UTILITY AIRSPADE®

PNEUMATIC SOIL EXCAVATION

Technical Applications Bulletin

Use of Compressed Air-Powered Excavation for Utility/Construction Work

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drawings by
STIMSON

published by
AIRSPADE®
PNEUMATIC SOIL EXCAVATION
Division of Guardair Corporation

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With illustrations and standard construction
detail drawings by STIMSON available online at
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INTRODUCTION

THE CASE FOR SOFT EXCAVATION

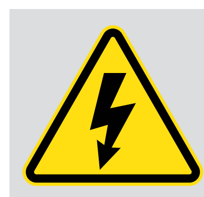
When it comes to underground utility lines, what you can't see can hurt you. The Common Ground Alliance (CGA), an association that promotes efforts to reduce damage to underground infrastructure, estimates there are over 20 million miles of gas, electric, water, sewer and telecommunication lines buried in the United States. That's the equivalent of more than one football field length of buried utilities for every man, woman, and child in the nation.

Digging without knowing the location of underground utilities can lead to injuries and fatalities, property damage, service disruptions and costly repairs. Consequently, utility companies and contractors go to great lengths to ensure employees are taking necessary safety precautions when working around underground utility infrastructure. Still, incidents continue to occur. According to the U.S. Department of Transportation, 1,815 pipeline incidents were caused by excavation damage between 1988 and 2014. These incidents resulted in 193 deaths, 757 injuries and nearly $545 million in property damage.

Among the incidents involving underground utility strikes in recent years:

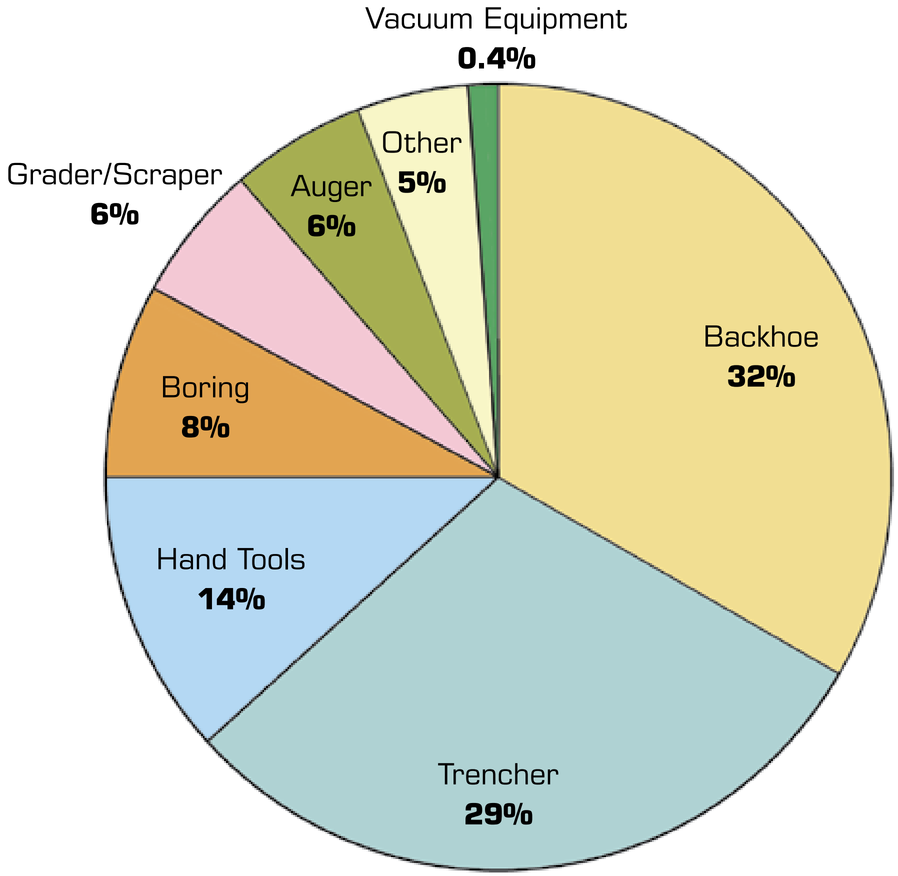
On June 7, 2010, a truck-mounted power auger punctured a 36-inch-diameter natural gas transmission line near Cleburne, TX. The operator was digging holes for the installation of new electric-service utility poles. The natural gas ignited, killed the auger operator and burned six workers. Total property damage and cleanup costs were estimated to be over $1 million.

On January 3, 2013, in Minneapolis, MN, workers attempting to run a sewer line struck a 36" water main with a backhoe causing 14 million gallons of water to flood the downtown area. Called Minneapolis' largest water leak in 30 years, the repair costs alone were estimated at $325,000. No doubt, the repair costs were small in comparison to the millions of dollars in water damage to adjacent businesses.

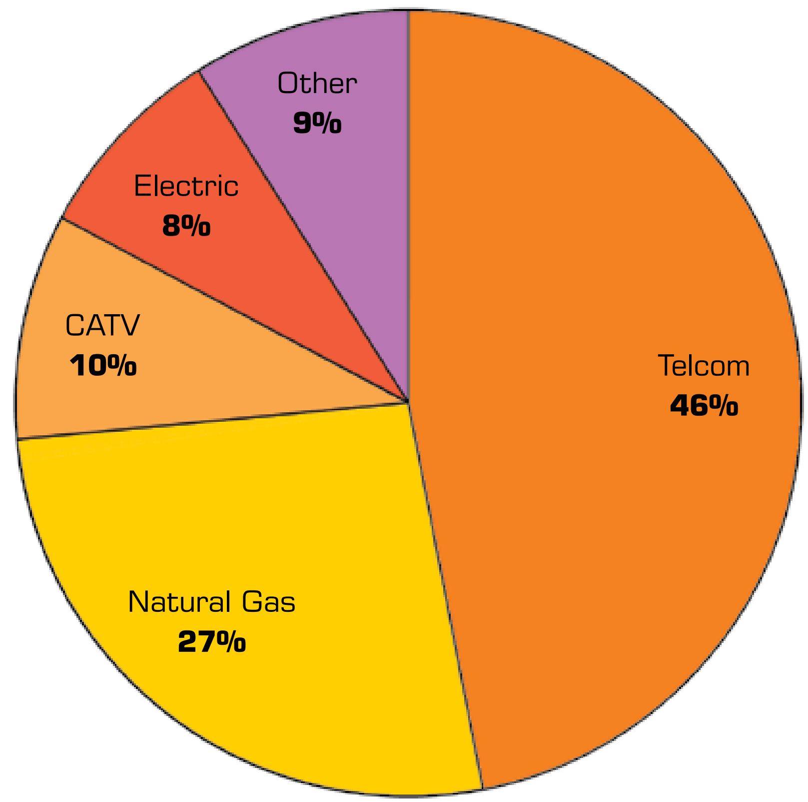


On August 20, 2014, a 38-year-old worker in Edmonds, WA, died when his jackhammer struck a 7,200-volt underground power line. On the day of the incident, the worker and two other employees were digging trenches and installing storm drains on a hospital campus. According to a news report, the incident also temporarily cut power to the hospital and some residents in the surrounding area. The Washington State Department of Labor & Industries levied over $50,000 in fines to two contractors for safety violations related to the fatal accident.

UNDERGROUND UTILITIES DAMAGE EVENTS BY EQUIPMENT 2017



UNDERGROUND UTILITIES DAMAGED 2017



While each incident has a unique set of circumstances and sequence of events, in all the above cases, hard excavation methodologies — excavation with augers, backhoes, or power tools — were used at the time of the strike. According to the CGA 2017 DIRT (Damage Information Reporting Tool) Report which collects annual data on inadvertent damage to underground utilities caused by excavation, 318,030 strikes were recorded nationwide. By an overwhelming margin, hard excavation was responsible for over 99.6% of all damage events.

