plan shall be made available, upon request, to all by the employee, and the required OSHA officials.

END

Attachment 4.B - Drill/Direct Push Type Rig Inspection Checklist

SITE/PROJECT NAME: _____
RIG INSPECTOR (NAME/CO.): _____
RIG INFORMATION:

Rig Type: Rotary/Auger Drilling Rig ☐ Direct Push Type (DPT) ☐
Owner: _____
Yr/Make: _____
Model: _____
VIN #: _____
Mileage: _____
Drill Hrs: _____

Inspector to initial columns below as appropriate

CATEGORY	INSPECTION ITEMS	PASS	FAIL	N/A	ACTION NEEDED
Emergency Switches	Kill switches are located and accessible to workers on both sides of the rotating stem. **NOTE:** Location and number of switches depend on the rig manufacturer, please refer to owner's manual (DPT typically has one switch on control panel).				
	Kill switches installed by the manufacturer are verified to be in operable condition and all workers are familiar with the location and operation of these switches. **NEVER BYPASS, DISABLE, OR REMOVE KILL DEVICES.**				
Protective Guards	Drive shafts, belts, chain drives, and universal joints are guarded to prevent accidental insertion of hands, fingers, or tools.				
Cables	Cables on drill rig are free of kinks, frayed wires, birdcages, flat spots, grease, and worn or missing sections.				
	Cables are terminated at the working end with a proper eye splice; either swaged, coupled, or using cable clamps.				
	Cable clamps are installed with the saddle on the live or load side. Clamps are not alternated and are of the correct size and number for the cable size.				
	Wire ropes are not allowed to bend around sharp edges without cushion material.				
Pulleys	Pulleys are not to be bent, cracked, or broken.				
	Pulleys operate smoothly and freely, without resistance.				
Cable Winches	Motor is mounted in correct location and tightly secured to drill rig.				
	Winch is capable of being placed in the free spool (unwind smoothly) and locked position correctly, demonstrating that the cable is suitable for lifting during drilling operations.				
Safety Latches	Hooks installed on hoist cables are the safety type with a functional latch to prevent accidental separation.				
	Safety latches are functional and completely span the entire throat of the hook and have positive action to close the throat except when manually displaced for connecting or disconnecting a load.				
Flights/Augers	Flights/Augers should not be bent, cracked, or broken. **NOTE:** Flights/Augers failing inspection must be removed from jobsite.				
	Flights should be blunt to prevent the risks of cuts.				
	Auger keys should not be bent, have any cracks/fractures, be excessively worn, or otherwise damaged.				
	Auger bolt holes and threads should not be damaged.				

