Brine Well Cavity Field Investigation Program

Health and Safety Orientation

Scope of Orientation

- Background
- Lines of Communication
- Site Access
- Health and Safety Plans
- Personal Protective Equipment
- Hydrogen Sulfide Management
- First Aid

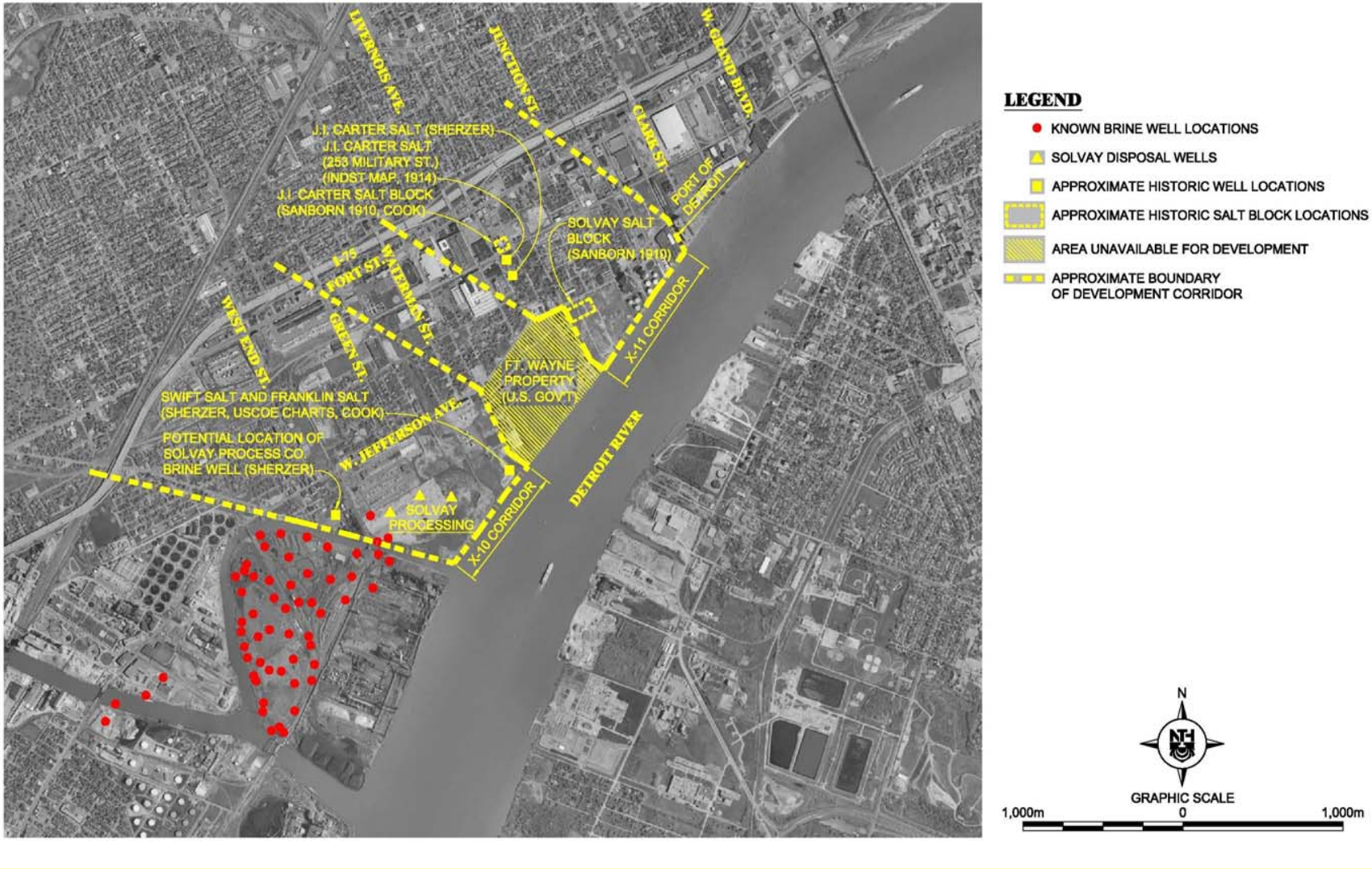
Scope of Orientation Continued

- Housekeeping
- Illumination
- Drilling Safety
- Fall Protection
- Flammable Hazards
- Hot Work Permits
- Confined Space Entry