By contrast, soft excavation — vacuum equipment augmented with compressed air or high-pressure water (hydro) to loosen the soil — was responsible for less than a 0.4% accident rate. While not suitable for all projects, soft excavation has proven by far to be the safest way to expose underground utilities. Thus, it's easy to see why many leading utilities and utility contractors are big proponents. By utilizing state-of-the-art equipment, such as vacuum equipment paired with the Utility AirSpade by Guardair Corporation, soft excavation is fast becoming a preferred methodology.

A BRIEF HISTORY

During the early 1960s, Brooklyn Union Gas Company first pioneered using a compressed air powered lance in conjunction with a vacuum truck as a better way to dig and reduce the costs associated with approximately 30,000 annual street openings for gas distribution pipe repair. Compressed air, or "dry excavation" to dig utility "potholes" proved to be a safe and reliable alternative to manual or mechanical methods of uncovering buried utility lines without damage.

Success with this methodology quickly led to the development of "small hole technology" -- now known as "keyhole technology" -- whereby repairs are made to underground facilities from the roadway surface using long-handled tools. This technology was first reported in the 1960s as utilities sought ways to reduce the size and cost of utility excavations and avoid putting "a man in the hole." Both Philadelphia Electric (PECO) and Peoples Gas of Chicago were early pioneers in developing keyhole maintenance techniques to reduce the number of large street openings that were both a nuisance to the public and costly to excavate and re-pave.

Early keyholing by PECO included repairs to leaking bell joints and cathodic protection. The pavement was cut with diamond saw blades and removed with pneumatic pavement breakers and concrete drills. A power-driven auger and air jet vacuum removed the spoils, augmented by a clam-shell post hole digger. These techniques seem rudimentary compared with today's rotary coring and vacuum excavators but resulted in substantial savings to PECO.

Over the next two decades, large dedicated vacuum excavation trucks and rotary coring devices were introduced at Southern California Edison as an alternative to traditional pavement breaking. During this same period, Dravo Corporation of Pittsburgh, PA began the development of a specialized air lance tool for excavation, later named "AirSpade". Throughout the 1980s and 1990s, AirSpade became widely accepted by other utilities including Baltimore Gas & Electric, and Pennsylvania-American Water.

In addition to uncovering utility lines, dry excavation was tested in several applications during the 1970s and 1980s. This included work with the Department of Defense to uncover landmines and unexploded ordnance, as well as "trenching" for construction. Improvements in equipment included advancements in AirSpade nozzle technology to provide faster excavation.

By the mid-1990s, dry excavation technology also became common within the arboriculture industry, as this same technology was applied to uncover sensitive tree roots without harm. As tree-service companies began to recognize the advantages of this diagnostic tool, many new, low-impact arboricultural applications were developed. Bartlett Tree Experts, the largest US tree-service company, became an early adaptor. At this same time, experiments with high-pressure water led to advancements in hydro excavation.

Typical repairs using dry and hydro excavation came to include cast iron main joint repair, sacrificial anode instillation, low-pressure service cut-offs, new service instillation, and valve box replacements. In addition to utility maintenance, these processes have direct application to other underground operations such as test holes, service drops and shallow slice pits for the telecom industry, daylighting and test holes for directional drilling, and inspection holes for pipeline integrity and Subsurface Utility Engineering (SUE).

Today, countless gas distribution companies and their contractors in North America practice keyhole technology using rotary coring, soft excavation, and core reinstatement. This process achieves average savings of almost $1,000 per repair vs. conventional methodologies. In a recent paper, the Gas Technology Institute reported that over 800,000 utility roadway cuts are made per year. Given the inherent safety and cost advantages, the use of soft excavation for trenching, potholing and keyholing is projected to grow significantly over the foreseeable future.

HIGHLIGHTING DIFFERENCES BETWEEN DRY AND HYDRO EXCAVATION

High-powered, mobile vacuum units are essential pieces of equipment for safely locating and uncovering underground utilities. Their effectiveness is greatly enhanced when operating in tandem with either compressed air, or high-pressure water — techniques known as **Dry Excavation** and **Hydro Excavation.**

In dry excavation, high-pressure compressed air delivered by a nearby air compressor, is directed at the work surface using a Utility AirSpade or equivalent tool. The compressed air agitates and loosens the soil, partially propelling it airborne. A vacuum system then sucks up the soil into a tank, where the soil is stored to be reused or transported offsite.

Hydro excavation works in a similar manner. High-pressure water, delivered by an onboard pump, is directed at the work surface where it cuts through the soil, creating a slurry. The vacuum system then sucks up the slurry into a tank where the soil is stored to be reused or transported offsite.

DRY AND HYDRO EXCAVATION APPLICATIONS

Both dry and hydro excavation have become standard operating practice for a wide array of applications including utility locating, keyholing, potholing, installing light poles, valve box cleaning, repairing water main breaks, cutting trenches for buried cable, fiber optic repair, cathodic protection for gas and water lines, and even window well installation.

Before deciding between these two techniques, understanding the underlying soil conditions is essential for selecting the proper equipment. Other factors include travel distance to the disposal site, State and local weight restrictions, excavation distance from the unit, job site requirements, and availability of water. Estimating the size of the job (volume of spoils) is also critical so that the correct-sized debris body (tank) can be employed to complete the work as efficiently as possible.

DRY EXCAVATION — ADVANTAGES

Dry excavation tends to be the preferred methodology where soils are not as compact, where water is not readily available, or where immediate backfill of the hole is required. In smaller-scale excavation projects, or when working around brittle underground utilities, this method is often preferred due to lower operating pressures.

Dry excavation allows for back-filling the hole with the same, dry excavated spoils. This eliminates the need to store and dispose a wet/muddy slurry of material generated by hydro excavation. Dry spoils can also be off-loaded on site as necessary. Backfilling excavated spoils eliminates the need to travel and pay for a dump site.

Another advantage is that limit-less quantities of compressed air can be generated on demand. Onboard compressors generate compressed air as required vs. the need to refill a water tank. Finally, when working around high voltage lines, dry excava-tion is more often the preferred choice since air is non-conductive.

HYDRO EXCAVATION – ADVANTAGES

Hydro excavation tends to be most effective with more compact soils including frozen surfaces. Onboard water heaters warm the water which aids in cutting through the soil. Water also acts as a lubricant and helps to prolong the life of vacuum equipment by reducing wear on vacuum hoses and other components in the air stream. Hydro excavation is especially useful for tank, pit, or general cleaning and does not produce the sandblasting effect common to dry excavation.

As a rule, when speed of excavation is the most important factor, hydro excavation is generally the methodology of choice.

VACUUM UNITS – A RANGE OF OPTIONS

AirVac manufactured by Guardair

Vacuum units are typically large, expensive, truck-mounted systems with the capacity to hold between 1,000 and 2,000 gallons of spoil. At the other end of the spectrum, small, cost-effective units such as the 82-gallon capacity AirVac, provide a high degree of mobility and are suited for smaller jobs. Maneuverability and small size provide an advantage on crowded job sites and where sensitive terrain might suffer damage from heavy, truck-mounted units.

Full Size Vacuum Truck

Vacuum trucks feature on-board compressed air or hydro packages that can be purchased as options. Choosing a vacuum truck featuring both capabilities significantly increases versatility and permits the contractor to deal with myriad conditions. Some utilities and State Departments of Transportation are beginning to require dry excavation for certain applications, for example where backfilling is required for Subsurface Utility Engineering (SUE) projects. On the other hand, the speed of hydro excavation is too significant to overlook for general potholing, which is why utility contractors often favor a machine with both capabilities.

OTHER CONSIDERATIONS

Contractors should choose a vacuum system to meet specific applications and achieve maximum job productivity. Options include cold weather packages with water heaters to cut through frozen ground, dual operator stations, hydraulic tool packages, off-loading and dumping capabilities, and auxiliary tool boxes. An on-board air compressor can provide a variety of uses such as powering pneumatic tools. An on-board water tank to provide fresh water at a job site, or the ability to tow an auxiliary trailer, may be other important features.

UTILITY AIRSPADE INNOVATIONS AND FEATURES

As dry excavation has grown for underground utility applications, the need for a specialized tool to meet safety and other concerns has become more acute. Given the potential hazards and costs associated with excavation of underground lines, Guardair Corporation drew upon expertise from utilities across the US to design the Utility AirSpade. Their concerns included:

- Maximizing digging efficiency of the tool
- Eliminating potential for spark-induced accidents
- Optimizing human factors and safety
- Providing protection from high voltage, underground electric lines

MAXIMIZING DIGGING EFFICIENCY

The key to maximizing digging efficiency is the design of the output nozzle. Proper nozzle design starts with an in-depth understanding of the effects of directing compressed air into soils.

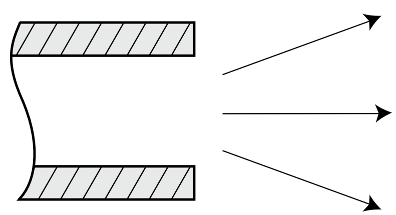
Soil is an unconsolidated assemblage of solid particles including clay, sand, silt, rock, and sometimes organic matter. Voids between the particles are occupied by air and/or water. When compressed air is directed into soil at close range, it enters the voids, expands, and fractures the soil in a fraction of a second. Non-porous materials such as metal or plastic pipes, cables, or even tree roots are unaffected.

To optimize nozzle performance, Guardair engineers recognized the importance of maximizing the exiting air speed (and subsequently the force) and tightly focusing the exiting air jet. This led to the development of the AirSpade Supersonic Nozzle, which converts compressed air into a high-speed, highly focused air jet moving at twice the speed of sound – Mach 2.

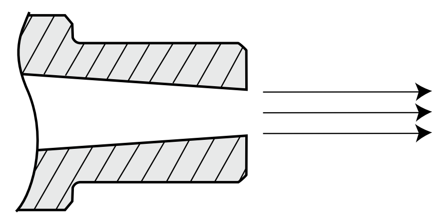
Equipped with the Supersonic Nozzle, AirSpade performs better in compact soils, provides faster excavation rates, and operates more efficiently by consuming less (expensive to produce) compressed air, thus saving time on the job site compared to other air excavation tools equipped with conventional nozzles. With a documented excavation rate of 1.0 to 1.5 cubic feet per minute (depending upon soil strength), the AirSpade is 2 to 3 times faster than hand digging and is highly effective in time-sensitive projects, while still protecting underground utility lines.

More efficient usage of compressed air also reduces air compressor operating hours. This translates directly into lower fuel costs and less wear and tear on the air compressor.

AirSpade Supersonic Nozzle: *Soil fractures from stress (force per unit area) applied to its surface. Focusing this force on a small unit area results in faster, and more efficient soil excavation. As shown in the diagrams below, air exiting from an open pipe, or from a conventional nozzle, expands rapidly outward, across 3 to 4 times the unit area, versus the focused output of the Supersonic Nozzle. In addition, open pipes or conventional nozzles operate at speeds below Mach 2. Thus, the Supersonic Nozzle outperforms these by a wide margin.*

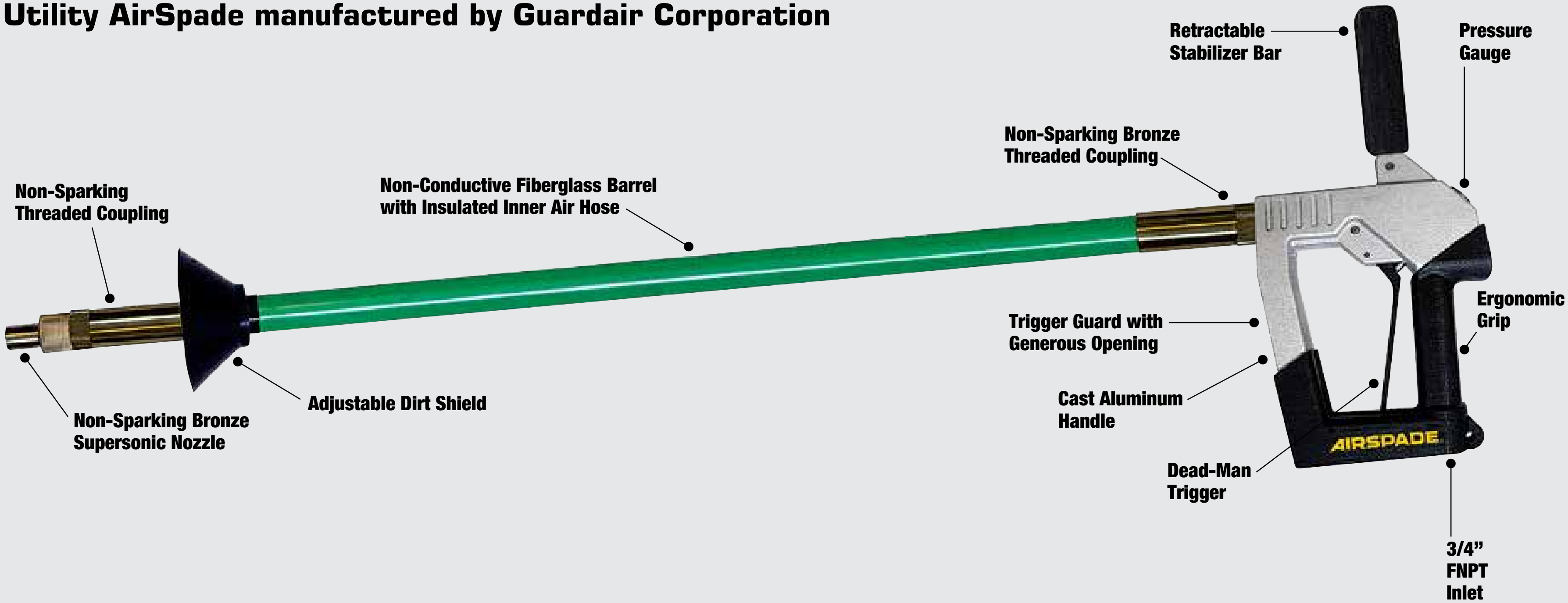


Conventional Nozzle



Supersonic Nozzle

Utility AirSpade manufactured by Guardair Corporation



ELIMINATE POTENTIAL SPARKING

The need to avoid sparks in a potentially flammable environment, such as within a utility trench while exposing a natural gas line, is easy to understand. Sparks, generated by "friction" can commonly occur when some metals impact each other, or impact other hard materials such as rocks, or concrete. Unlike ferrous-based metals — containing iron (such as steel) — bronze does not generate sparks upon impact and is considered to be "non-sparking" in nature. To eliminate this concern, Utility AirSpade features a bronze Supersonic Nozzle and bronze barrel couplings.

HUMAN FACTORS AND SAFETY

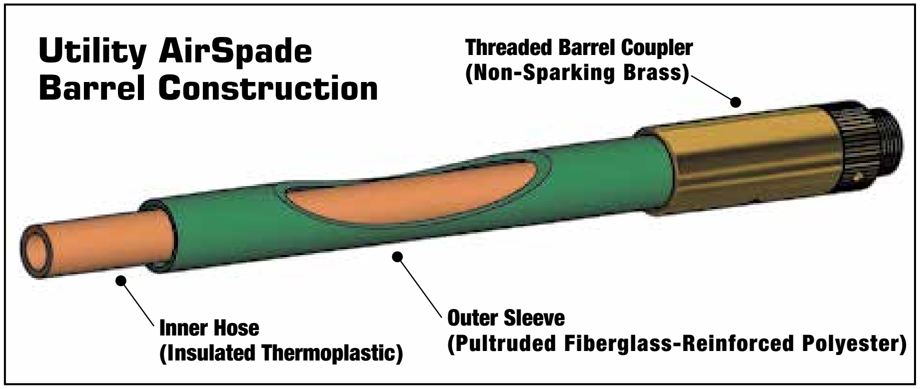
Properly designed air excavation tools must incorporate ergonomic features, be easy to use, and, above all, be safe.