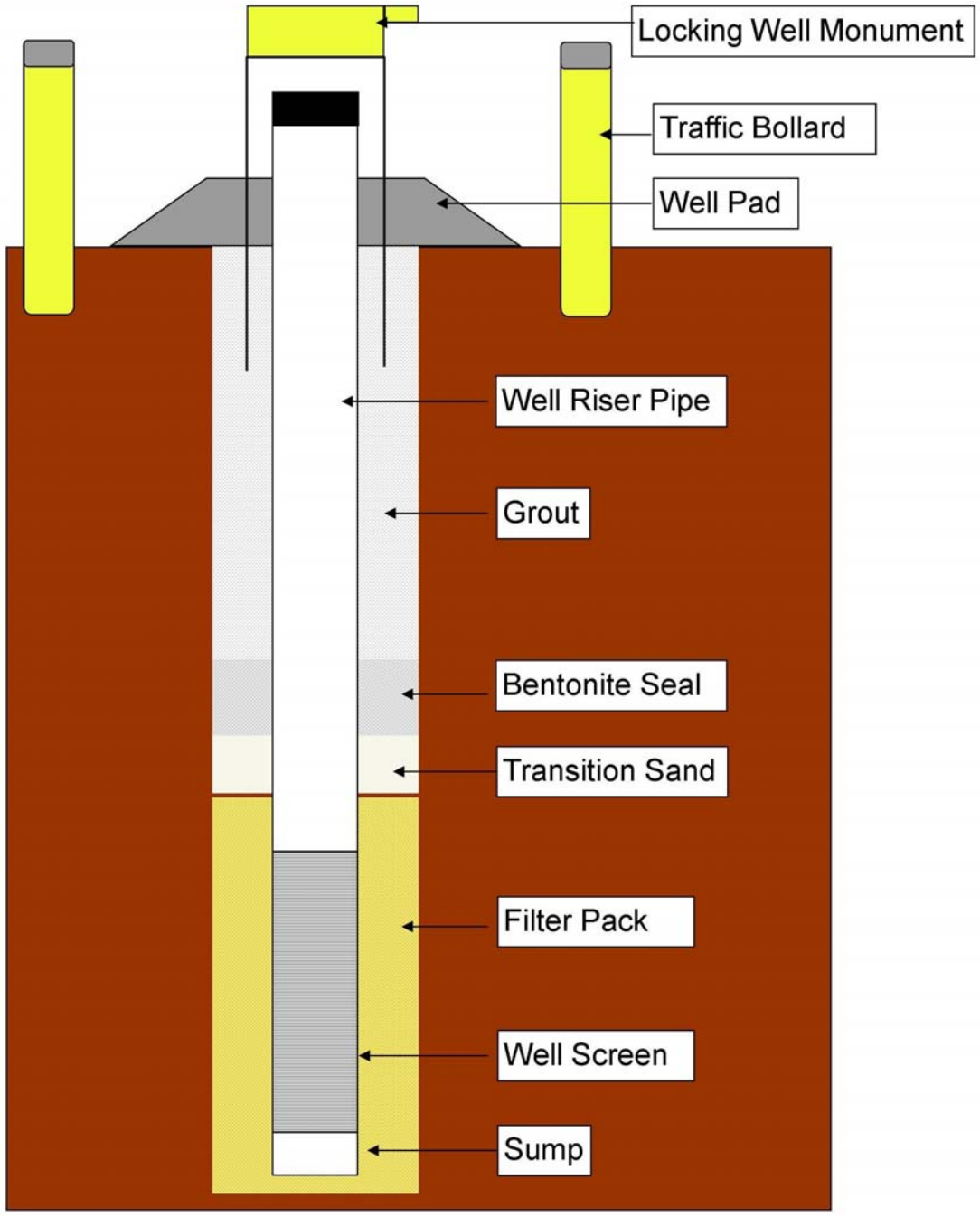
CATEGORY	INSPECTION ITEMS	PASS	FAIL	N/A	ACTION NEEDED
Flights/Augers (cont.)	Inspect flights/augers for metal burrs. **NOTE:** Burrs must be filed to flat surface.				
	Avoid stacking augers; all should lay flat on ground.				
	Avoid manually lifting/moving augers. Should be lifted/moved with cable lines, or, at a minimum, by two persons.				
Drill String	Drill string should not be bent or have any cracks/fractures.				
	Drill string connecting pins should not be bent, have any cracks/fractures, or be excessively worn.				
Mast	Mast is free of bends, cracks, or broken sections.				
	All mounting hardware (pins, bolts, etc.) should be in place.				
	No moving of drill rig while mast is in vertical position.				
	Maintenance/repairs to be performed on mast only in horizontal position.				
Hammering Device	Hammer free of cracks, fatigue, or other signs of excessive wear.				
	Hammer connections are secure.				
Leveling Devices	Outriggers move in/out and up/down smoothly and freely while using controls on drill rig, with no hydraulic leaks.				
	Outriggers are extended prior to and whenever the mast is raised off its cradle. Outriggers must maintain pressure to continuously support and stabilize the drill rig (even while unattended).				
	Outriggers are properly supported on the ground surface to prevent settling into the soil (use of outrigger support pads).				
Controls	Controls are intact, properly labeled, have freedom of movement, and have no loose wiring or connections.				
	Controls are not blocked or locked into an operating position.				
	Installed lights, signals, gauges, and alarms operate properly.				
Lifting Devices	Slings, chokers, and lifting devices are inspected before using and are in proper working order. **NOTE:** Damaged units are to be labeled and removed from jobsite.				
	Shackles/Clevises are in proper working order with pins/ screws in place that is to be used while lifting.				
	Cables and lifting devices are not operated erratically or with a jerking action to overcome resistance.				
Hydraulic System	Hydraulic lines are secure, in good condition with no signs of excessive wear, and not leaking. **NOTE:** Check while pressurized.				
	Hydraulic lines are not in a bent or pinched position causing additional fluid restrictions/pressures.				
	Hydraulic oil reservoir has appropriate amount of oil and not leaking.				
	Documentation available to confirm that pressure relief valve was checked during shop maintenance activity and noted on maintenance log.				
Pump Lines (water, grout, etc.)	Suction/Discharge hoses, pipes, valves, and fittings are secured and not leaking.				
	High pressure hoses have a safety chain, cable, or strap at each end to prevent whipping in the event of a failure.				
Fire Prevention	A fire extinguisher of appropriate size is located on drill rig and readily available/accessible for drilling crew (recommended 20 lb.).				
	Documentation available to confirm that the drilling crew has received training on proper use of fire extinguishers.				
Ladders	Drill rig has a permanently attached or proper portable ladder to be used for access to drilling platform.				
Tracks	Tracks on rig are not excessively worn and free of any debris or foreign material.				

