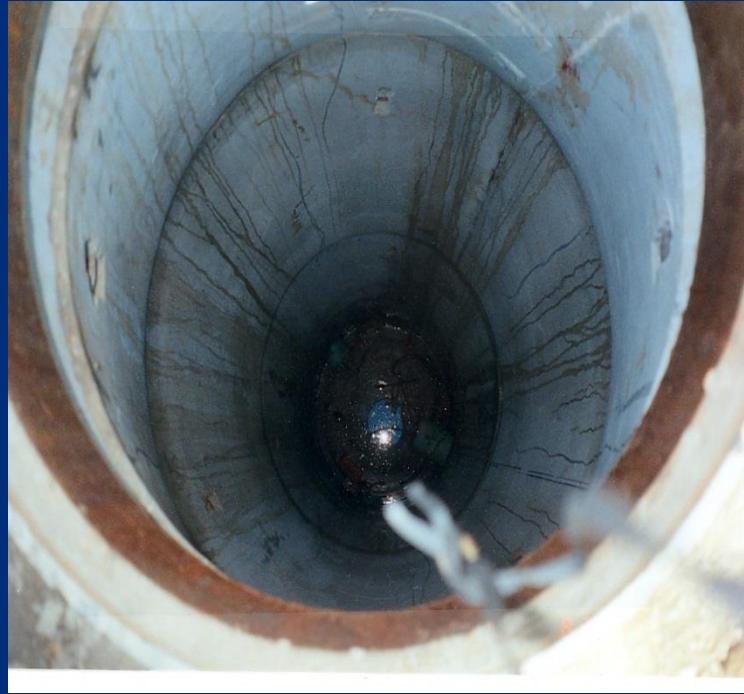


# Silent Killer in a Newly Constructed Manhole



Occupational  
Safety and Health  
Administration

# Reason For the Intervention

- OSHA received notification of a construction site fatality on August 5, 2004 – day following the incident
- Reported that the employee was found at the bottom of a manhole
- New sewer system under construction - SIC Code 1623



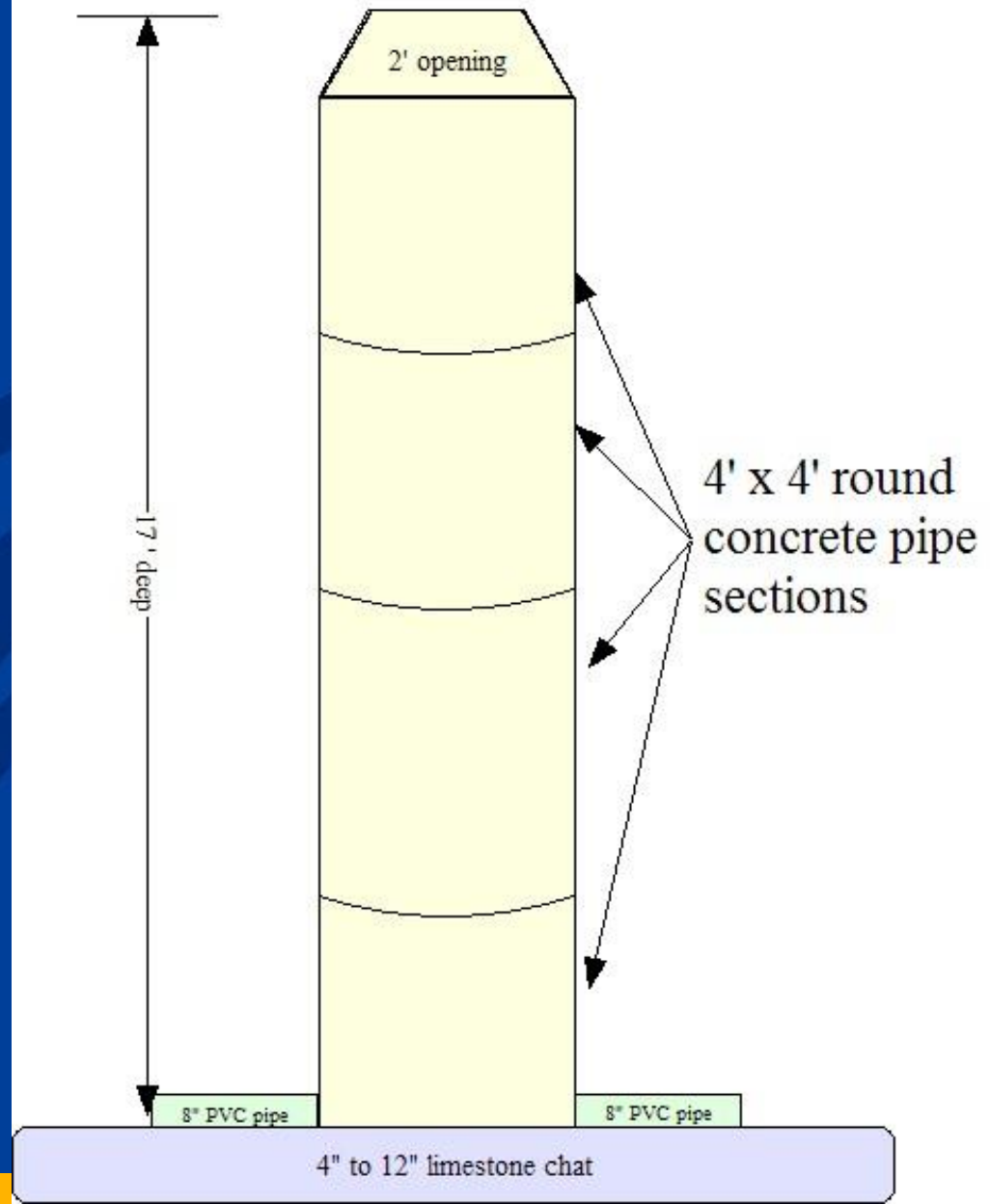
# The Site

- Company laying sewer pipe & manholes for a new housing development
- 6 employees onsite
- Farm land; slightly hilly; slope of ground ~ 1 to 4
- Manhole was adjacent to an entrance ramp to a highway



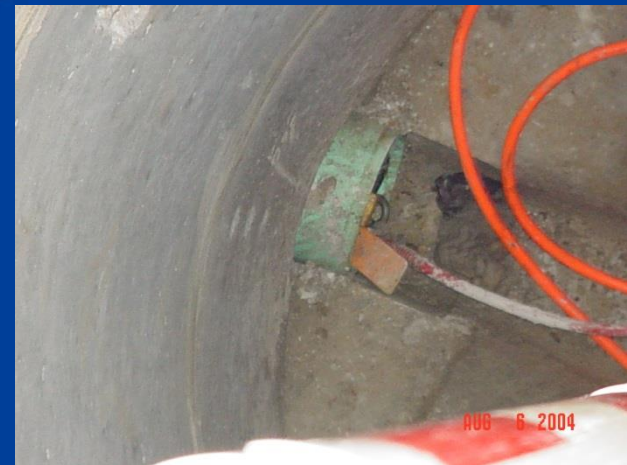
# The Confined Space

- 2 foot opening
- 4 foot wide internal diameter
- Riser was constructed of 4' X 4' concrete pipe sections
- 17 feet deep outside 16 1/2 feet inside
- Two 8" PVC Pipes in the bottom
- Built on a 4" to 12" bed of limestone chat



# Code Requirements

- City codes require a vacuum test – must maintain 10 inches of mercury for a specific time based on depth of manhole
- If vacuum test fails, then sections of the manhole must be grouted to get a better seal



# The Incident

- After vacuum test failure, employee reportedly was assigned the grouting task
- Grouting is done by hand and takes about 1 hour
- The employee was working alone
- The employee was found at the bottom of the manhole unconscious



# Manhole Conditions

- After recovery, the medical examiner requested sampling of manhole
- Fire Department – Haz Mat Division took some multi-gas readings about 3 hours after recovery
- Results were 16.3 to 17% for oxygen and 0.0 to 4.5 % LEL
- Zero readings for carbon monoxide and hydrogen sulfide
- No readings taken for carbon dioxide

# Inspection Activity

- The employer did not have a confined space entry program
- OSHA's Salt Lake City Technical Center Health Response Team assisted with site analysis
- Direct Reading Instruments results 9 days later revealed:
  - Oxygen – 16.0 to 18.2 %
  - CO<sub>2</sub> – 1.8 to 3.5 % or 18,000 to 35,000 PPM
  - LEL – 5 to 8 %





# Inspection Activities (cont.)

- Grab or bulk air samples taken with a medium flow pump at 3 L/Min.
- Collected in aluminum bags
- Lab results as follows:
  - Oxygen – 12.5 to 14.1 %
  - CO<sub>2</sub> – 16,845 to 23,968 PPM
  - Methane – 776 to 1372 PPM



# Carbon Dioxide

- Colorless odorless gas
  - Displaces oxygen leading to oxygen deficiency
- Special problem in Midwest area
  - Limestone Rock
    - Calcium Carbonate
  - Acidic topsoil
  - Acid leaches from soil, which then contacts the limestone producing Carbon Dioxide
- Numerous fatalities
  - Especially in new sewer/vault leak testing using a vacuum
  - Pulls carbon dioxide into the space
    - Oxygen measured at less than 3% on other similar fatalities
    - **5 similar cases known Nation-wide since 2000; 2 cases with 4 fatalities in the Kansas City area**

# Oxygen Deficient Atmospheres

19.5 %	Minimum acceptable oxygen level.
15 - 19%	Decreased ability to work strenuously. Impair coordination. Early symptoms.
12-14%	Respiration increases. Poor judgment.
10-12%	Respiration labored. Lips blue.
8-10%	Mental failure. Fainting, Nausea, Unconsciousness, Vomiting.
6-8%	4-5 minutes - possible recovery, 6 minutes - 50% fatal, & 8 minutes - fatal.
4-6%	Coma almost instantaneously. Death