Scope of Orientation Continued

- Excavations
- Lock Out / Tag Out
- Hazard Communication
- Environmental Requirements
- Weekly Safety Briefings
- Accident Reporting

Detroit River International Crossing
Solution Mining Research Summary



Single Well Injection Method

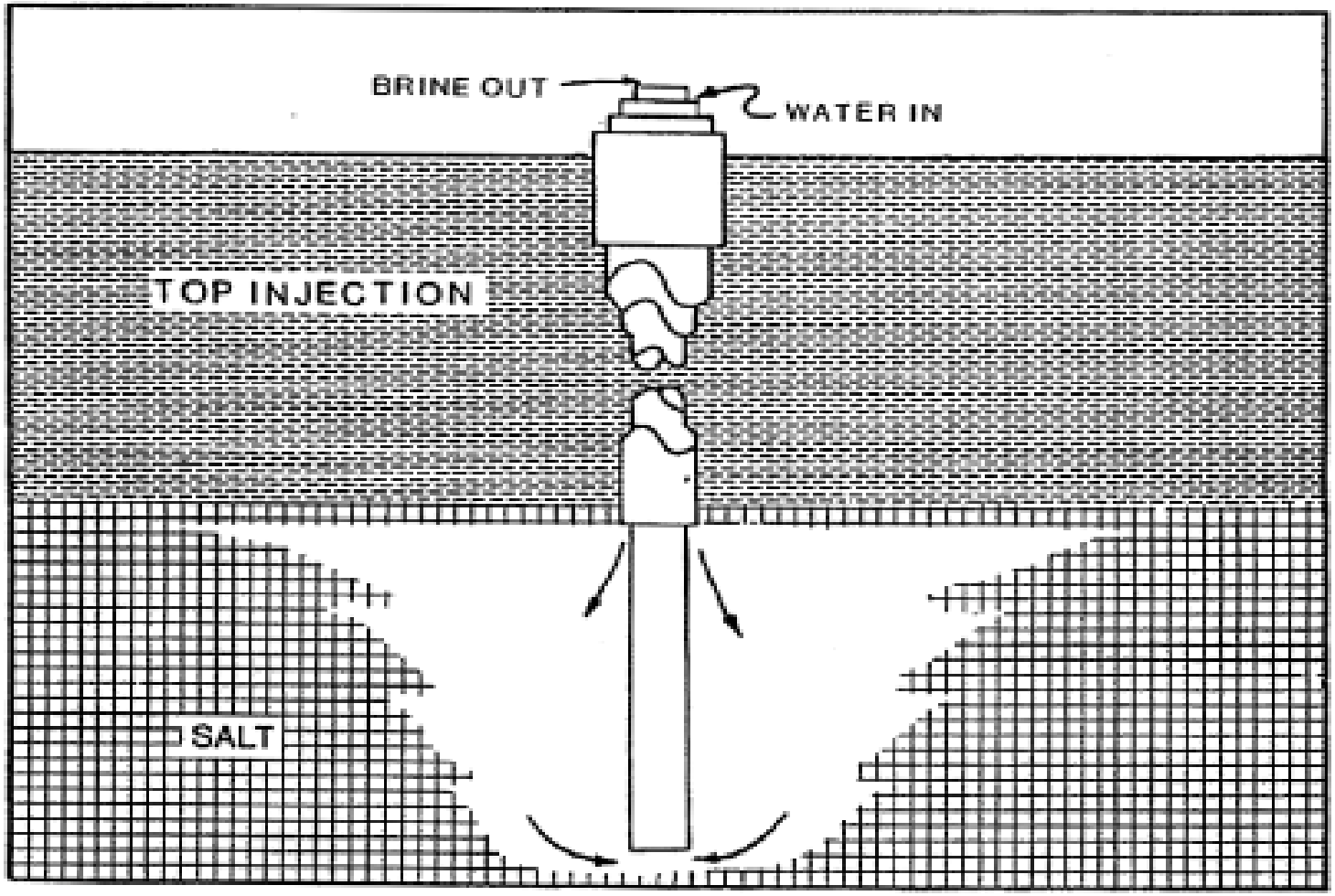


Figure A-1. Single well injection method of brine extraction and resulting "morning glory" cavity. (Russell, 1993)

Evaluation of Bedrock by Direct Investigation – Drilling Program

Drilling Program Objectives

•Define Specific Bedrock Lithology

•Identification of marker beds (subsidence potential)

•Solution voids / cavities / galleries

•Void propagation toward surface (rubble zones)

Crossing X-10 Corridor

Suspected
Producers

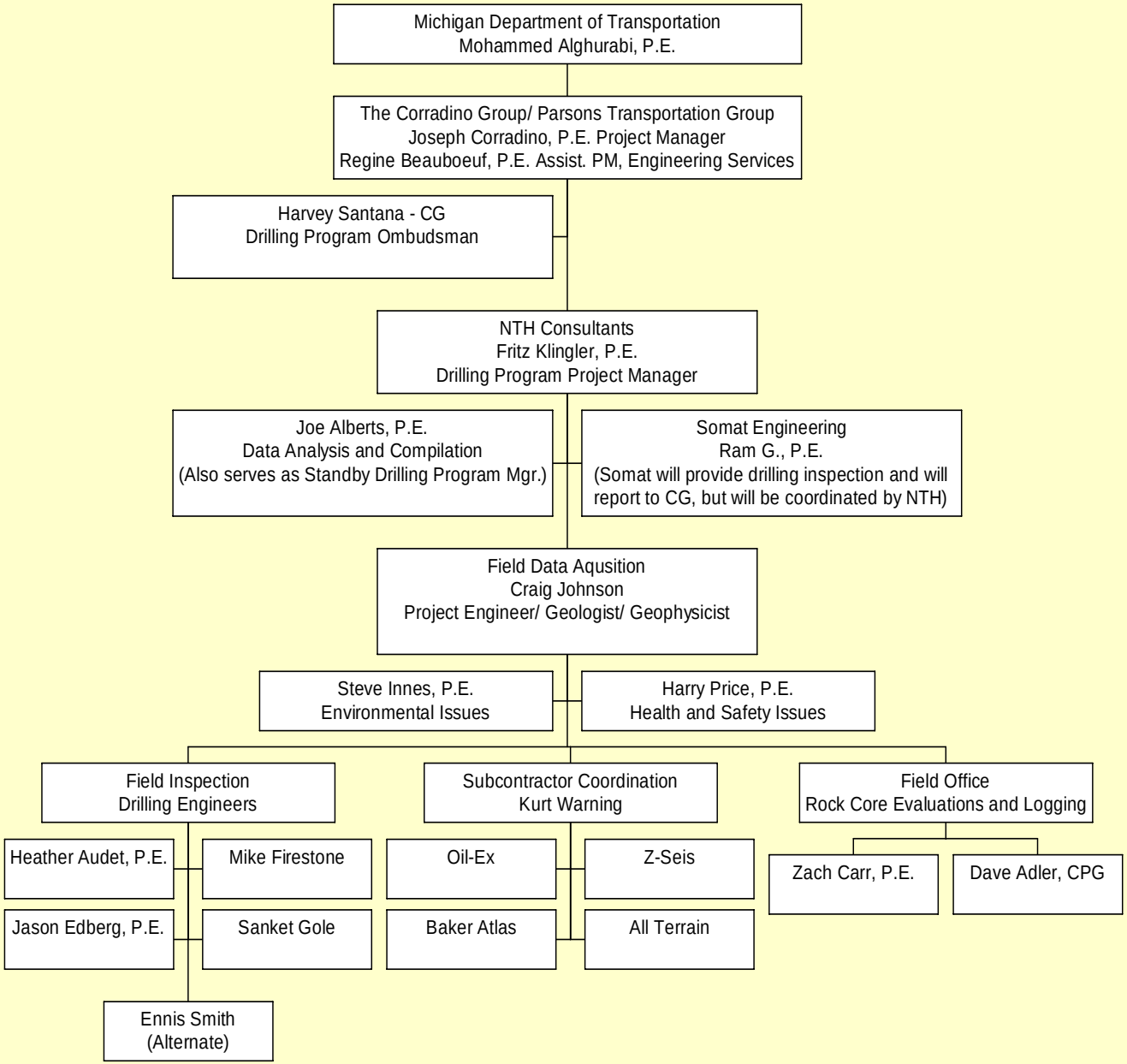
- Solvay Processing
- Franklin Salt (Swift)

Crossing X-11 Corridor

Suspected
Producers

- Solvay Processing
- J.I. Carter Salt Company

Detroit River International Crossing
Brine Well Cavity Field Investigation Program
Field Communications
Organization Chart



Site Access

- Work Areas defined by security fence (typically chain link)
- Security personnel will be provided as needed
- All visitors must sign in with NTH or SOMAT “Drilling Engineer in Charge”
- Everyone must complete Health and Safety Orientation, visitors and workers
- Workers must read and sign the NTH Health and Safety Plan or equivalent

Health and Safety Plans

- Individual Employers working on-site responsible for their own plans
- NTH is the MDEQ Permitee, individual plans must be compatible with NTH Plan
- Workers operating heavy equipment must be certified by their respective employers. Certificates must be provided
- Must contain required training items

Hospitals

Primary Hospital

Detroit Receiving Hospital

4201 St. Antoine Street

Detroit, MI 48226

(313) 745-3374 (ER)

Hospitals

Alternate Hospital

Henry Ford Medical Center

2799 W. Grand Blvd.

Detroit, MI 48202

(313) 916-2559

Call will be made by EMS Personnel as to actual hospital for emergency treatment

Personal Protective Equipment

- Must comply with 29 CFR 1910
- Work clothes must meet MIOSHA
- All personnel on-site shall wear 360^0 reflective vests or shirts

Physical Properties of Hydrogen Sulfide

- Hydrogen Sulfides Chemical Formula is H_2S
- H_2S is Extremely Toxic
- H_2S is a colorless, flammable gas with a strong odor of rotten eggs
- H_2S is heavier than air (specific gravity 1.192)

Physical Properties of Hydrogen Sulfide

- Odor threshold of H_2S is at a concentration 0.008 parts per million (ppm) and is easily noticed by most individuals at a concentration of 1.0 ppm.
- Olfactory fatigue quickly occurs a concentrations above 100 ppm
- H_2S is soluble in water (2.9 volume of gas per volume of water at 20^0 C)

Definitions

Threshold Limit Value, TLV, One of the following categories of chemical exposure:

Time Weighted Average,**TWA**, concentration for a nominal 8 hr. day, 40-hour week, to which nearly all workers may be repeatedly exposed without adverse effects

Short Term Exposure Limit, **STEL**, 15-minute TWA that should not be exceed

Ceiling, **C**, Concentration that should not be exceeded even instantaneously

Definitions

Time Weighted Average, TWA, is computed as follows:

$$TWA = \frac{\text{Sum of (concentrations x time)}}{\text{total time}}$$

In Example

$$= \frac{(0.34 \text{ hr x50 ppm})+(7.66 \text{ hrs x 19 ppm})}{\text{8-hours}}$$

TWA = 20.3 ppm for 8 hours >20 ppm

Definitions

Permissible exposure limit, **PEL**, Time-weighted average and ceiling concentrations similar to the threshold limit values published in 1968

- **Recommended exposure limit**, **REL**, Time-weighted averages and ceiling concentrations based on NIOSH evaluations
- **Immediately dangerous to life and health**, **IDLH**, The maximum level from which a worker could escape without escape impairing symptoms or any irreversible health effects

Physical Properties of Hydrogen Sulfide

- OSHA has set a Ceiling Limit of 20 ppm and a 10-minute maximum peak of 50 ppm (**PEL**)
- NIOSH recommends a Ceiling Limit of 10 ppm **(REL)**
- NIOSH recommends an IDLH concentration of 100 ppm (**REL**)
- Permit requirement is a time weighted average of 0.2 ppm over one hour at the limits of the site **(PEL)**

Definitions

- **LEL/ LFL** Lower Explosive or Lower Flammable Limit, Minimum concentration of a combustible gas in air below which propagation of flame will not occur in the presence of an ignition source that is flammable.
- **UEL/UFL** Upper Explosive or Upper Flammable limit, Maximum concentration of a combustible gas in air above which flame propagation will not occur in the presence of an ignition source that is flammable

Physical Properties of Hydrogen Sulfide

- Lower Flammable Limit for H_2S is 4% (40,000 ppm)
- Upper Flammable Limit for H_2S is 44% (440,000 ppm)
- Ignition temperature is 500^0 F
- Vapor Pressure is 17.6 atmospheres

Physiological Response

- H_2S is an extremely toxic and irritating gas
- Free H_2S in the blood reduces its oxygen-carrying capacity, thereby depressing the nervous system
- H_2S is oxidized rapidly to sulfates in the body

Physiological Response

- **10 ppm**; Beginning eye irritation
- **50 to 100 ppm**; Slight conjunctivitis and respiratory tract irritation after 60 minutes of exposure
- **100 ppm**; Coughing, eye irritation, loss of smell after 2 to 15 minutes. Altered respiration, pain in eyes and drowsiness after 30 minutes followed by throat irritation after1 hour. Death may occur in 8 to 18 hours

Physiological Response

- **200 – 300 ppm**; Marked conjunctivitis and respiratory tract irritation after 1 hour of exposure
- **500 – 700 ppm**; Loss of consciousness and probable death in 30 minutes to 1 hour
- **700 – 1000 ppm**; Rapid unconsciousness, cessation of respiration and death
- **1000-2000 ppm**; Unconsciousness at once, death in a few minutes

Short-term Exposures

- Exposure to high levels of H_2S can cause immediate death
- Low level exposure can cause eye pain, photo sensitivity, redness of eyes, blurred vision, irritation of respiratory tract and lungs, nausea, dizziness, and confusion

Long-term Exposure

- Exposure to H_2S is not known to cause cancer but testing has been limited
- Continuous exposure to H_2S can cause blurred vision, headaches, trouble sleeping, bronchitis, coughing spells, and shortness of breath
- H_2S has not been investigated for its effects on reproduction

Effects on Metals

H_2S Corrosion of Metals

- General corrosion – galvanic corrosion evidenced by tarnishing
- Pitting – galvanic corrosion at localized sites often from impurities in metals
- Stress corrosion cracking –Metal sulfide along grain boundaries exerts tensile stresses. Galvanic cell also develops between the metal and the metal sulfide
- Susceptibility to stress corrosion increases with high strength, less ductile materials

Effects on Metals

- Hydrogen embrittlement / Blisters –hydrogen absorbed into the matrix of the metal
- Crack initiation is a function of stress and hydrogen level
- Embrittlement and Sulfide cracking are a function of the acidity of the medium, the more basic the medium is the less the susceptibility
- Stress corrosion and embrittlement lead to brittle failures

Effects on Elastomers

H_2S Corrosion of Elastomers

- Viton, Neoprene, Nitrile deteriorate rapidly in high pressure H_2S environments at temperatures above 300^0 F
- Teflon will withstand the environment but is subject to creep
- National Association of Corrosion Engineers recommends fluorocarbon materials, Buna N, Nylon, Viton A

Emergency Escape Procedures

- On-site alert will be by blasts of an air horn, repeated in groups of 3 blasts by the Drilling Engineer in Charge
- Check air direction indicators, proceed to up wind briefing area
- Exit site through upwind gate
- Drilling Engineer in Charge will notify Health and Safety Officer or designated representative
- Health and safety officer or representative will provide notifications per communication plan

Location and Use of Safety Equipment

- Safety equipment will be located in the site safety trailer
- Individual employers are responsible for the training of their employees
- All personnel on site shall be familiar with the use of an emergency escape self contained breathing apparatus

Emergency Escape Self Contained Breathing Apparatus

If utilized:

- The apparatus consists of a 10-minute supply of compressed breathable air, a valve/pressure gauge and a hood
- If directed to use, remove hood and place over head. Use will require removal of hard hat and glasses or other protective eye ware
- Turn valve until air flow starts, do not open fully valve
- Exit the area as directed

Self Contained Breathing Apparatus

- A minimum of two 30-minute self contained breathing apparatus (SCBA) will be present on each drill site
- Employees who are designated to wear SCBA's must be under medical monitoring
- Employees who must use SCBA's must be trained and fit tested
- Employers must provide documentation of medical monitoring, training, and fit testing to NTH

Briefing Areas

- Briefing areas have been established for each drill location and are shown on the individual drill location site plans
- Monitor wind direction indicators at drill location
- Proceed to upwind briefing area at the drill location in the event of an emergency
- Drilling Engineer in Charge will point out gate and briefing area locations to visitors

Detection and Warning Equipment

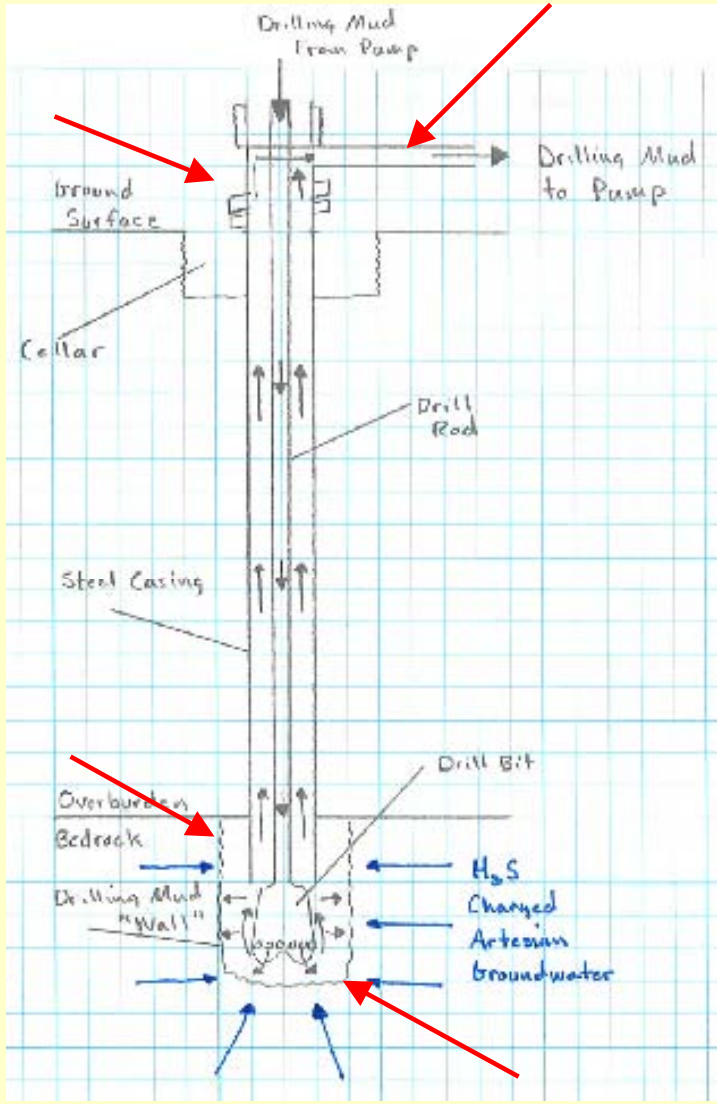
- The site is classified as a Class IV H_2S well
- Monitors will be on the drilling platform and with persons working around rig
- Hand held quad gas detectors will be used to monitor for the presence of H_2S
- H_2S sensor alarm will be set to the NIOSH ceiling limit for H_2S of 10 ppm

Detection and Warning Equipment

- Sensors will also monitor Oxygen, Flammable Gases, and Carbon Monoxide
- Oxygen Alarm levels will be set to a minimum of 19.5% and a maximum of 23.5%
- Carbon Monoxide Alarm level will be set at 35 ppm
- Flammable sensor alarm will be set at 10% of the Lower Flammable Limit for Methane

Corrective Actions

- Corrective action will be a function of concentration of H_2S and pressure, if any
- Corrective action could include closing the blow-out preventor, even with drill rods in the hole
- Increase density of drilling mud
- Increase the pH of drilling mud
- Add H_2S scavenging mud additives



Permittee's Contingency Plan

- Two copies of the plan will be on site with the Drilling Engineer in Charge
- Emergency contact numbers are included in the plan
- All communications with the community will be through the Corradino Group
- Warning signs will be provided in English and Spanish
- Plan will be activated if the H_2S reaches 10 ppm for 2 minutes at the drill head or 0.2 ppm for 1 hour (TWA) downwind at site perimeter

Permittee's Contingency Plan Continued

- If a concentration of 10 ppm or higher at the perimeter is encountered, operations shall be suspended temporarily until corrective measures are employed
- Neighborhood Notification, if required, will be through a telephone service and through the City of Detroit Police Department in conjunction with the Detroit Fire Department.

Evacuation

- Evacuation centers will be contracted for for the duration of the project, prior to the start of the work.
- Bus transportation will be provided by the Corradino Group. Locations will be announced by the Ombudsman.

First Aid

A minimum of 2 persons per shift must:

- Be trained in Red Cross or equivalent emergency first aid procedures
- Be trained in Red Cross or equivalent techniques for Cardiopulmonary resuscitation (CPR)

Illumination

- Each area must have adequate lighting for personnel to safely perform work activities and identify potential hazards
- While work activities are in progress, access ways and site work areas will be sufficiently lighted
- A minimum of illumination intensity of 10 foot-candles will be provided on a jobsite where work is being performed

Illumination Continued

- A minimum illumination intensity of 5 foot-candles shall be provided to areas where work is not being immediately performed but workers may pass through
- A minimum illumination intensity of 50 foot-candles shall be provided for first aid station
- Protect adjacent properties from light pollution

Drilling Safety

- Drilling operations must be aware of buried and overhead utilities
- Drilling operations must consider potential fire sources
- Uplift on rig may create unstable conditions
- Be aware of potential gas traps
- Slip, trip, and fall

Fall Protection

- Any work performed from a height of six feet or greater (excluding ladders and use of scaffolds) requires the use of fall protection
- Fall protection can consist of prevention measures **or** a full-body harness attached to an anchorage point capable of withstanding 5000 pounds of force.
- Employees required to use Fall Protection must be trained in its use

Flammable Hazards

Flammable hazards are from 3 general sources

- Hydrogen Sulfide
- Methane
- Flammable fuels and lubricants

Fire extinguishers must provided in vehicles, on drill rig and in safety trailer

Hot Work Permits

- Authorization of Hot Work must be obtained prior to any hot work commencing
- Hot work permits must be posted in areas of operation
- All criteria for the hot work will be noted on the permit and will be followed.
- Provide fire watch during the work and for 15 minutes after work is completed

Confined Space Entry

- Confined space entries if required will be performed under a confined space entry permit
- Personnel performing a confined space entry must provide evidence of confined space entry training

Excavations

- If required, will comply with MIOSHA requirements
- If present, will be protected as required by MIOSHA

Lock Out / Tag Out

- During the course of the project, employees may be exposed to hazardous energy sources
- Release of this stored energy could result in serious physical damage to employees
- Work involving hazardous energy sources (electrical, mechanical, hydraulic or pneumatic surges) shall be conducted under the NTH Lockout/Tagout Program or equivalent.

Hazard Communication

Under the OSHA Hazard Communication Standard, each employer has the responsibility to:

- Inform employees about hazardous chemicals in their work area upon initial assignment and whenever a new hazard is introduced
- Verify all containers are labeled as to their content and hazards and that labels are legible and not removed.

Hazard Communication Continued

- Inform workers of hazards when performing non-routine tasks
- Inform other employers of the hazardous chemicals their employees may be exposed to while working and any precautionary measures that must be taken to protect these employees during normal operation conditions or foreseeable emergencies

Environmental Requirements

- Borings 1 through 6, 10 and 12 are located in areas of known near surface contamination
- Borings 11, 14 and 16 are located in areas of potential near surface contamination
- All persons entering these drill sites will have to read the Environmental Health and Safety Plan and sign the signature page to satisfy MDEQ notification requirements

Weekly Safety Briefing

- Weekly tool box safety meetings will be held for each work shift. Times will be scheduled to minimize interruptions of drilling operations
- Topics will include Hydrogen Sulfide Safety, briefing areas, and any health or safety problems encountered in the preceding week
- All persons on-site at the time of the meeting are expected to attend and sign in

Accident Reporting

- Near miss and accident investigation reports are provided in the NTH Health and Safety Plan
- Forms must be completed for each accident or near miss
- As the permitee, NTH will be responsible for the necessary reporting and notifications

Summary – Site Visitors

- With the hard hat sticker you will be receiving, visitors may have a guided access to the individual sites (Exception: Emergency Services)
- You must sign in with the Drilling Engineer in Charge
- You must sign the Environmental Health and Safety Plan, if required

Summary – On-site Workers

- Must read and understand and sign the NTH Health and Safety Plan or equal
- Must read and understand the Communications Protocol
- Must read and understand the Hydrogen Sulfide Contingency Plan
- Must sign in daily with the Drilling Engineer in Charge

Questions??