CATEGORY	INSPECTION ITEMS	PASS	FAIL	N/A	ACTION NEEDED
General	Drill rig meets regulations for transport on state/federal highways (inspection sticker, license plate, etc.).				
	Documentation available to verify that rig was inspected prior to arriving at ExxonMobil job sites.				
	Does the rig size meet job requirements?				
	Maintenance log available for previous 3 months to confirm proper maintenance/inspection.				
Exhaust	Exhaust system should be free from defect and routes engine exhaust away from drill rig workers.				
Fuels	Fuel stored in an approved and properly labeled container.				
	Fuel transfer lines free from signs of excessive wear and not leaking.				
	Refueling and transferring of fuel is performed in an approved area with sufficient containment to prevent spillage.				
Exclusion/ Work Zones	The exclusion/work zone is centered over the borehole and the radius equal to or greater than the height of the mast (measured from ground level).				
	The exclusion/work zone should be clear of tripping hazards.				
Overhead Obstructions	Except where electrical distribution and transmission lines have been de-energized and visibly grounded, drill rigs will be operated proximate to under, by, or near power lines in accordance with the following: * 50 KV or less - minimum clearance of 10 feet * 50 KV or greater - add 0.4 inches for every KV over 50 KV * If voltage is unknown, maintain at least 20 feet of clearance.				
	While the rig is in transit, clearance from energized power lines will be maintained as follows: * Less than 50 KV - 4 feet * 50 thru 365 KV - 10 feet * 366 thru 720 KV - 16 feet				
Rig Repairs	Repairs, when possible, are conducted offsite to reduce the risk of any onsite incidents.				
Specialized PPE	When working at elevated heights, workers are to wear a fall restraining device attached in a manner to restrict fall to less than six feet.				
	When working in wet/slippery conditions, all workers have a lug-type sole or similar slip resistant sole, on their safety footwear to prevent slipping.				

RECOMMENDED SPARE PARTS OR ITEMS TO BE SENT WITH DRILL CREW

DRILL RIG	DPT RIG
Emergency Switch	Emergency Switch
Drive Coupling	Drive Caps
Shear pins/keys (for drive coupling)	Cutter Head
Pump Packing	Pull Cap
Pump Hoses	Liner Cutter
Auger Bolts	Rod to Cap Pins
Rod to cap pins	Liner Holder (used while cutting)
Cutter Head	Spill Kit (5 gal. Bucket with oil dry and absorbent pads)
Safety Latches, Hooks, Clamps	
Split Spoon Cutter Head	
Spill Kit (5 gal. bucket with oil dry and absorbent pads)	

Attachment 5.A - Simplified Well Construction Diagram



Attachment 5.B - Typical Job Safety Analysis for Equipment Loading and Unloading

Job Being Analyzed:	**LOADING AND UNLOADING BACKHOE/FORKLIFT**	Date Started:	

Instructions: load and unload in dry even area. Watch for lift sliding on ramps, to close to the side, lift in right gear		
FLAT AND LEVEL WORK		
STEPS	**HAZARDS**	**PREVENTION**
1. Check area for hazards	Uneven ground, wet obstruction	Park on dry flat area with nothing in the way
2. Try to have a spotter	Vision not being able to see where you are	Spotter - to check closeness to sides and ramp
3. Verify truck is in gear with brake on and wheels chalked	Truck and trailer could move when loading or unloading	Leave in gear, brake on and wheels chalked
4. Check hitch	Hitch coming loose when loading	Check hitch, verify it is locked with pin and safety chain is attached
5. Loading	Weather can make lift slide on ramps and trailer	Load in dry, level area - use 4-wheel drive, low gear: watch and be aware
6. Ramps	Not even, pins loose: raise and lower properly	Check ramps before lowering and when raising lift properly
7. Tying down	Mast too high, not enough chains, in gear with brake on and wheels chalked	Check mast height: use 4 chains tying down, chalk wheels, check load after driving a few miles
8. Unloading - same steps in reverse, check lift, verify it is in good condition		
9. Check forklift	Brakes out of adjustment popping out of gearing, shutting off emergency brake	Check out before loading and driving off lift, oil levels
10.		
11.		

Comments:		
If off unloading with forks, fwd insure forks are high enough for fork clearance		
Complete forklift inspection		
Do not load/unload equipment with engine running		
OPERATOR SAFETY COMMITTEE:		
Operator 1:	**Operator 2:**	**Operator 3:**
Management 1:	Safety Director:	Guest: