

Appendix E Health and Safety Plan

For the

Removal Action High Street Outfall and 40th Avenue Storm Sewer System

Vasquez Boulevard/Interstate 70 Site, Operable Unit #2

Prepared for:

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June 19, 2015

HEALTH AND SAFETY PLAN

PROJECT NAME: Design Investigation and
Removal Action
High Street Outfall and 40th Avenue
Storm Sewer System

PROJECT SITE LOCATION: Vasquez Boulevard/Interstate 70 Site
Operable Unit 2
Western Portion of Denver Coliseum
Parking Lot and Globeville Landing
Park adjacent to the South Platte
River
Intersection of Arkins Ct and
McFarland Dr
Denver, CO 80216

PROJECT MANAGER: Timothy Shangraw

SITE SAFETY AND HEALTH OFFICER: Robert Jelinek

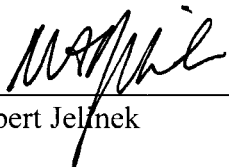
PREPARATION DATE: June 19, 2015

APPROVED BY: EMSI Project Manager



Timothy Shangraw 6/23/15
(Date)

APPROVED BY: EMSI On-Site Health and Safety Officer (HSO)



Robert Jelinek 6-23-15
(Date)

This document was prepared for the sole use of Engineering Management Support, Inc., the City and County of Denver, and the regulatory agencies involved with the project, the only intended beneficiary of our work. No other parties should rely on the information contained herein without the prior written consent of EMSI.

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1 PURPOSE AND INTRODUCTION

The purpose of this Health and Safety Plan (HASP), prepared by Engineering Management Support, Inc. (EMSI), is to provide background information, assign responsibilities, and establish personal protection standards and safety procedures for tasks associated with a design investigation and the “environmental components” of constructing a barrier system associated with the open channel stormwater drainage structure planned to pass through and downstream of Operable Unit 2 (OU-2) of the Vasquez Boulevard/Interstate 70 (VB/I-70) Superfund Site. The stormwater drainage structure to be constructed in OU-2 is part of the High Street Outfall and 40th Avenue Storm Sewer System that is intended to convey stormwater from Regional Transportation District (RTD), Colorado Department of Transportation (CDOT), and City and County of Denver (CCD) projects that are being developed in the VB/I-70 watershed area.

The planned barrier system is located in the parking lot west of the Denver Coliseum and in a portion of Globeville Landing Park between the parking lot and the South Platte River, as shown on Figures E-1 and E-2. Activities identified in this HASP will be completed in accordance with the Removal Action Work Plan (RAWP). This HASP is Appendix E to the RAWP. Companion documents to this HASP include the Sampling and Analysis Plan (SAP) and Materials Management Plan (MMP). The SAP and MMP are Appendices C and D, respectively, to the RAWP.

The activities for which this HASP applies include conducting a design investigation (drilling of soil borings, collection of waste material and visually-impacted soil samples, completing the borings as piezometers and sampling groundwater, and monitoring for soil gas) and the “environmental components” (i.e., removal of waste material and visually-impacted soils, and groundwater [dewatering water]) associated with construction of the barrier system.

Included in this HASP are an applicability statement, historical Site characterization results, a brief description of work to be conducted, Site-specific health and safety procedures, emergency contacts and procedures, and a compliance agreement. Prior to any work being conducted at the Site, a copy of this HASP will be distributed to all EMSI employees and subcontractors. Prior to anyone entering the Site, they will be required to read this HASP and sign the Compliance Agreement.

2 APPLICABILITY

EMSI personnel, subcontractors and visitors who have the potential to be exposed to chemical or physical hazards are held responsible for operating in accordance with the applicable Occupational Safety and Health Administration (OSHA) rules and regulations, especially provisions of 29 CFR 1910.120, 1910.134, 1910.1001-1101, 1910.1200, and 29 CFR 1926; these provisions are incorporated into this document by reference. Those Site personnel who will perform work at the Site shall produce written documentation at least three (3) days prior to the

commencement of field activities verifying completion of appropriate health and safety training, in accordance with 29 CFR 1910.120, the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard. Many of the training requirements included in these regulations have been summarized by OSHA in a publication entitled, *Training Requirements in OSHA Standards and Training Guidelines* (OSHA, 1998). Personnel are also responsible for adherence to applicable state or local regulations that relate to their respective Site activities.

EMSI requires that subcontractors shall abide by a HASP for their employees covering, among other things, exposure to hazardous materials, and shall complete all work in accordance with the HASP. The subcontractor may choose to use EMSI's HASP as a guide in developing its own HASP or may choose to adopt in full EMSI's HASP. In either case, EMSI's HASP will be considered the primary HASP for all project-related activities; if a HASP is provided by a subcontractor, it will be considered an attachment to this HASP. EMSI reserves the right to review the subcontractor's HASP at any time. All subcontractors shall, at a minimum, follow all provisions of EMSI's HASP and/or applicable OSHA guidelines; whichever is more stringent or appropriate. Although EMSI has prepared the HASP, the City and County of Denver, each subcontractor, and any organizations performing oversight shall be responsible for the health and safety of their employees at the job Site and for providing and verifying that each and every person present at the job Site has the appropriate health and safety training.

Inadequate health and safety precautions on the part of a subcontractor, or EMSI's opinion that subcontractors personnel are or may be exposed to health hazards, can be cause for EMSI to suspend the subcontractor's Site work and ask the subcontractor's personnel to evacuate the hazard area.

3 HISTORICAL SITE CHARACTERIZATION RESULTS

Visibly-impacted soil and material beneath and in the vicinity of the alignment of the proposed barrier system have been characterized, as discussed in Section 2.1 of the RAWP. Compounds of potential concern in the waste material and soil consist of volatile organic compounds (VOCs), polynuclear-aromatic hydrocarbons (PAHs), arsenic, and lead. A trace amount of asbestos was detected at one location, raising the concern that asbestos containing material (ACM) may be present in the subsurface material.

As discussed in Section 2.2 of the RAWP, groundwater quality along the alignment of the barrier system has also been characterized. Compounds of potential concern in groundwater consist of VOCs, arsenic, cadmium, copper, lead, manganese, and zinc. Groundwater depths below the ground surface within and adjacent to the limits of the alignment were measured in 2010 and 2011. Groundwater level depths ranged from 10.7 to 23.8 feet below ground surface.

Soil gas monitoring was conducted in 2010 during the advancement of borings for Site characterization within the limits of the channel alignment. Methane concentrations ranged from 0.5 to 43.4 percent by volume in air (% v/v). Additional measurements to the southeast of the alignment detected methane concentrations up to 56.7 % v/v. During advancement of borings in

2011, well-head gas at the ground surface was measured and Lower Explosive Limits (LELs) of 100% were recorded at many of the well-heads. Soil gas monitoring results are detailed in Section 2.3 of the RAWP.

4 SCOPE OF WORK

A detailed description of the work to be conducted is provided in Section 3 of the RAWP.

EMSI will manage the design investigation, prepare a results report, participate in and oversee field activities, coordinate with the analytical laboratory, and interact with the City and County of Denver and any regulatory agency personnel. EMSI will be supported by Foresight West Surveying for field surveying and utility clearances; Site Services Drilling for soil boring and piezometer construction, CTL Thompson for geotechnical testing of subsurface samples; and TestAmerica for laboratory analysis of solid and liquid samples.

During implementation of the “environmental components” (i.e., removal of waste material and visually-impacted soils and groundwater [dewatering water]) associated with construction of the barrier system, EMSI will manage and oversee one or more contractors who will remove asphalt pavement and subsurface materials and transport these materials offsite for disposal. The excavation contractor(s) will also be responsible for dewatering the area around the excavation, treatment of the dewatering water (if necessary), and discharge of the water either to the South Platte River or Sand Creek. EMSI will also manage and oversee a barrier system installation contractor.

5 BIOLOGICAL, PHYSICAL, AND CHEMICAL HAZARD EVALUATION

A potential for biological, physical, and chemical hazards will exist at the Site during design investigation activities and implementation of the “environmental components” associated with construction of the drainage structure. A conceptual Site layout plan showing potential facilities and truck traffic routes that might be employed during the “environmental components” is provided as Figure 6 in the RAWP. Potential hazards are described below.

5.1 Biological Hazards

Possible biological hazards include venomous insects (e.g., bees, wasps, spiders) and to a lesser extent poisonous snakes (e.g., rattlesnakes). Exposure to these hazards will be minimized with appropriate protective clothing.

5.2 Physical Hazards

The only personnel who will be allowed access to the Site will be EMSI and subcontractor personnel and City and County of Denver and/or regulatory agency visitors accompanied by an EMSI employee.

Physical hazards which may be encountered include the presence of support vehicles (driller's support truck, forklift for water treatment tanks and equipment) and semi-trucks on the Site, drilling activities (i.e., drill rig), exposure to electrical and other utility hazards, potential for improperly grounded electrical equipment, and noise. In addition, there is a possibility of slip/trip/fall hazards during soil and groundwater sampling, traversing wet/slippery surfaces (e.g., solids storage area shown on Figure 6 of the RAWP), and strains/sprains from carrying of sampling equipment, samples, sample coolers, and heavy tools or equipment. These hazards are discussed in greater detail in Sections 6 and 7.

The potential for extreme weather conditions may exist depending upon the implementation schedule. Extreme weather conditions may include excessive heat or cold, thunderstorms, high wind conditions, heavy rains, and snow/ice. Special precautions will be taken during periods of extreme weather, and work may be halted by the respective Site Safety Officer (SSO) until the severe weather has subsided. In addition, subcontractors may elect to independently halt their activities in the event of extreme weather conditions, especially thunderstorms. Additional information regarding heat and cold stress and other physical hazards is provided in Appendix E-1.

5.3 Chemical Hazards

Based on available information as summarized in Section 3, the primary chemical of concern at the Site are expected to be VOCs, PAHs, metals, soil gas, and ACM in waste material. Exposure could occur from inhalation of dust, vapors, soil gas, or ACM and/or direct skin contact with subsurface materials and groundwater containing these chemical of concern. Contact with the eyes is also a route of exposure for asbestos.

Toxicological properties and hazard assessments of chemicals of concern are provided in Appendix E-2.

6 GENERAL HEALTH AND SAFETY PROCEDURES

This section presents general safety procedures to be followed during the planned activities at the Site. The measures contained herein will be supplemented as necessary with standard safe work practices.

6.1 Organizational Structure

An organizational chart for Site health and safety is included as Figure E-3. This chart presents the identification of Site safety personnel, as follows:

Project Manager

The EMSI Project Manager, Timothy Shangraw, will be responsible for overall design, implementation, safety, and cost/schedule control of the activities described in the RAWP. He will be responsible for making the proper personal protection equipment (PPE) available to EMSI personnel, ensuring that adequate time and budget is available for health and safety activities for EMSI personnel, and making available qualified personnel to perform Site work in a safe manner. He will also be responsible for monitoring compliance of subcontractors and field personnel with this HASP and will have the authority to stop Site work in the event of safety violations or safety concerns.

EMSI On-Site Representative/Health and Safety Officer (HSO)

The EMSI On-Site Representative, Robert Jelinek, will have responsibility for coordinating and overseeing all field-related aspects of the Site investigation and will also serve as the Health and Safety Officer (HSO). In conjunction with the Project Manager, the On-Site Representative/HSO will have day-to-day responsibilities for acquainting field personnel with potential hazards, implementing the health and safety program described in this HASP, and ensuring that work is being performed in a safe manner in accordance with the HASP. In many cases, the EMSI On-Site Representative will be the Project Manager.

Site Safety Officer (SSO)

While conducting activities at the Site, each of the program subcontractors will designate one of their on-Site personnel as the Site Safety Officer (SSO) for the work being performed by the respective subcontractor (Figure E-3). The SSO should be familiar with local emergency services and will be responsible for ensuring that work by the subcontractor is being performed in a safe manner in accordance with the subcontractor's HASP. The SSO will also monitor on-Site hazards and physical condition of their respective personnel. Each SSO has the authority to shutdown operations if the operation poses a potential threat to field personnel.

Field Personnel

All field personnel shall be familiar with the contents of this HASP and sign the Compliance Agreement. Field personnel are also responsible for following the directions of the SSO, performing all work in a safe manner, and maintaining/inspecting PPE.

6.2 On-Site Control

There will be no on-Site control at the Site during the design investigation activities. On-Site control during implementation of the "environmental components" associated with construction

of the barrier system will be provided by temporary barricades erected around the drainage channel excavation and the water treatment equipment, if any. All personnel performing work defined in this HASP and any visitors must sign in and out using a field Log Book maintained by the EMSI On-Site Representative.

6.3 Personal Protective Equipment (PPE)

Due to the anticipated level of risk and hazards involved in performing the design investigation tasks and construction activities, Level D PPE, the lowest level, is anticipated to be appropriate for most activities. The specific protective equipment for Level D will consist of the following:

- Steel-toed boots,
- Hard hat,
- Work gloves, or Nitrile gloves, as necessary based on the specific activity,
- Safety glasses, as necessary based on the specific activity (e.g., when collecting samples of landfill materials where ACM may be present),
- Hearing protection (e.g., earplugs or earmuffs), as necessary based on the specific activity, and
- A safety vest or shirt of bright yellow/lime or orange color.

If the action levels for oxygen, carbon monoxide, combustibles, and hydrogen sulfide are not exceeded (see Section 6.7 below), but the action level of volatile organics is exceeded, consideration may be given to continue working by upgrading PPE to a modified Level C. Modified Level C PPE would include Level D protective equipment with the addition of a National Institute for Occupational Safety and Health (NIOSH)-approved full-face or half-mask air purifying respirator. The decision to continue working under these conditions will be made by the On-Site Representative/Health and Safety Officer.

6.4 Communication

This section discusses the equipment and procedures for normal field communications and communications in the event of an emergency.

A cellular telephone shall be carried by the HSO and each SSO. An air horn will be located in each field vehicle for announcing emergency evacuation procedures and backup for other forms of communication. Three long air horn blasts is the emergency signal to indicate that all personnel should leave the work area.

The following standard hand signals will be used in the event that verbal communication becomes impossible:

Hand Signal	Explanation
Hand gripping throat	Out of air, can't breathe
Grip partner's wrist or both hands around waist	Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, I am all right, I understand
Thumbs down	No, negative

6.5 Safe Work Practices and Limitations

Site activities will be conducted during daylight hours only. Daylight hours are defined as 7:00 AM to 7:00 PM from May 1 to October 31 and as 8:00 AM to 5:00 PM from November 1 to April 30. The HSO must provide permission for fieldwork conducted by EMSI staff or subcontractors beyond daylight hours or on weekends and holidays. The HSO will review pertinent health and safety matters with on-Site personnel in daily health and safety meetings. Additional work practices and limitations are listed as follows:

- All Site personnel shall acknowledge in the Compliance Agreement (Section 10) that they have read, understood, and agree to comply with this HASP.
- In addition to an initial health and safety meeting, daily project health and safety meetings will be conducted by the HSO (or designated representative) at the start of each workday to discuss the upcoming activities for the day and to address the health and safety procedures to be followed.
- Applicable OSHA guidelines will be followed for all Site activities.
- Dress in accordance with the activity-specific level of protection.
- Eating, drinking, gum or tobacco chewing, and smoking are not permitted in work areas.
- Any person under a physician’s care, taking medication, or those who experience allergic reactions must inform the HSO.
- The buddy system must be employed at all times. At least two people from EMSI or their subcontractors should be present during all active field tasks unless specifically permitted by the HSO or designated representative.
- The wearing of contact lenses for on-Site personnel is prohibited by best management practice and OSHA.
- Be aware of symptoms of heat or cold stress, exposure to hazardous chemicals or dangerous atmospheres, and work-related injuries.
- All potential underground utilities (gas, electric, sanitary and storm sewer, water, telephone, cable, fiber optic) at the Site must be identified and marked prior to the commencement of any drilling or excavation activity.
- Good personal hygiene practices are especially important when working in the proximity of potentially hazardous compounds. Of particular importance is the need to keep fingers away from the face unless they have been carefully washed. Cuts and abrasions should be covered by an appropriate dressing.
- Proper lifting techniques should be followed at all times to minimize the risk of back injury.

- All accidents and hazardous material exposure incidents will be reported on the appropriate forms, discussed in Section 6.10.

6.6 Fire Prevention

All flammable and/or combustible liquids (i.e., gasoline, diesel fuel) shall be stored in approved safety containers that meet the specifications of National Fire Protection Association (NFPA) Code 30 and OSHA 29CFR1910.106(a)(29). Smoking or open flames are not permitted within 20 feet of any flammable liquid container.

All personnel performing work at the Site must be trained in the proper use of fire extinguishers. OSHA-approved portable fire extinguishers will be located in every field vehicle. These extinguishers shall be rated for Class A (wood, paper), B (flammable liquid), and C (electrical) fires, and their locations shall be clearly identified with signs and/or labels. As required by 29CFR1910.157(d), at least one fire extinguisher with the appropriate rating must be located within 75 feet of a Class A fire hazard and 50 feet of a Class B or C fire hazard.

6.7 Health and Safety Practices during Drilling into and Excavation of Waste Material and Visually-Impacted Soils

Hazards associated with drilling into and/or excavation of waste material and visually-impacted soils include oxygen depletion/enrichment and the presence of toxic and flammable and/or explosive gases. The U.S. Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL's) for some of the more common atmospheric conditions/contaminants that are encountered during drilling and excavation activities are as follows:

Test	Permissible Exposure Limit
Oxygen	19.5% to 23.5%
Carbon Monoxide (CO)	Under 35 parts per million (ppm)
Lower Flammable (Explosive) Limit (LFL/LEL)	Under 10% of LFL/LEL
Hydrogen Sulfide (H ₂ S)	Under 10 ppm
Aromatic hydrocarbons	Under 5 ppm

If site activities include drilling into and/or excavation of waste material and visually-impacted soils, the following action levels and actions shall apply:

Constituent (Instrument)	Action Level	Action
Oxygen (4 Gas Meter)	Below 19.8% in breathing zone	Clear area by 10 feet minimum. Retest site after 2 minutes.
Carbon Monoxide (4 Gas Meter)	35 ppm in breathing zone	Clear area by 10 feet minimum. Retest site after 2 minutes.

Constituent (Instrument)	Action Level	Action
Combustibles (4 Gas Meter)	10% of Lower Explosive Limit (LEL)	Clear area by 10 feet and turn off motor. Retest site after 2 minutes.
Hydrogen Sulfide (4 Gas Meter)	10 ppm	Clear area by 10 feet minimum. Retest site after 2 minutes.
Volatile Organics (PID)	5 ppm	Clear area by 10 feet minimum. Retest site after 2 minutes.

If flammable gas is suspected to be present, the following health and safety practices shall be followed:

- A flammable gas indicator shall be utilized at all times during trenching, excavation, drilling, or when working within ten (10) feet of an open excavation.
- Before personnel are permitted to enter an open trench or excavation, the trench or excavation shall be monitored to ensure that flammable gas is not present in concentrations exceeding 1% and that oxygen is present at a minimum concentration of 19.8%. When in an excavation or trench, each work party shall work no more than five (5) feet from a continuous flammable gas and oxygen monitor.
- When trenching, excavating, or drilling deeper than two (2) feet into the fill, or in the presence of detectable concentrations of flammable gas, the soils shall be wetted and the operating equipment shall be provided with spark proof exhausts.
- A dry chemical fire extinguisher, ABC rated, shall be provided on all equipment used in areas containing waste material.
- Personnel within or near an open trench or drill hole shall be fully clothed, and wear shoes with non-metallic soles, gloves, hard hat and safety goggles or glasses.
- Smoking shall not be permitted in any area within one hundred (100) feet of the excavation.
- Personnel shall be kept upwind of any open trench unless the trench is continuously monitored.
- All other applicable Safety and Health Regulations for Construction, as promulgated in 29 CFR by OSHA, shall be met. Applicable regulations include, but may not be limited to, the confined space standard (Part 1926.21(b)(6)(i) and (ii) in Subpart C); gases, vapors, fumes, dusts and mists (Part 1926.55 in Part 1926 Subpart E); fire protection and

prevention (Part 1926 Subpart F); and trenching and excavation (Part 1926 Subpart P).

- Compliance with OSHA’s confined space requirements for general industry, as promulgated in 29 CFR 1910.146 and Appendices A- F.

6.8 Authorized Project Field Personnel

Only authorized project personnel will be granted access to active work areas during field activities. A Log Book will be maintained by the EMSI On-Site Representative or his designee to record the personnel performing work at or visiting the Site.

6.9 Medical Monitoring

Medical monitoring will be performed in a manner prescribed by and consistent with each contractor’s corporate policies.

6.10 Record Keeping and Reporting

The following records and/or logs will be maintained in the EMSI field vehicle at the Site:

- Daily Sign-in Log that documents all personnel entering and exiting the Site;
- Daily Health and Safety Meeting Log that documents personnel attending daily health and safety meetings and a brief summary of the meeting;
- Accident Report Forms that document any accidents and/or injuries at the Site, including corrective actions;
- HAZWOPER Training, Medical Monitoring, and Fit Testing Certification that document compliance with applicable requirements of 29 CFR 1910.120 for all personnel performing work at the Site; and
- Material Safety Data Sheets (MSDSs, also referred to as SDSs) that provide health and safety and emergency response information on chemicals, if any, and materials used at the Site.

All accidents (including vehicular accidents while traveling to/from the Site), injuries, illnesses, chemical exposures, fires, and/or deviations from the HASP shall be reported to the HSO. The HSO must complete an Accident Report Form for all accidents or injuries occurring at the Site. The accident or injury must be reported to the Project Manager and appropriate actions taken.

7 CONSTRUCTION-RELATED HEALTH AND SAFETY PROCEDURES

This section presents selected safety procedures to be followed during the design investigation and construction activities; this section is not intended to be all-inclusive. Applicable OSHA and Department of Transportation (DOT) requirements will be followed at all times. The measures contained herein will be supplemented as necessary with standard safe work practices. Each subcontractor will be responsible for ensuring that each of its employees complies with the

appropriate OSHA construction standards and providing appropriate warnings to their Site personnel.

7.1 Hazard Communication

In accordance with 29 CFR 1910.1200, MSDSs will be retained in the EMSI field vehicle. It is the responsibility of all subcontractors to furnish EMSI with current (less than one year old) MSDSs for chemicals used by the subcontractor; before work starts.

7.2 Back Safety/Lifting

Proper lifting techniques must be followed at all times to minimize the risk of back injury. These techniques include:

1. Size up load before lifting. Test by lifting one of the corners or pushing. If object is too heavy, get a mechanical aid or help from another person.
2. When performing the lift:
 - Place your feet close to the object and center yourself over the load.
 - Bend the knees.
 - Lift straight up, smoothly and let your legs do the work, not your back.
 - Avoid overreaching or stretching to pick up or set down a load.
3. Make sure you have a clear path to carry the load.
4. Do not twist or turn your body once you have made the lift.
5. Always push, not pull, the object when possible.

Alternate techniques for carrying or moving loads are to be used whenever possible to minimize lifting and bending requirements. These alternatives include hoists, forklifts, dollies, and carts.

7.3 Electrical Safety General

All applicable regulations contained in Subpart S (Electrical) of 29 CFR 1910, Subpart K (Electrical) of 29 CFR 1926, Subpart V (Power Transmission and Distribution) of 29 CFR 1926, and any other applicable requirements must be followed during the performance of all construction-related tasks at the Site. In particular, the requirements outlined in 29 CFR 1910.331 through .335 (Electrical Safety-Related Work Practices) will be followed at all times.

While any employee is exposed to contact with the parts of fixed electric equipment or circuits which have been de-energized, the circuits energizing the parts shall be locked out or tagged or both in accordance with 29 CFR 1910.333(b) and 29 CFR 1926.417. It is the responsibility of all Site personnel to understand and follow these requirements.

7.4 Fall Protection

Appropriate measures will be taken to reduce the risk of falls during the performance of tasks requiring the use of ladders and/or scaffolding, including:

1. All ladders and scaffolding must meet OSHA specifications for design and safety.
2. All ladders and scaffolding must be properly secured before use per OSHA requirements.
3. Appropriate fall protection equipment must be worn at all times while working on ladders and scaffolding.

Additional requirements for the use of ladders and scaffolding, as outlined in 29 CFR 1926.450 through 543 (Subpart L, Ladders and Scaffolding), must also be followed at all times.

7.5 Operation of Mechanized Equipment and Motor Vehicles

All mechanized equipment (e.g., drilling equipment) and other motor vehicles (e.g., support trucks, excavators, backhoes, loaders, semi-trucks) shall only be operated by qualified personnel who have been trained by their employer in the proper use of the equipment. The equipment will be operated according to all applicable OSHA and Department of Transportation (DOT) regulations. Specifically, the requirements of 29 CFR 1926.600 through .606 (Subpart O. "Motor Vehicles, Mechanized Equipment, and Marine Operations") will be observed, including, but not limited to the following:

1. Seat belts must be worn at all times.
2. All heavy equipment must be equipped with a reverse signal alarm.
3. All earth moving equipment must be equipped with rollover protective structures.

7.6 Struck-By and Caught-In/Caught-Between Hazards

The potential for being struck by falling or swinging objects, or situations where an employee is caught in or caught between heavy equipment and/or other items, are to be minimized by following any and all appropriate OSHA precautions. In particular, the drilling subcontractor should incorporate provisions of 29 CFR 1926.600 (a)(3)(i), which refers to suspension of equipment or parts, 29 CFR 1926.651(e), which refers to falling loads, and 29 CFR 1926, Subpart O. which refers to machinery and heavy equipment. Precautions should include, but not be limited to, Site personnel listening for back up alarms and watching for spotters and backing equipment.

The use of towing and lifting equipment should be in accordance with OSHA and other applicable requirements.

7.7 Material Handling - General

The potential for injury due to improper material handling is to be minimized by following the material handling and storage requirements found in Subpart N of 29 CFR 1910 (Materials Handling and Storage). The following general procedures, as listed in 29 CFR 1910.176, will be followed at all times:

1. When mechanical handling equipment is used, sufficient safe clearance shall be allowed.
2. Storage of material shall not create a hazard. Materials stored in tiers must be stacked, blocked, interlocked, and limited in height so that they are stable and secure against sliding or collapse.
3. Storage areas shall be kept relatively free from accumulation of materials that constitute hazards from tripping, fire or explosion.

Covers and/or guardrails shall be provided as necessary to protect personnel from hazards of open pits, tanks, and excavations.

8 EMERGENCY CONTACTS AND PROCEDURES

8.1 Emergency Contacts

In the event of an emergency related to the field activities, notification of the appropriate contacts from Table E-1 should be made. A hospital route map is included as Figure E-4.

When calling for assistance in an emergency situation, the following information should be provided:

1. Name of person making the call.
2. Telephone number at location of person making the call.
3. Name of person(s) exposed or injured.
4. Nature of emergency.
5. Actions already taken.

Recipient of call should hang up first – **NOT** the caller.

8.2 Emergency Procedures

The following standard emergency procedures will be used by on-Site personnel. The EMSI HSO and/or a designated substitute shall be notified of any on-Site emergencies and be responsible for ensuring that the appropriate procedures are followed.

Pre-Emergency Planning: The provisions of this section will be discussed with on-Site field personnel during the health and safety orientation meeting. A copy of Table E-1 and Figure E-4 shall be clearly displayed in the support vehicle.

Lines of Authority: Figure E-3 presents the line of authority for Site operations with respect to safety. The subcontractor SSO representatives shall assume responsibility for the health and safety of their workers.

Personnel Injury in the Work Zone: Upon noticing any apparently serious injury in the work zone, the designated emergency signal (three horn blasts) will be sounded by the closest EMSI or subcontractor observer. All work must be halted, and all personnel must report to the location designated by the HSO at the initial safety meeting and wait until clearance is given to resume work. The HSO and/or Project Manager (see Figure E-3) should evaluate the nature of the injury. If the accident is deemed serious (i.e., bodily harm has occurred) by the Site HSO or respective SSO, an ambulance should be requested.

After any serious injury, the HSO will be responsible for evaluating Site and work zone conditions and determining the appropriate response measures, if any, that need to be implemented prior to work continuing after the injury.

Fire/Explosion: Proper storage of gasoline and other flammable liquids should be maintained to prevent or avoid spreading of a fire. Upon notification of a fire or explosion on-Site, the designated emergency signal, three horn blasts, will be sounded and all Site personnel must report to the location designated by the HSO at the initial safety meeting. The fire department will be alerted and all personnel moved to a safe distance from the involved area. Workers must know the location, use, and limitations of available on-Site fire extinguishers. The escape route from the Site will be determined by the HSO prior to start of the design investigation and construction activities and will be shared with field personnel at the initial safety meeting prior to the start of work.

PPE Failure: If any Site worker experiences a failure or alteration of PPE that affects the protection factor, that person and his/her "buddy" will immediately stop work. Commencement of work will not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure: If any other equipment fails to operate properly, the EMSI on-Site representative and the HSO will be notified to evaluate the effect of this failure on continuing operations on-Site. If the failure affects the safety of personnel or prevents completion work tasks, all personnel will leave the work zone until the situation is evaluated and appropriate actions taken.

In all situations when an on-Site emergency results in evacuation of the work zone, personnel will not re-enter until any of the following conditions have been met, as appropriate:

- The conditions resulting in the emergency have been corrected.
- The hazards have been reassessed by the HSO and the Project Manager.
- The HASP has been reviewed and revised, if necessary.
- Site personnel have been briefed on any changes in the HASP.

8.3 Location of Site Resources

A support vehicle will be established at the Site that contains a cell phone, air horn, this HASP, the daily log book, monitoring instrument manuals, multiple sets of maps and directions to the

nearest hospital, first aid kit, portable eye wash, fire extinguisher, other safety supplies (e.g., extra gloves, ear plugs, hard hats, safety glasses, and other PPE) and any other important items.

9 REFERENCES

National Institute for Occupational Safety and Health (NIOSH), 2015, NIOSH Pocket Guide to Chemical Hazards, Atlanta, Georgia, February 13. <http://www.cdc.gov/niosh/npg/npgsyn-z.html>.

U.S. Department of Labor, Occupational Safety and Health Administration, 1998 (revised), Training Requirements in OSHA Standards and Training Guidelines, OSHA 2254.

10 HEALTH AND SAFETY COMPLIANCE AGREEMENT

I have read, understand, and agree to comply with the health and safety procedures in this Health and Safety Plan (HASP). In addition, I have attended, understand, and agree to comply with the information presented in the health and safety pre-activity meeting. I hereby agree that (1) compliance with the HASP is a condition of entry to the Site, and (2) non-compliance with the HASP may result in work stoppage and/or dismissal from the Site.

Printed Name Organization Signature Date

Personnel health and safety pre-activity meeting conducted by:

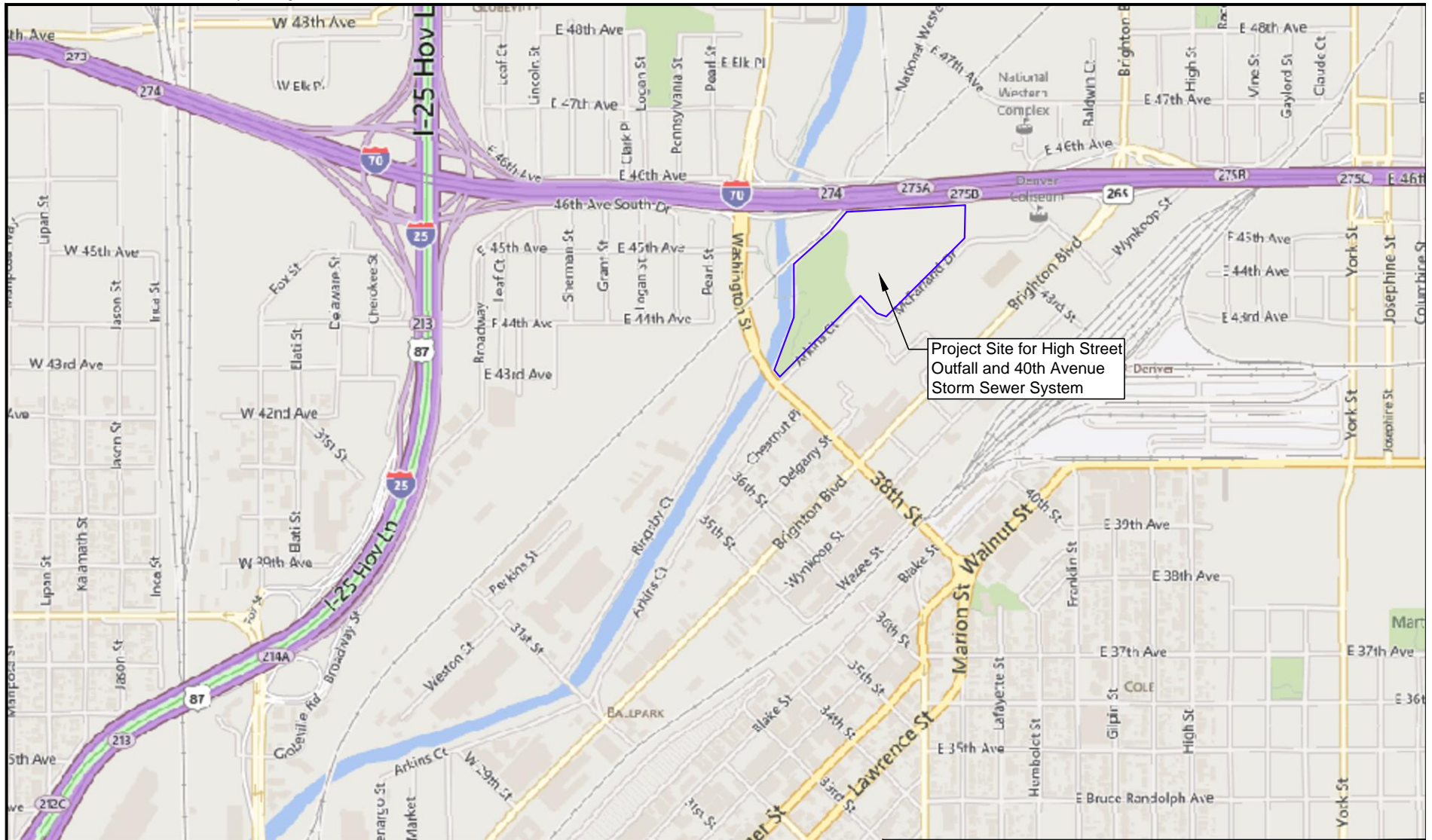
Name Organization Signature Date

Tables

Table E-1 List of Emergency Telephone Contacts

<u>Agency/Facility</u>	<u>Telephone No.</u>	<u>Contact</u>
All Emergencies	911	Sheriff, Fire, Ambulance
St. Joseph Hospital 1375 E. 19 th Ave. Denver, CO 80218	303-801-2000	See attached Hospital Route Map (Figure E-4)
Engineering Management Support, Inc. (office)	303-940-3426 x. 9	Tim Shangraw (Project Manager)
EMSI on-Site cellular telephones	303-619-5179 303-808-7227 303-807-9601	Tim Shangraw Paul Rosasco Bob Jelinek

Figures



Project Site for High Street
Outfall and 40th Avenue
Storm Sewer System

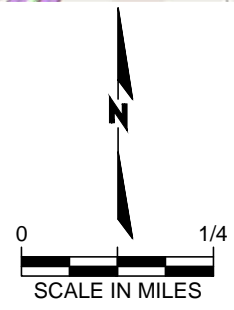
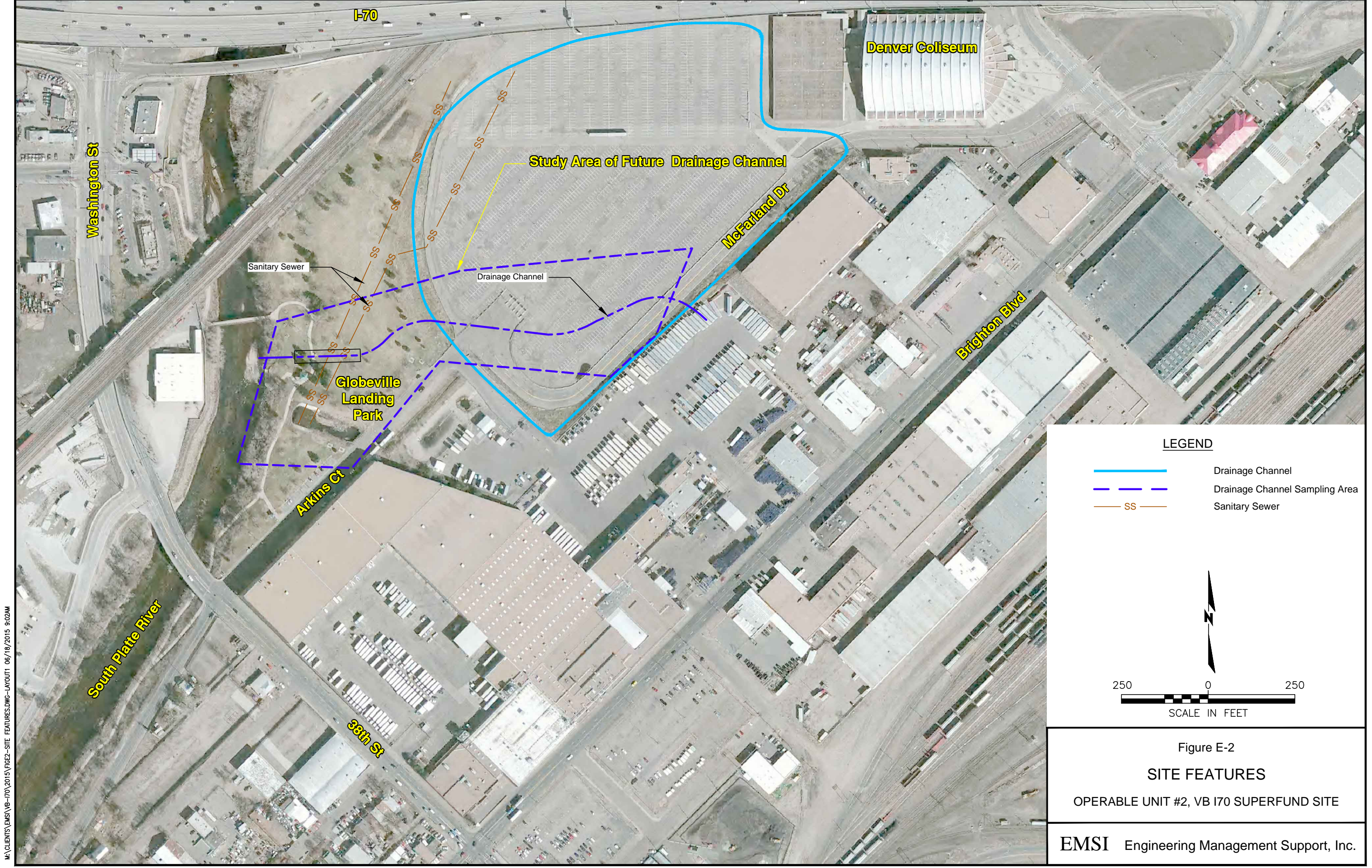


Figure E-1
SITE LOCATION MAP
OPERABLE UNIT #2, VB I70 SUPERFUND SITE

EMSI Engineering Management Support, Inc.



LEGEND

- Drainage Channel
- - - - Drainage Channel Sampling Area
- SS Sanitary Sewer

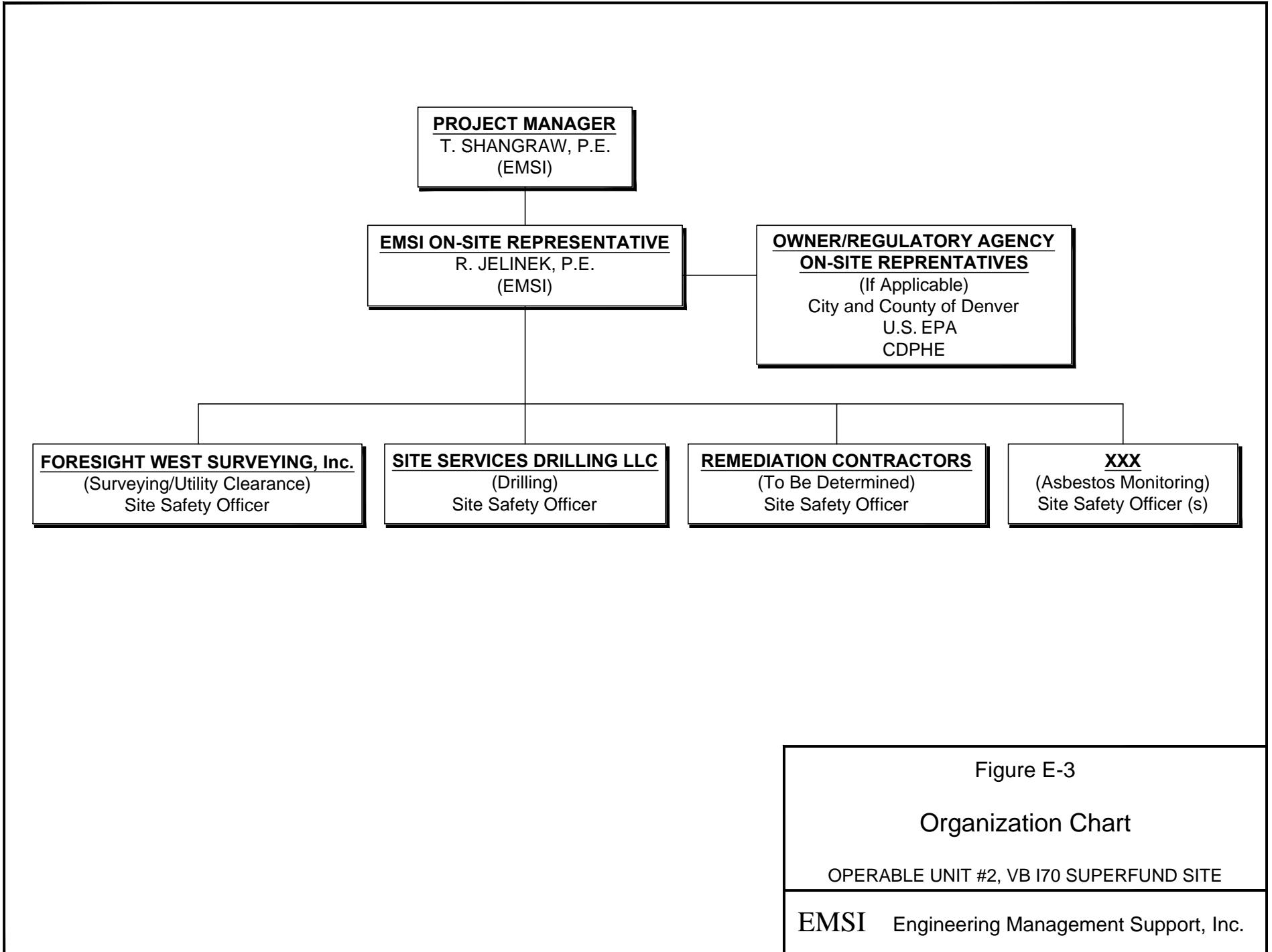


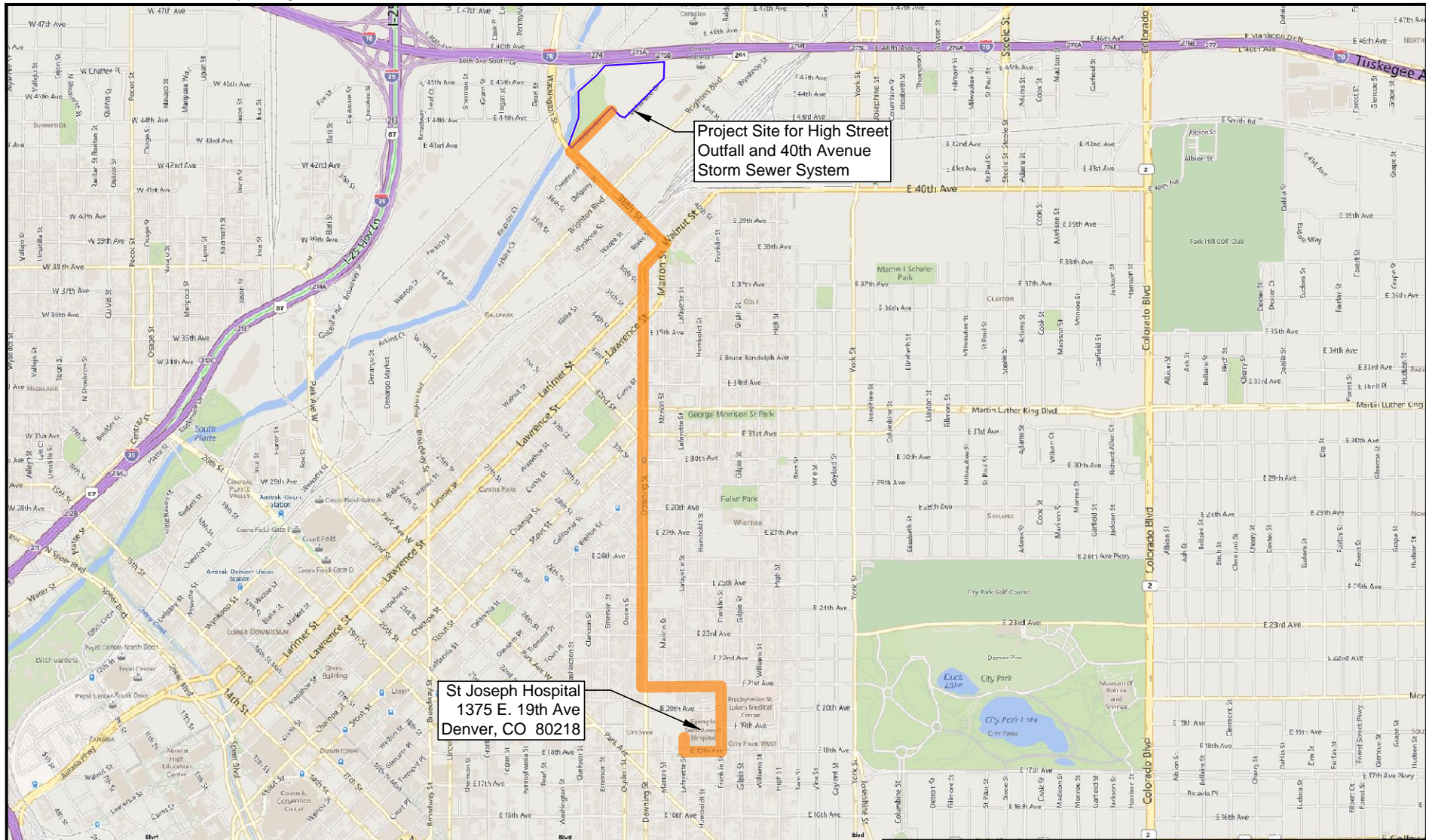
Figure E-2

SITE FEATURES

OPERABLE UNIT #2, VB I70 SUPERFUND SITE

M:\CLIENTS\EMSI\VB-I70\2015\FIG-E2-SITE FEATURES.DWG-LAYOUT1 06/18/2015 9:02AM





Project Site for High Street
Outfall and 40th Avenue
Storm Sewer System

St Joseph Hospital
1375 E. 19th Ave
Denver, CO 80218

LEGEND



Hospital Route
Directions:
Head SW on Arkins Ct to 38th
Left on 38th
Right on Walnut
Left on Downing
Left on E. 21st Ave
Right on Franklin
Right on E. 18th Ave.
Right on Lafayette

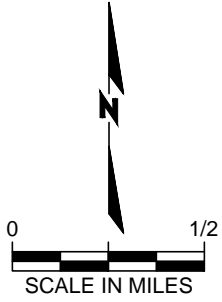


Figure E-4
HOSPITAL ROUTE MAP
OPERABLE UNIT #2, VB I70 SUPERFUND SITE

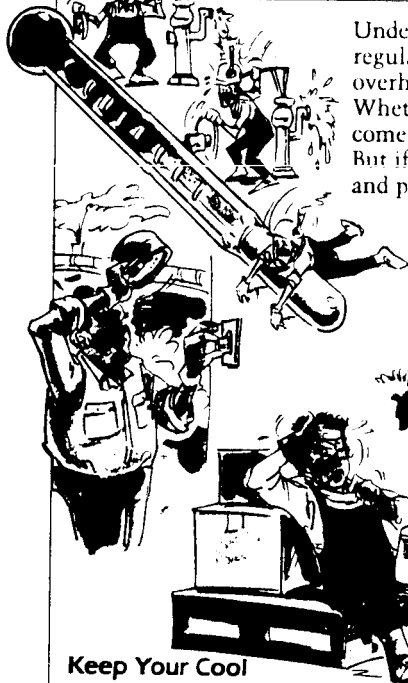
Appendix E-1

First Aid and Emergency Care

UNDERSTANDING AND PREVENTING **HEAT STRESS**



HEAT STRESS: IT'S A MATTER OF DEGREE



Under certain conditions, your body may have trouble regulating its temperature. As a result, your body overheats and suffers from some degree of heat stress. Whether mild, moderate, or severe, heat stress can come on suddenly and be dangerous to your health. But if you're prepared, you can "keep your cool" and prevent heat-related problems.

When It's Too Hot for You to Handle

Hard work or play can overload your body with extra heat—especially if you're active in a hot, humid, or poorly ventilated environment. These conditions make it harder for your body to handle heat—the sweat pours out, you don't feel well or work well, and you may feel dizzy or faint. If these signs of heat stress go unrecognized and untreated, serious—and sometimes permanent—health problems can occur.

Keep Your Cool

Our bodies vary in their ability to handle heat. But everyone can learn to avoid the adverse health and safety effects of heat stress. Keep your cool by knowing your body and its limitations, by understanding heat stress, and by preventing heat stress in the first place.



Know Your Body

Your body has a "heat regulator" that controls body temperature. But activity, heat, humidity, or lack of air movement can overwork this mechanism.

Understand Heat Stress

Protect yourself from heat stress. Learn to recognize warning signs—such as heavy sweating, fatigue, and dizziness—and know how heat stress is treated.

Prevent Heat Stress

Take an active role to prevent heat problems. Know the factors that increase your risk and take steps to reduce them, such as drinking water and acclimatizing to the heat.

This booklet is not intended to replace your company's health and safety policies or professional medical care.

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HOW YOUR BODY HANDLES HEAT

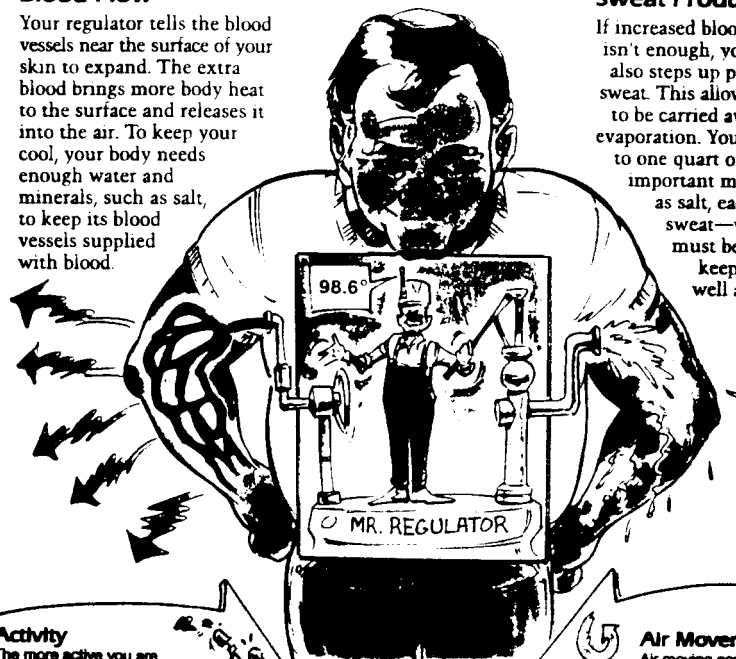
You have a natural mechanism that regulates the **core temperature** deep inside your body. You maintain a normal core temperature of 98.6° F by releasing excess heat into the air. The heat leaves your body through the blood vessels near the skin's surface and through the evaporation of sweat. Your level of activity and certain environmental conditions make the regulator work harder to increase your body's blood flow and sweat production.

Blood Flow

Your regulator tells the blood vessels near the surface of your skin to expand. The extra blood brings more body heat to the surface and releases it into the air. To keep your cool, your body needs enough water and minerals, such as salt, to keep its blood vessels supplied with blood.

Sweat Production

If increased blood flow alone isn't enough, your regulator also steps up production of sweat. This allows more heat to be carried away through evaporation. You can lose up to one quart of water, plus important minerals such as salt, each hour you sweat—water which must be replaced to keep you feeling well and healthy.



Activity

The more active you are, the more heat your muscles generate. Heavy physical activity also sets up competition between your muscles and skin for the blood supply.

Environmental Temperature

As the temperature in your environment goes up, so does your body temperature. When it's hot from the sun or other radiant heat sources, such as a furnace, your body can't transfer heat to the air as effectively.

Humidity

The higher the humidity, the less sweat evaporates. That's because the moisture content in the air is already high, making it difficult for the air to absorb more moisture.

Air Movement

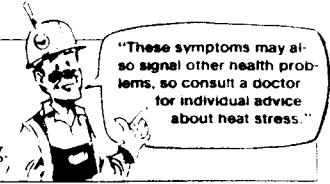
Air moving across your skin carries away heat from its surface; it also helps sweat evaporate. But with little air movement, these processes don't work as well.

"When these conditions prevent me from regulating your body's temperature, you're in danger of having heat stress."

UNDERSTAND HEAT STRESS

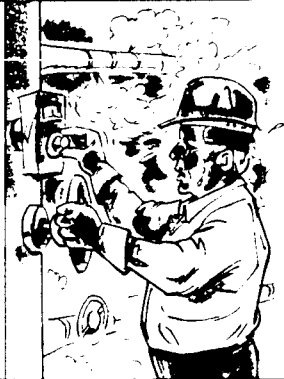
When your body's heat regulator is pushed too far and your body overheats, some form of heat stress occurs. It may be mild, moderate, or severe; symptoms may range from excessive sweating to dizziness to

unconsciousness. Since even severe heat stress can appear suddenly, learn the warning signs and how they're treated, so you can be more comfortable and productive, and prevent heat problems from occurring.



Mild: Minor Heat Problems

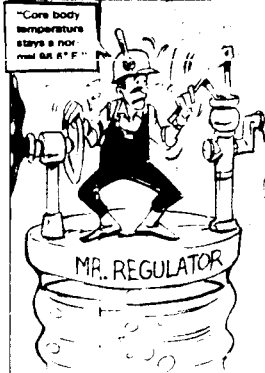
This is usually the earliest and least serious form of heat stress. Mild heat stress is always reversible and usually isn't dangerous unless the symptoms persist. Although you usually can continue work soon after treatment, always inform your supervisor if you have symptoms of mild heat stress.



Signs and Symptoms

You may have one or more of these symptoms.

- Excessive sweating.
- Painful spasms in muscles during or several hours after activity (heat cramps).
- Tiny red bumps on skin and a prickling sensation (called prickly heat).
- Irritability, mild dizziness, or weakness.



What's Going On

Sweating causes your body to lose too much water and minerals. This imbalance may cause muscles to cramp. Your sweat glands may become blocked and inflamed, causing a rash. Too little blood flowing to the brain causes irritability, dizziness and other symptoms.

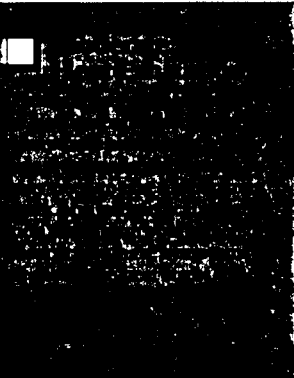


Treatment

Follow this self-care:

- Rest in a cool or shady area.
- Drink water or other fluids.
- Use warm, moist compresses over cramping muscles, followed by gentle massage.
- Use a mild drying lotion to relieve the rash; keep skin dry and clean.

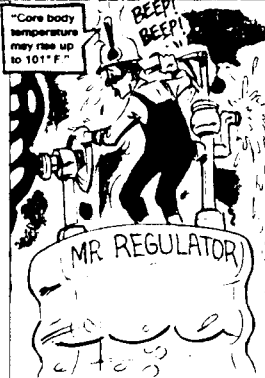
Taking additional salt is usually **not** necessary.



Signs and Symptoms

You may have one or more of these symptoms.

- Excessive sweating.
- Cold, moist, pale skin (or flushed skin).
- Thirst.
- Extreme weakness or fatigue.
- Headache, nausea, or loss of appetite.
- Dizziness or giddiness.
- A rapid, weak pulse.



What's Going On

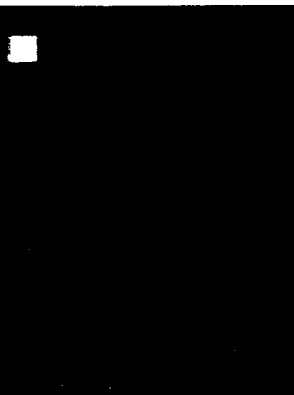
Losing too much water and minerals reduces the blood supply to major organs, such as the brain, muscles, and skin. Your heart works harder to maintain the blood supply, straining your cardiovascular system. Some organs, such as the brain, may not get enough blood.



Treatment

You may need medical treatment, as well as this self-care:

- Rest in a cool or shady area.
- Drink water or other fluids.
- Take additional salt only if advised.
- Use cool compresses on forehead, around the neck, and under armpits.



Signs and Symptoms

You may have one or more of these symptoms.

- Lack of sweating.
- Hot, dry, flushed skin.
- Deep, rapid breathing.
- A rapid, weak, and possibly irregular pulse.
- Headache, nausea, or delirium.
- Loss of consciousness.
- Convulsions.



What's Going On

Your regulator becomes so overburdened that blood flow and sweat cannot cool your body enough. Your body becomes so overheated that sweat glands and other organs don't function normally. This can affect vital organs, including your heart and brain, and may cause permanent damage.



Treatment

Call for medical help right away. While waiting for medical treatment, begin first aid:

- Rest in a cool or shady area.
- Remove outer clothing.
- Lower body temperature with cool compresses, increasing air movement, or both.
- Drink water or other fluids (if conscious).

CHECKPOINTS FOR PREVENTING HEAT STRESS

"Don't wait until you're thirsty to have a drink of water—thirst is not a good indicator of how much water your body needs."



✓ Know Your Environment

Your company controls the work environment so it's safe. You can help by knowing which factors increase your risk of heat stress. Talk with your supervisor about ways to reduce them, so you can take special precautions to protect yourself when the risk is especially high, such as on hot, humid days.

✓ Drink Plenty of Water

Increase the water you drink to replenish the water you lose from sweating. Drink more than you need to satisfy your thirst. It's best to replenish regularly by drinking small amounts frequently throughout the day. You may need to drink a glass of water or more every hour.

✓ Take Appropriate Breaks

Whether you need rest breaks depends on conditions such as air temperature, sun exposure, and how hard you're working. Your company monitors these conditions and establishes a safe work/rest regimen for you and your coworkers.

✓ Wear Proper Clothing

Your employer supplies you with heat-protective clothing and equipment, such as heat shields, if needed. When possible, wear loose, lightweight clothing, which encourages heat to be released

There are several steps you and your employer can take to prevent heat stress. Both supervisors and employees can recognize risks and follow safety

procedures to reduce them. Be sure to inform your employer about any medical conditions you have and discuss whether you might be at increased risk.



"If you're physically fit, you may acclimatize up to 50% faster."



✓ Acclimatize Yourself

Your employer may give you guidelines to help you adapt to the heat. This natural process, called **acclimatization**, takes about 7 to 10 days. It usually consists of short periods of working in the heat, which gradually increase in time and intensity. If you spend time out of the heat due to vacation or reassignment, you may need to acclimatize yourself again.

✓ Stay in Good Shape

Conditioned muscles work more efficiently and generate less body heat, while extra body weight makes you work harder. People in good condition tend to acclimatize better because their cardiovascular systems respond better.

✓ Eat Wisely

Hot, heavy meals add heat to your body and divert blood to your digestive system, so eat lightly during your workday. Remember, too, a normal diet usually supplies all the salt you need to replace the salt lost through sweating.

✓ Know Special Risks

Alcohol (including beer), **caffeine**, **medications** such as those used to control high blood pressure or allergies, **medical conditions** including diabetes, **recent illnesses** such as flu, and increasing **age** all increase your risk of heat stress.



"TEAMWORK HELPS YOU BEAT THE HEAT"

In many jobs, heat is a fact of life. Since too much heat can be harmful to your health and be a safety problem, your company wants to help you reduce the risk of heat stress by monitoring and controlling the work environment. Be sure to follow company procedures, such as adjusting gradually to working in the heat and drinking plenty of water. You'll feel better on and off the job knowing what heat stress is and how to prevent it.




KRAMES
COMMUNICATIONS
MORE THAN INFORMATION

Consultants:

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With contributions by:

Dale M. Shapiro, CIH, Industrial Hygiene Manager
Mary E. Willis, RN, Occupational Health
Terrance G. Yonash, Corporate Safety Director

 Lithographed in Canada

Appendix E-2

Toxicological Properties and Hazard Assessments

Landfill Gas

Typical components of landfill gas are as follows:

Typical Landfill Gas Components		
Component	Percent by Volume	Characteristics
methane	45–60	Methane is a naturally occurring gas. It is colorless and odorless. Landfills are the single largest source of U.S. man-made methane emissions
carbon dioxide	40–60	Carbon dioxide is naturally found at small concentrations in the atmosphere (0.03%). It is colorless, odorless, and slightly acidic.
nitrogen	2–5	Nitrogen comprises approximately 79% of the atmosphere. It is odorless, tasteless, and colorless.
oxygen	0.1–1	Oxygen comprises approximately 21% of the atmosphere. It is odorless, tasteless, and colorless.
ammonia	0.1–1	Ammonia is a colorless gas with a pungent odor.
NMOCs (non-methane organic compounds)	0.01–0.6	NMOCs are organic compounds (i.e., compounds that contain carbon). (Methane is an organic compound but is not considered an NMOC.) NMOCs may occur naturally or be formed by synthetic chemical processes. NMOCs most commonly found in landfills include acrylonitrile, benzene, 1,1-dichloroethane, 1,2-cis dichloroethylene, dichloromethane, carbonyl sulfide, ethyl-benzene, hexane, methyl ethyl ketone, tetrachloroethylene, toluene, trichloroethylene, vinyl chloride, and xylenes.
sulfides	0–1	Sulfides (e.g., hydrogen sulfide, dimethyl sulfide, mercaptans) are naturally occurring gases that give the landfill gas mixture its rotten-egg smell. Sulfides can cause unpleasant odors even at very low concentrations.
hydrogen	0–0.2	Hydrogen is an odorless, colorless gas.
carbon monoxide	0–0.2	Carbon monoxide is an odorless, colorless gas.
Source: Tchobanoglous, Theisen, and Vigil 1993; EPA 1995		

The routes of exposure from these contaminants are primarily through inhalation of organic vapors and dusts, and by direct contact with contaminated media. Hazard information regarding the major components of landfill gas that are of concern is included below.

Methane (CH₄)

Methane is usually a component of landfill gas. Pure methane is a colorless and odorless gas. It has practically no toxic effects below the flammable limits. While methane has no noticeable toxic effects, high concentrations can displace oxygen and serve as a simple asphyxiate. Methane has a lower explosive limit (LEL) of 5 percent and an upper explosive limit (UEL) of 15 percent by volume in air.

OSHA does not regulate exposure to methane by a specific standard. However, methane is a flammable gas and must be controlled at least 20 percent below its LEL; below 10 percent of the LEL in excavations and confined spaces.

Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless, non-irritating gas generally produced as a by-product of incomplete combustion of carbonaceous materials. The toxicity of carbon monoxide results from the way it interferes with the body's ability to transport oxygen. Therefore, in carbon monoxide poisoning, red blood cells are less able to pick up oxygen for transport from the lungs to the rest of the body, and are also less able to release whatever oxygen they do pick up. The first symptoms include headache, fatigue, and lightheadedness. At higher levels, skin flushing, rapid heart rate, and lowered blood pressure occur. Carbon monoxide poisoning is treated by administering oxygen to the patient.

The OSHA recommended exposure limit (REL) for carbon monoxide is 35 parts per million (ppm) as an 8-hour time weighted average (TWA), with a ceiling limit of 200 ppm, which should not be exceeded at any time during the workday. Specific information from the National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards is included in this Appendix.

Hydrogen Sulfide (H₂S)

Hydrogen sulfide is a colorless, toxic gas that is identified by the offensive odor of rotten eggs. It is heavier than air, flammable, and is generally a component of landfill gas. Hydrogen sulfide can cause irritation of eyes, nose and throat, beginning at approximately 10 ppm. Long-term exposure (30 minutes or longer) to high concentrations can cause drowsiness, staggering and nausea, which can lead to death due to respiratory system failure.

The odor of hydrogen sulfide can be detected at approximately 0.03 ppm, becomes offensive at 3 ppm, and causes irritation at 10 ppm. An especially dangerous situation is brief exposure to concentrations of 50 ppm, which can cause a person to lose the sense of smell. This has been described in accident reports as "I first smelled hydrogen sulfide,

then it went away.” This is called olfactory fatigue. The toxic effect of hydrogen sulfide paralyzes the respiratory control center, which leads to suffocation and then death.

Hydrogen sulfide has a wide flammable range (LEL 4.0%, UEL 44.0%). This property, coupled with its heavier-than-air density, makes it a hazard in trenches and low-lying areas.

Hydrogen sulfide is regulated by OSHA on a 20 ppm ceiling Permissible Exposure Limit (PEL) concentration. A ceiling concentration means that this level cannot be exceeded during any part of the work period. OSHA has also established a Recommended Exposure Limit (REL) concentration at 10 ppm, and an Immediately Dangerous to Life or Health (IDLH) concentration of 100 ppm. Specific information from the NIOSH Pocket Guide to Chemical Hazards is included in this Appendix.

Ammonia

Ammonia is a compound of nitrogen and hydrogen with the formula NH_3 in the gas form. It is a colorless gas with a characteristic pungent smell. Ammonia can be a potential skin, eye, and throat irritant. OSHA has also established a PEL concentration at 50 ppm, and an IDLH concentration of 300 ppm. Ammonia is flammable. Its LEL is 15 percent and its UEL is 28 percent. However, ammonia is unlikely to collect at a concentration high enough to pose an explosion hazard. Specific information from the NIOSH Pocket Guide to Chemical Hazards is included in this Appendix.

Benzene

Benzene is a colorless and highly flammable liquid with a sweet smell. Benzene is commonly used in industrial processing and can be present at waste facilities. The primary route of exposure to benzene is through inhalation. Benzene over-exposure can cause damage to the liver, kidneys, lungs, heart and the brain, and can cause DNA strand breaks and chromosomal damage. Benzene causes cancer in both animals and humans. OSHA has established a PEL concentration at 1 ppm and an IDLH concentration of 500 ppm. Its LEL is 1.2 percent and it has a UEL of 7.8 percent. It is not anticipated that benzene alone is likely to collect at concentrations high enough to pose explosion or ignition hazards. Specific information from the NIOSH Pocket Guide to Chemical Hazards is included in this Appendix.

Search the NIOSH Pocket Guide

SEARCH

Enter search terms separated by spaces.

Carbon monoxide

Synonyms & Trade Names Carbon oxide, Flue gas, Monoxide

CAS No. 630-08-0	RTECS No. FG3500000 (/niosh-rtecs/FG3567E0.html)	DOT ID & Guide 1016 119 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide119/) (http://www.cdc.gov/Other/disclaimer.html) 9202 168 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide168/) (http://www.cdc.gov/Other/disclaimer.html) (cryogenic liquid)
Formula CO	Conversion 1 ppm = 1.15 mg/m ³	IDLH 1200 ppm See: 630080 (/niosh/idlh/630080.html)
Exposure Limits NIOSH REL : TWA 35 ppm (40 mg/m ³) C 200 ppm (229 mg/m ³) OSHA PEL † (nengapdxg.html) : TWA 50 ppm (55 mg/m ³)		Measurement Methods NIOSH 6604 (/niosh/docs/2003-154/pdfs/6604.pdf) ; OSHA ID209 (http://www.osha.gov/dts/sltc/methods/inorganic/id209/id209.html) (http://www.cdc.gov/Other/disclaimer.html) , ID210 (http://www.osha.gov/dts/sltc/methods/inorganic/id210/id210.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)

Physical Description Colorless, odorless gas. [Note: Shipped as a nonliquefied or liquefied compressed gas.]

MW: 28.0	BP: -313°F	MLT: -337°F	Sol: 2%	VP: >35 atm	IP: 14.01 eV
	FLP: NA (Gas)	UEL: 74%	LEL: 12.5%	RGasD: 0.97	

Flammable Gas

Incompatibilities & Reactivities Strong oxidizers, bromine trifluoride, chlorine trifluoride, lithium**Exposure Routes** inhalation, skin and/or eye contact (liquid)**Symptoms** headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope**Target Organs** cardiovascular system, lungs, blood, central nervous system

Personal Protection/Sanitation (See protection codes (protect.html)) Skin: Frostbite Eyes: Frostbite Wash skin: No recommendation Remove: When wet (flammable) Change: No recommendation Provide: Frostbite wash	First Aid (See procedures (firstaid.html)) Eye: Frostbite Skin: Frostbite Breathing: Respiratory support
---	--

Respirator Recommendations**NIOSH****Up to 350 ppm:**

(APF = 10) Any supplied-air respirator

Up to 875 ppm:

(APF = 25) Any supplied-air respirator operated in a continuous-flow mode

Up to 1200 ppm:

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern†

(APF = 50) Any self-contained breathing apparatus with a full facepiece

(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern†

Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection ([pgintrod.html#mustread](#))See also: **INTRODUCTION** ([/niosh/npg/pgintrod.html](#)). See **ICSC CARD:** 0023 ([/niosh/ipcsneng/neng0023.html](#)). See **MEDICAL TESTS:** 0040 ([/niosh/docs/2005-110/nmed0040.html](#))



Search the NIOSH Pocket Guide

SEARCH

Enter search terms separated by spaces.

Carbon dioxide

Synonyms & Trade Names Carbonic acid gas, Dry ice [Note: Normal constituent of air (about 300 ppm)].

CAS No. 124-38-9	RTECS No. FF6400000 (/niosh-rtecs/FF61A800.html)	DOT ID & Guide 1013 120 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide120/) Ⓞ (http://www.cdc.gov/Other/disclaimer.html) 1845 120 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide120/) Ⓞ (http://www.cdc.gov/Other/disclaimer.html) (dry ice) 2187 120 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide120/) Ⓞ (http://www.cdc.gov/Other/disclaimer.html) (liquid)
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Formula CO ₂	Conversion 1 ppm = 1.80 mg/m ³	IDLH 40,000 ppm See: 124389 (/niosh/idlh/124389.html)
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Exposure Limits NIOSH REL : TWA 5000 ppm (9000 mg/m ³) ST 30,000 ppm (54,000 mg/m ³) OSHA PEL † (nengapdxg.html) : TWA 5000 ppm (9000 mg/m ³)	Measurement Methods NIOSH 6603 Ⓞ (/niosh/docs/2003-154/pdfs/6603.pdf) ; OSHA ID172 (http://www.osha.gov/dts/sltc/methods/inorganic/id172/id172.html) Ⓞ (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) Ⓞ (http://www.cdc.gov/Other/disclaimer.html)
--	--

Physical Description Colorless, odorless gas. [Note: Shipped as a liquefied compressed gas. Solid form is utilized as dry ice.]

MW: 44.0	BP: Sublimes	MLT: -109°F (Sublimes)	Sol(77°F): 0.2%	VP: 56.5 atm	IP: 13.77 eV
	FLP: NA	UEL: NA	LEL: NA	RGasD: 1.53	

Nonflammable Gas

Incompatibilities & Reactivities Dusts of various metals, such as magnesium, zirconium, titanium, aluminum, chromium & manganese are ignitable and explosive when suspended in carbon dioxide. Forms carbonic acid in water.

Exposure Routes inhalation, skin and/or eye contact (liquid/solid)

Symptoms headache, dizziness, restlessness, paresthesia; dyspnea (breathing difficulty); sweating, malaise (vague feeling of discomfort); increased heart rate, cardiac output, blood pressure; coma; asphyxia; convulsions; frostbite (liquid, dry ice)

Target Organs respiratory system, cardiovascular system

Personal Protection/Sanitization (See protection codes (protect.html)) Skin: Frostbite Eyes: Frostbite Wash skin: No recommendation Remove: No recommendation Change: No recommendation Provide: Frostbite wash	First Aid (See procedures (firstaid.html)) Eye: Frostbite Skin: Frostbite Breathing: Respiratory support
--	--

Respirator Recommendations
NIOSH/OSHA
Up to 40000 ppm:
(APF = 10) Any supplied-air respirator
(APF = 50) Any self-contained breathing apparatus with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection ([pgintrod.html#mustread](http://www.cdc.gov/niosh/npg/pgintrod.html#mustread))

See also: [INTRODUCTION \(/niosh/npg/pgintrod.html\)](http://www.niosh.gov/npg/pgintrod.html). See ICSC CARD: [0021 \(/niosh/ipcsneng/neng0021.html\)](http://www.niosh.gov/ipcsneng/neng0021.html)

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Hydrogen sulfide					
Synonyms & Trade Names Hydrosulfuric acid, Sewer gas, Sulfuretted hydrogen					
CAS No. 7783-06-4	RTECS No. MX1225000 (/niosh-rtecs/MX1225000.html)		DOT ID & Guide 1053 117 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide117/) ☒ (http://www.cdc.gov/Other/disclaimer.html)		
Formula H ₂ S	Conversion 1 ppm = 1.40 mg/m ³		IDLH 100 ppm See: 7783064 (/niosh/IDLH/7783064.html)		
Exposure Limits NIOSH REL : C 10 ppm (15 mg/m ³) [10-minute] OSHA PEL † (nengapdxg.html) : C 20 ppm 50 ppm [10-minute maximum peak]			Measurement Methods NIOSH 6013 ☒ (/niosh/docs/2003-154/pdfs/6013.pdf) ; OSHA ID141 (http://www.osha-slc.com/methods/inorganic/id141/id141.html) ☒ (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha-slc.com/methods/index.html) ☒ (http://www.cdc.gov/Other/disclaimer.html)		
Physical Description Colorless gas with a strong odor of rotten eggs. [Note: Sense of smell becomes rapidly fatigued & can NOT be relied upon to warn of the continuous presence of H ₂ S. Shipped as a liquefied compressed gas.]					
MW: 34.1	BP: -77°F	FRZ: -122°F	Sol: 0.4%	VP: 17.6 atm	IP: 10.46 eV
	FLP: NA (Gas)	UEL: 44.0%	LEL: 4.0%	RGasD: 1.19	
Flammable Gas					
Incompatibilities & Reactivities Strong oxidizers, strong nitric acid, metals					
Exposure Routes inhalation, skin and/or eye contact					
Symptoms irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite					
Target Organs Eyes, respiratory system, central nervous system					
Personal Protection/Sanitation (See protection codes (protect.html)) Skin: Frostbite Eyes: Frostbite Wash skin: No recommendation Remove: When wet (flammable) Change: No recommendation Provide: Frostbite wash			First Aid (See procedures (firstaid.html)) Eye: Frostbite Skin: Frostbite Breathing: Respiratory support		
Respirator Recommendations NIOSH Up to 100 ppm: (APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern (APF = 10) Any supplied-air respirator* (APF = 50) Any self-contained breathing apparatus with a full facepiece Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection (pgintrod.html#mustread)					
See also: INTRODUCTION (/niosh/npg/pgintrod.html) . See ICSC CARD: 0165 (/niosh/ipcsneng/neng0165.html)					

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Ammonia

Synonyms & Trade Names Anhydrous ammonia, Aqua ammonia, Aqueous ammonia [Note: Often used in an aqueous solution.]

CAS No. 7664-41-7	RETECS No. BO0875000 (/niosh-retecs/BOD59F8.html)	DOT ID & Guide 1005 125 (http://www.wapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide125/) http://www.cdc.gov/Other/disclaimer.html (anhydrous) 2672 154 (http://www.wapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide154/) http://www.cdc.gov/Other/disclaimer.html (10-35% solution) 2073 125 (http://www.wapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide125/) http://www.cdc.gov/Other/disclaimer.html (>35-50% solution) 1005 125 (http://www.wapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide125/) http://www.cdc.gov/Other/disclaimer.html (>50% solution)
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Formula NH ₃	Conversion 1 ppm = 0.70 mg/m ³	IDLH 300 ppm See: 7664417 (/niosh/idlh/7664417.html)
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Exposure Limits NIOSH REL : TWA 25 ppm (18 mg/m ³) ST 35 ppm (27 mg/m ³) OSHA PEL † (nengapdxg.html): TWA 50 ppm (35 mg/m ³)	Measurement Methods NIOSH 3800 (/niosh/docs/2003-154/pdfs/3800.pdf), 6015 (/niosh/docs/2003-154/pdfs/6015.pdf), 6016 (/niosh/docs/2003-154/pdfs/6016.pdf); OSHA ID188 (http://www.osha.gov/dts/sltc/methods/inorganic/id188/id188.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) http://www.cdc.gov/Other/disclaimer.html
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Physical Description Colorless gas with a pungent, suffocating odor. [Note: Shipped as a liquefied compressed gas. Easily liquefied under pressure.]

MW: 17.0	BP: -28°F	FRZ: -108°F	Sol: 34%	VP: 8.5 atm	IP: 10.18 eV
	FLP: NA (Gas)	UEL: 28%	LEL: 15%	RGasD: 0.60	

[Note: Although NH₃ does not meet the DOT definition of a Flammable Gas (for labeling purposes), it should be treated as one.]

Incompatibilities & Reactivities Strong oxidizers, acids, halogens, salts of silver & zinc [Note: Corrosive to copper & galvanized surfaces.]

Exposure Routes inhalation, ingestion (solution), skin and/or eye contact (solution/liquid)

Symptoms irritation eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite

Target Organs Eyes, skin, respiratory system

Personal Protection/Sanitation (See protection codes (protect.html)) Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated (solution) Remove: When wet or contaminated (solution) Change: No recommendation Provide: Eyewash (>10%), Quick drench (>10%)	First Aid (See procedures (firstaid.html)) Eye: Irrigate immediately (solution/liquid) Skin: Water flush immediately (solution/liquid) Breathing: Respiratory support Swallow: Medical attention immediately (solution)
---	---

Respirator Recommendations**NIOSH****Up to 250 ppm:**

(APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern*
 (APF = 10) Any supplied-air respirator*

Up to 300 ppm:

(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
 (APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern*
 (APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern
 (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern
 (APF = 50) Any self-contained breathing apparatus with a full facepiece
 (APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
 (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern
 Any appropriate escape-type, self-contained breathing apparatus

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Benzene					
Synonyms & Trade Names Benzol, Phenyl hydride					
CAS No. 71-43-2	RTECS No. CY1400000 (/niosh-rtecs/CY155CCO.html)		DOT ID & Guide 1114 130 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide130/) Ⓕ		
Formula C ₆ H ₆	Conversion 1 ppm = 3.19 mg/m ³		IDLH Ca [500 ppm] See: 71432 (/niosh/idlh/71432.html)		
Exposure Limits NIOSH REL : Ca TWA 0.1 ppm ST 1 ppm See Appendix A (nengapdx.html) OSHA PEL : [1910.1028] TWA 1 ppm ST 5 ppm See Appendix F (nengapdx.html)			Measurement Methods NIOSH 1500 Ⓕ (/niosh/docs/2003-154/pdfs/1500.pdf), 1501 Ⓕ (/niosh/docs/2003-154/pdfs/1501.pdf), 3700 Ⓕ (/niosh/docs/2003-154/pdfs/3700.pdf), 3800 Ⓕ (/niosh/docs/2003-154/pdfs/3800.pdf); OSHA 12 (http://www.osha.gov/dts/sltc/methods/organic/org012/org012.html) Ⓕ (http://www.cdc.gov/Other/disclaimer.html), 1005 (http://www.osha.gov/dts/sltc/methods/validated/1005/1005.html) Ⓕ (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) Ⓕ (http://www.cdc.gov/Other/disclaimer.html)		
Physical Description Colorless to light-yellow liquid with an aromatic odor. [Note: A solid below 42°F.]					
MW: 78.1	BP: 176°F	FRZ: 42°F	Sol: 0.07%	VP: 75 mmHg	IP: 9.24 eV
Sp.Gr: 0.88	FLP: 12°F	UEL: 7.8%	LEL: 1.2%		
Class IB Flammable Liquid: FLP. below 73°F and BP at or above 100°F.					
Incompatibilities & Reactivities Strong oxidizers, many fluorides & perchlorates, nitric acid					
Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact					
Symptoms irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]					
Target Organs Eyes, skin, respiratory system, blood, central nervous system, bone marrow					
Cancer Site [leukemia]					
Personal Protection/Sanitation (See protection codes (protect.html)) Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet (flammable) Change: No recommendation Provide: Eyewash, Quick drench			First Aid (See procedures (firstaid.html)) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately		
Respirator Recommendations (See Appendix E (nengapdx.html))					
NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection (pgintrod.html#mustread)					
See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0015 (/niosh/ipcsneng/neng0015.html) See MEDICAL TESTS: 0022 (/niosh/docs/2005-110/nmed0022.html)					

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Centers for Disease Control and Prevention 1600 Clifton Road Atlanta, GA 30329-4027, USA
 800-CDC-INFO (800-232-4636) TTY: (888) 232-6348 - [Contact CDC-INFO](#)



Polycyclic Aromatic Hydrocarbons (PAHs)/Semi-Volatile Organics (SVOCs)

ROUTES OF ENTRY

Ingestion, inhalation of vapor or dust, skin absorption, skin or eye contact.

HARMFUL EFFECTS

PAHs are mixtures of semi-volatile organic compounds such as acenaphthene, benzo(a)pyrene, chrysene, and naphthalene. Specific information for individual PAH compounds can be found under the name of the individual PAH.

Local Effects:

Contact with some PAH compounds can cause irritation to skin, eyes, and mucous membranes. Chapping or burning of the skin and/or photosensitivity may occur after repeated contact. Exposure to large quantities of some PAH compounds can cause headaches, nausea, and vomiting. When heated to decomposition, some PAH compounds can emit irritating fumes and acrid smoke.

Systemic Effects:

Some individual compounds present in TPH act as central nervous system depressants. Some individual PAH compounds are known mutagens and/or carcinogens.

U.S. EPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.

(<http://www.epa.gov/ttn/atw/hlthef/polycycl.html>)

POINTS OF ATTACK

Liver, kidney, respiratory system, central nervous system, eyes, and skin.

PERMISSIBLE EXPOSURE LIMIT (PEL)

0.1 milligrams per cubic meter (mg/m^3) for a 10-hour workday, 40-hour workweek, for Coal Tar Pitch PAHs (NIOSH).

0.2 mg/m^3 for all PAHs (OSHA).

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Arsenic (inorganic compounds, as As)

Synonyms & Trade Names Arsenic metal; Arsenia

Other synonyms vary depending upon the specific As compound. [Note: OSHA considers "Inorganic Arsenic" to mean copper acetoarsenite and all inorganic compounds containing arsenic except ARSINE.]

CAS No. 7440-38-2
 (metal)

RTECS No. CG0525000 (metal)
 (/niosh-rtcs/CG802C8.html)

DOT ID & Guide 1558 152 (<http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide152/>)
 (metal)
 1562 152 (<http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide152/>)
 (dust)
Formula As (metal)**Conversion**
IDLH Ca [5 mg/m³ (as As)]
 See: 7440382 (/niosh/idlh/7440382.html)

Exposure Limits **NIOSH REL** : Ca C 0.002 mg/m³
 [15-minute] See [Appendix A \(nengapdx.html\)](#)
OSHA PEL : [1910.1018] TWA 0.010 mg/m³
Measurement Methods
NIOSH 7300 (</niosh/docs/2003-154/pdfs/7300.pdf>), **7301** (</niosh/docs/2003-154/pdfs/7301.pdf>), **7303** (</niosh/docs/2003-154/pdfs/7303.pdf>), **7900** (</niosh/docs/2003-154/pdfs/7900.pdf>), **9102** (</niosh/docs/2003-154/pdfs/9102.pdf>);

OSHA ID105 (<http://www.osha.gov/dts/sltc/methods/inorganic/id105/id105.html>)
 (http://www.cdc.gov/Other/disclaimer.html)
 See: **NMAM** (/niosh/docs/2003-154/) or **OSHA Methods** (<http://www.osha.gov/dts/sltc/methods/index.html>)
 (http://www.cdc.gov/Other/disclaimer.html)
Physical Description Metal: Silver-gray or tin-white, brittle, odorless solid.**MW:** 74.9**BP:**
Sublimes**MLT:** 1135°F
(Sublimes)**Sol:** Insoluble**VP:** 0 mmHg (approx)**IP:** NA**Sp.Gr:** 5.73
(metal)**FLP:** NA**UEL:** NA**LEL:** NA

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame.

Incompatibilities & Reactivities Strong oxidizers, bromine azide [Note: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.]**Exposure Routes** inhalation, skin absorption, skin and/or eye contact, ingestion**Symptoms** Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, resp irritation, hyperpigmentation of skin, [potential occupational carcinogen]**Target Organs** Liver, kidneys, skin, lungs, lymphatic system**Cancer Site** [lung & lymphatic cancer]**Personal Protection/Sanitation** (See [protection codes \(protect.html\)](#))**Skin:** Prevent skin contact**Eyes:** Prevent eye contact**Wash skin:** When contaminated/Daily**Remove:** When wet or contaminated**Change:** Daily**Provide:** Eyewash, Quick drench**First Aid** (See [procedures \(firstaid.html\)](#))**Eye:** Irrigate immediately**Skin:** Soap wash immediately**Breathing:** Respiratory support**Swallow:** Medical attention immediately**Respirator Recommendations**(See [Appendix E \(nengapdx.html\)](#))**NIOSH****At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:**

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter.

[Click here \(pgintrod.html#npr\)](#) for information on selection of N, R, or P filters.

Any appropriate escape-type, self-contained breathing apparatus

[Important additional information about respirator selection \(pgintrod.html#mustread\)](#)See also: [INTRODUCTION \(/niosh/npg/pgintrod.html\)](#) See [ICSC CARD: 0013 \(/niosh/ipcseng/neng0013.html\)](#) See [MEDICAL TESTS: 0017 \(/niosh/docs/2005-110/nmed0017.html\)](#)

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Cadmium dust (as Cd)					
<p>Synonyms & Trade Names Cadmium metal; Cadmium Other synonyms vary depending upon the specific cadmium compound.</p>					
<p>CAS No. 7440-43-9 (metal)</p>	<p>RTECS No. EU9800000 (metal) (/niosh-rtecs/EU958940.html)</p>	<p>DOT ID & Guide 2570 154 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide154/) (http://www.cdc.gov/Other/disclaimer.html) (cadmium compound)</p>			
<p>Formula Cd (metal)</p>	<p>Conversion</p>	<p>IDLH Ca [9 mg/m³ (as Cd)] See: 7440439 (/niosh/idlh/7440439.html)</p>			
<p>Exposure Limits NIOSH REL *: Ca See Appendix A (nengapdx.html) [*Note: The REL applies to all Cadmium compounds (as Cd).] OSHA PEL *: [1910.1027] TWA 0.005 mg/m³ [*Note: The PEL applies to all Cadmium compounds (as Cd).]</p>		<p>Measurement Methods NIOSH 7048 (/niosh/docs/2003-154/pdfs/7048.pdf), 7300 (/niosh/docs/2003-154/pdfs/7300.pdf), 7301 (/niosh/docs/2003-154/pdfs/7301.pdf), 7303 (/niosh/docs/2003-154/pdfs/7303.pdf), 9102 (/niosh/docs/2003-154/pdfs/9102.pdf); OSHA ID121 (http://www.osha.gov/dts/sltc/methods/inorganic/id121/id121.html) (http://www.cdc.gov/Other/disclaimer.html), ID125G (http://www.osha.gov/dts/sltc/methods/inorganic/id125g/id125g.html) (http://www.cdc.gov/Other/disclaimer.html), ID189 (http://www.osha.gov/dts/sltc/methods/inorganic/id189/id189.html) (http://www.cdc.gov/Other/disclaimer.html), ID206 (http://www.osha.gov/dts/sltc/methods/inorganic/id206/id206.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)</p>			
<p>Physical Description Metal: Silver-white, blue-tinged lustrous, odorless solid.</p>					
<p>MW: 112.4</p>	<p>BP: 1409°F</p>	<p>MLT: 610°F</p>	<p>Sol: Insoluble</p>	<p>VP: 0 mmHg (approx)</p>	<p>IP: NA</p>
<p>Sp.Gr: 8.65 (metal)</p>	<p>FLP: NA</p>	<p>UEL: NA</p>	<p>LEL: NA</p>		
<p>Metal: Noncombustible Solid in bulk form, but will burn in powder form.</p>					
<p>Incompatibilities & Reactivities Strong oxidizers; elemental sulfur, selenium & tellurium</p>					
<p>Exposure Routes inhalation, ingestion</p>					
<p>Symptoms pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen]</p>					
<p>Target Organs respiratory system, kidneys, prostate, blood</p>					
<p>Cancer Site [prostatic & lung cancer]</p>					
<p>Personal Protection/Sanitization (See protection codes (protect.html)) Skin: No recommendation Eyes: No recommendation Wash skin: Daily Remove: No recommendation Change: Daily</p>			<p>First Aid (See procedures (firstaid.html)) Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately</p>		
<p>Respirator Recommendations (See Appendix E (nengapdx.html)) NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters. Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection (pgintrod.html#mustread)</p>					
<p>See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0020 (/niosh/ipcsneng/neng0020.html) See MEDICAL TESTS: 0035 (/niosh/docs/2005-110/nmed0035.html)</p>					

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SEARCH

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Copper (dusts and mists, as Cu)					
Synonyms & Trade Names Copper metal dusts, Copper metal fumes					
CAS No. 7440-50-8	RTECS No. GL5325000 (/niosh-rtecs/GL5140C8.html)		DOT ID & Guide		
Formula Cu	Conversion		IDLH 100 mg/m ³ (as Cu) See: 7440508 (/niosh/idlh/7440508.html)		
Exposure Limits NIOSH REL *: TWA 1 mg/m ³ [*Note: The REL also applies to other copper compounds (as Cu) except Copper fume.] OSHA PEL *: TWA 1 mg/m ³ [*Note: The PEL also applies to other copper compounds (as Cu) except copper fume.]			Measurement Methods NIOSH 7029  (/niosh/docs/2003-154/pdfs/7029.pdf) , 7300  (/niosh/docs/2003-154/pdfs/7300.pdf) , 7301  (/niosh/docs/2003-154/pdfs/7301.pdf) , 7303  (/niosh/docs/2003-154/pdfs/7303.pdf) , 9102  (/niosh/docs/2003-154/pdfs/9102.pdf) ; OSHA ID121 (http://www.osha.gov/dts/sltc/methods/inorganic/id121/id121.html)  (http://www.cdc.gov/Other/disclaimer.html), ID125G (http://www.osha.gov/dts/sltc/methods/inorganic/id125g/id125g.html)  (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html)  (http://www.cdc.gov/Other/disclaimer.html)		
Physical Description Reddish, lustrous, malleable, odorless solid.					
MW: 63.5	BP: 4703°F	MLT: 1981°F	Sol: Insoluble	VP: 0 mmHg (approx)	IP: NA
Sp.Gr: 8.94	FLP: NA	UEL: NA	LEL: NA		
Noncombustible Solid in bulk form, but powdered form may ignite.					
Incompatibilities & Reactivities Oxidizers, alkalis, sodium azide, acetylene					
Exposure Routes inhalation, ingestion, skin and/or eye contact					
Symptoms irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; in animals: lung, liver, kidney damage; anemia					
Target Organs Eyes, skin, respiratory system, liver, kidneys (increased risk with Wilson's disease)					
Personal Protection/Sanitation (See protection codes (protect.html)) Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: Daily			First Aid (See procedures (firstaid.html)) Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately		
Respirator Recommendations NIOSH/OSHA Up to 5 mg/m³: (APF = 5) Any quarter-mask respirator. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters.* Up to 10 mg/m³: (APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters.* (APF = 10) Any supplied-air respirator* Up to 25 mg/m³: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode* (APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter.* Up to 50 mg/m³: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters. (APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter* (APF = 50) Any self-contained breathing apparatus with a full facepiece (APF = 50) Any supplied-air respirator with a full facepiece Up to 100 mg/m³: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters. Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection (pgintrod.html#mustread)					
See also: INTRODUCTION (/niosh/npg/pgintrod.html) . See ICSC CARD: 0240 (/niosh/ipcsneng/neng0240.html) . See MEDICAL TESTS: 0057 (/niosh/docs/2005-110/nmed0057.html)					

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Lead					
Synonyms & Trade Names Lead metal, Plumbum					
CAS No. 7439-92-1	RTECS No. OF7525000 (/niosh-rtecs/OF72D288.html)		DOT ID & Guide		
Formula Pb	Conversion		IDLH 100 mg/m ³ (as Pb) See: 7439921 (/niosh/idlh/7439921.html)		
Exposure Limits NIOSH REL *: TWA (8-hour) 0.050 mg/m ³ See Appendix C (nengapdx.html) [*Note: The REL also applies to other lead compounds (as Pb) -- see Appendix C.] OSHA PEL *: [I910.1025] TWA 0.050 mg/m ³ See Appendix C (nengapdx.html) [*Note: The PEL also applies to other lead compounds (as Pb) -- see Appendix C.]			Measurement Methods NIOSH 7082 (/niosh/docs/2003-154/pdfs/7082.pdf) , 7105 (/niosh/docs/2003-154/pdfs/7105.pdf) , 7300 (/niosh/docs/2003-154/pdfs/7300.pdf) , 7301 (/niosh/docs/2003-154/pdfs/7301.pdf) , 7303 (/niosh/docs/2003-154/pdfs/7303.pdf) , 7700 (/niosh/docs/2003-154/pdfs/7700.pdf) , 7701 (/niosh/docs/2003-154/pdfs/7701.pdf) , 7702 (/niosh/docs/2003-154/pdfs/7702.pdf) , 9100 (/niosh/docs/2003-154/pdfs/9100.pdf) , 9102 (/niosh/docs/2003-154/pdfs/9102.pdf) , 9105 (/niosh/docs/2003-154/pdfs/9105.pdf) ; OSHA ID121 (http://www.osha.gov/dts/sltc/methods/inorganic/id121/id121.html) (http://www.cdc.gov/Other/disclaimer.html) , ID125G (http://www.osha.gov/dts/sltc/methods/inorganic/id125g/id125g.html) (http://www.cdc.gov/Other/disclaimer.html) , ID206 (http://www.osha.gov/dts/sltc/methods/inorganic/id206/id206.html) (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) (http://www.cdc.gov/Other/disclaimer.html)		
Physical Description A heavy, ductile, soft, gray solid.					
MW: 207.2	BP: 3164°F	MLT: 621°F	Sol: Insoluble	VP: 0 mmHg (approx)	IP: NA
Sp.Gr: 11.34	FLP: NA	UEL: NA	LEL: NA		
Noncombustible Solid in bulk form.					
Incompatibilities & Reactivities Strong oxidizers, hydrogen peroxide, acids					
Exposure Routes inhalation, ingestion, skin and/or eye contact					
Symptoms lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension					
Target Organs Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue					
Personal Protection/Sanitation (See protection codes (protect.html)) Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: Daily Remove: When wet or contaminated Change: Daily			First Aid (See procedures (firstaid.html)) Eye: Irrigate immediately Skin: Soap flush promptly Breathing: Respiratory support Swallow: Medical attention immediately		
Respirator Recommendations (See Appendix E (nengapdx.html)) NIOSH/OSHA Up to 0.5 mg/m³: (APF = 10) Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators. Click here (pgintrod.html#nrrp) for information on selection of N, R, or P filters. (APF = 10) Any supplied-air respirator Up to 1.25 mg/m³: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode (APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter. Up to 2.5 mg/m³: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here (pgintrod.html#nrrp) for information on selection of N, R, or P filters. (APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode (APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter (APF = 50) Any self-contained breathing apparatus with a full facepiece (APF = 50) Any supplied-air respirator with a full facepiece Up to 50 mg/m³: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode Up to 100 mg/m³: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here (pgintrod.html#nrrp) for information on selection of N, R, or P filters. Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection (pgintrod.html#mustread)					
See also: INTRODUCTION (/niosh/npg/pgintrod.html) See ICSC CARD: 0052 (/niosh/ipcsneng/neng0052.html) See MEDICAL TESTS: 0127 (/niosh/docs/2005-110/nmed0127.html)					

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Manganese compounds and fume (as Mn)

Synonyms & Trade Names Manganese metal; Colloidal manganese, Manganese-55
 Synonyms of other compounds vary depending upon the specific manganese compound.

CAS No. 7439-96-5 (metal)	RTCS No. OO9275000 (metal)	DOT ID & Guide
Formula Mn (metal)	Conversion	IDLH 500 mg/m ³ (as Mn) See: 7439965

Exposure Limits **NIOSH REL** *: TWA 1 mg/m³ ST 3 mg/m³ [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl, Methyl cyclopentadienyl manganese tricarbonyl, and Manganese tetroxide.]
OSHA PEL *: C 5 mg/m³ [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl and Methyl cyclopentadienyl manganese tricarbonyl.]

Measurement Methods
NIOSH 7300 [\(/niosh/docs/2003-154/pdfs/7300.pdf\)](/niosh/docs/2003-154/pdfs/7300.pdf), **7301** [\(/niosh/docs/2003-154/pdfs/7301.pdf\)](/niosh/docs/2003-154/pdfs/7301.pdf), **7303** [\(/niosh/docs/2003-154/pdfs/7303.pdf\)](/niosh/docs/2003-154/pdfs/7303.pdf), **9102** [\(/niosh/docs/2003-154/pdfs/9102.pdf\)](/niosh/docs/2003-154/pdfs/9102.pdf);
OSHA ID121 (<http://www.osha.gov/dts/sltc/methods/inorganic/id121/id121.html>) [\(/http://www.cdc.gov/Other/disclaimer.html\)](http://www.cdc.gov/Other/disclaimer.html), **ID125G** (<http://www.osha.gov/dts/sltc/methods/inorganic/id125g/id125g.html>) [\(/http://www.cdc.gov/Other/disclaimer.html\)](http://www.cdc.gov/Other/disclaimer.html)
 See: **NMAM** (</niosh/docs/2003-154/>) or **OSHA Methods** (<http://www.osha.gov/dts/sltc/methods/index.html>) [\(/http://www.cdc.gov/Other/disclaimer.html\)](http://www.cdc.gov/Other/disclaimer.html)

Physical Description A lustrous, brittle, silvery solid.

MW: 54.9	BP: 3564°F	MLT: 2271°F	Sol: Insoluble	VP: 0 mmHg (approx)	IP: NA
Sp.Gr: 7.20 (metal)	FLP: NA	UEL: NA	LEL: NA		

Metal: Combustible Solid

Incompatibilities & Reactivities Oxidizers [Note: Will react with water or steam to produce hydrogen.]

Exposure Routes inhalation, ingestion

Symptoms Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage

Target Organs respiratory system, central nervous system, blood, kidneys

Personal Protection/Sanitization (See [protection codes \(protect.html\)](http://www.cdc.gov/niosh/npg/protect.html))

Skin: No recommendation
Eyes: No recommendation
Wash skin: No recommendation
Remove: No recommendation
Change: No recommendation

First Aid (See [procedures \(firstaid.html\)](http://www.cdc.gov/niosh/npg/firstaid.html))

Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations

NIOSH

Up to 10 mg/m³:

(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100.

[Click here \(pgintrod.html#npr\)](http://www.cdc.gov/niosh/npg/pgintrod.html#npr) for information on selection of N, R, or P filters.

(APF = 10) Any supplied-air respirator

Up to 25 mg/m³:

(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
 (APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter.

Up to 50 mg/m³:

(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter.

[Click here \(pgintrod.html#npr\)](http://www.cdc.gov/niosh/npg/pgintrod.html#npr) for information on selection of N, R, or P filters.

(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
 (APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
 (APF = 50) Any self-contained breathing apparatus with a full facepiece
 (APF = 50) Any supplied-air respirator with a full facepiece

Up to 500 mg/m³:

(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:

(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter.

[Click here \(pgintrod.html#npr\)](http://www.cdc.gov/niosh/npg/pgintrod.html#npr) for information on selection of N, R, or P filters.

Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection ([pgintrod.html#mustread](http://www.cdc.gov/niosh/npg/pgintrod.html#mustread))

See also: [INTRODUCTION \(/niosh/npg/pgintrod.html\)](/niosh/npg/pgintrod.html). See ICSC CARD: [0174 \(/niosh/ipcsneng/neng0174.html\)](/niosh/ipcsneng/neng0174.html). See MEDICAL TESTS: [0131 \(/niosh/docs/2005-110/nmed0131.html\)](/niosh/docs/2005-110/nmed0131.html)

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Zinc oxide					
Synonyms & Trade Names Zinc peroxide					
CAS No. 1314-13-2	RTECS No. ZH4810000 (/niosh-rtecs/ZH496510.html)		DOT ID & Guide 1516 143 (http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/guidepage.aspx/guide143/) ☞ (http://www.cdc.gov/Other/disclaimer.html)		
Formula ZnO	Conversion		IDLH 500 mg/m ³ See: 1314132 (/niosh/idlh/1314132.html)		
Exposure Limits NIOSH REL : Dust: TWA 5 mg/m ³ C 15 mg/m ³ Fume: TWA 5 mg/m ³ ST 10 mg/m ³ OSHA PEL: T (nengapdxg.html) : TWA 5 mg/m ³ (fume) TWA 15 mg/m ³ (total dust) TWA 5 mg/m ³ (resp dust)			Measurement Methods NIOSH 7303 ☞ (/niosh/docs/2003-154/pdfs/7303.pdf) , 7502 ☞ (/niosh/docs/2003-154/pdfs/7502.pdf) ; OSHA ID121 (http://www.osha.gov/dts/sltc/methods/inorganic/id121/id121.html) ☞ (http://www.cdc.gov/Other/disclaimer.html) , ID143 (http://www.osha.gov/dts/sltc/methods/inorganic/id143/id143.html) ☞ (http://www.cdc.gov/Other/disclaimer.html) See: NMAM (/niosh/docs/2003-154/) or OSHA Methods (http://www.osha.gov/dts/sltc/methods/index.html) ☞ (http://www.cdc.gov/Other/disclaimer.html)		
Physical Description White, odorless solid.					
MW: 81.4	BP: ?	MLT: 3587°F	Sol(64°F): 0.0004%	VP: 0 mmHg (approx)	IP: NA
Sp.Gr: 5.61	FLP: NA	UEL: NA	LEL: NA		
Noncombustible Solid					
Incompatibilities & Reactivities Chlorinated rubber (at 419°F), water [Note: Slowly decomposed by water.]					
Exposure Routes inhalation					
Symptoms Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough; lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; malaise (vague feeling of discomfort); chest tightness; dyspnea (breathing difficulty), rales, decreased pulmonary function					
Target Organs respiratory system					
Personal Protection/Sanitation (See protection codes (protect.html)) Skin: No recommendation Eyes: No recommendation Wash skin: No recommendation Remove: No recommendation Change: No recommendation			First Aid (See procedures (firstaid.html)) Breathing: Respiratory support		
Respirator Recommendations NIOSH/OSHA Up to 50 mg/m³: (APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters. (APF = 10) Any supplied-air respirator Up to 125 mg/m³: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode (APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter. Up to 250 mg/m³: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters. (APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode (APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter (APF = 50) Any self-contained breathing apparatus with a full facepiece (APF = 50) Any supplied-air respirator with a full facepiece Up to 500 mg/m³: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here (pgintrod.html#nrp) for information on selection of N, R, or P filters. Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection (pgintrod.html#mustread)					
See also: INTRODUCTION (/niosh/npg/pgintrod.html) . See ICSC CARD: 0208 (/niosh/ipcseng/neng0208.html) . See MEDICAL TESTS: 0246 (/niosh/docs/2005-110/nmed0246.html)					

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