The Utility Air Spade handle has been designed to comfortably fit the hand and features a hand opening large enough to accommodate lineman gloves. Besides housing the dead-man trigger, the handle body also functions as a trigger guard to prevent accidental activation. When desired, a retractable auxiliary handle provides positive, two-handed control.

Finally, compressed air is a powerful, yet potentially dangerous utility, so the Utility AirSpade has been engineered to handle high-speed air flow of Mach 2, as well as air pressures up to 150 psi.

PROTECTION FROM HIGH VOLTAGES

When excavating in the vicinity of underground utilities, the potential exists to uncover and expose high-voltage electrical lines. Consequently, to protect workers at the job site, the Utility AirSpade features an insulated fiberglass barrel assembly — incorporating a high-dielectric fiberglass outer barrel and an insulated inner air hose. Together, these components provide an electrical insulation rating of 75 kV per foot.



UTILITY AIRSPADE DEVELOPMENT

To meet these requirements, Guardair Corporation developed the Utility AirSpade incorporating the following features essential for the safe excavation of underground utilities:

- Heavy-duty, cast aluminum handle with full-size grip opening
- Retractable stabilizer bar for two-handed operator control
- Dead-man trigger with trigger guard prevents accidental activation
- Integral air pressure gauge ensures optimal operating performance
- Electrically insulated, 4’ fiberglass barrel rated to 75 kV per foot
- Non-sparking bronze barrel sleeves and threaded connectors
- Adjustable, dirt shield protects the operator from dislodged soil
- Non-sparking bronze Supersonic Nozzle
- ¾” FNPT air inlet


VACTOR
HXX
VACUUM EXCAVATOR
CAUTION
WATCH FOR APPROACHING
TRAINS!

UTILITY AIRSPADE SAFETY FEATURES

Every Utility AirSpade is equipped with the following safety features:

Dead-Man Trigger
Drop a home-made air lance in the full-on position and it has the potential to "whip" and cause serious injury. The Utility AirSpade incorporates a dead-man trigger, which immediately shuts off the air supply if released.

Lightweight Construction
Home-made air lances made from heavy, iron pipe accelerate operator fatigue and that's when accidents are most likely to occur. The Utility AirSpade's lightweight aluminum and fiberglass construction minimizes weight, making it easier to use for longer periods of time.

Thermal Insulation
Ask any arborist or underground utility worker — air-excavation tools can get hot! The Utility AirSpade's thermally insulated handle and fiberglass barrel provide superior thermal protection, enabling operators to work longer and more effectively.

Ergonomic Design
Comfortable, ergonomic tools are safe tools. The Utility AirSpade's ergonomic design minimizes musculoskeletal stress and maximizes operator comfort.

Electrical Insulation
How would you like to uncover an underground electric cable with an uninsulated, iron pipe air lance? When properly used, the Utility AirSpade's insulated fiberglass barrel provides a degree of protection from electric shock hazard.

Compressed Air Safe
Compressed air is a very powerful but potentially dangerous utility. Has that home-made air lance been tested and certified to operate at 100 psi? The Utility AirSpade has been. Enough said!

HAZARDS & HIDDEN COSTS OF HOME-MADE TOOLS

Utility companies and contractors are under pressure to control operating costs. With air compressors common on job sites, some work crews fashion their own air-powered excavation tools – in hopes of finding cheaper alternatives to safe, commercially available tools such as the Utility AirSpade.

"Workers say, it's only blowing air so we can make a tool for $100," explains Craig Schoen, AirSpade National Sales Manager. "So, they take a length of steel pipe, add a ball valve, and attach it to an air compressor."

While building a home-made tool from spare parts might be cheaper, there are significant hazards and hidden costs which should be considered.

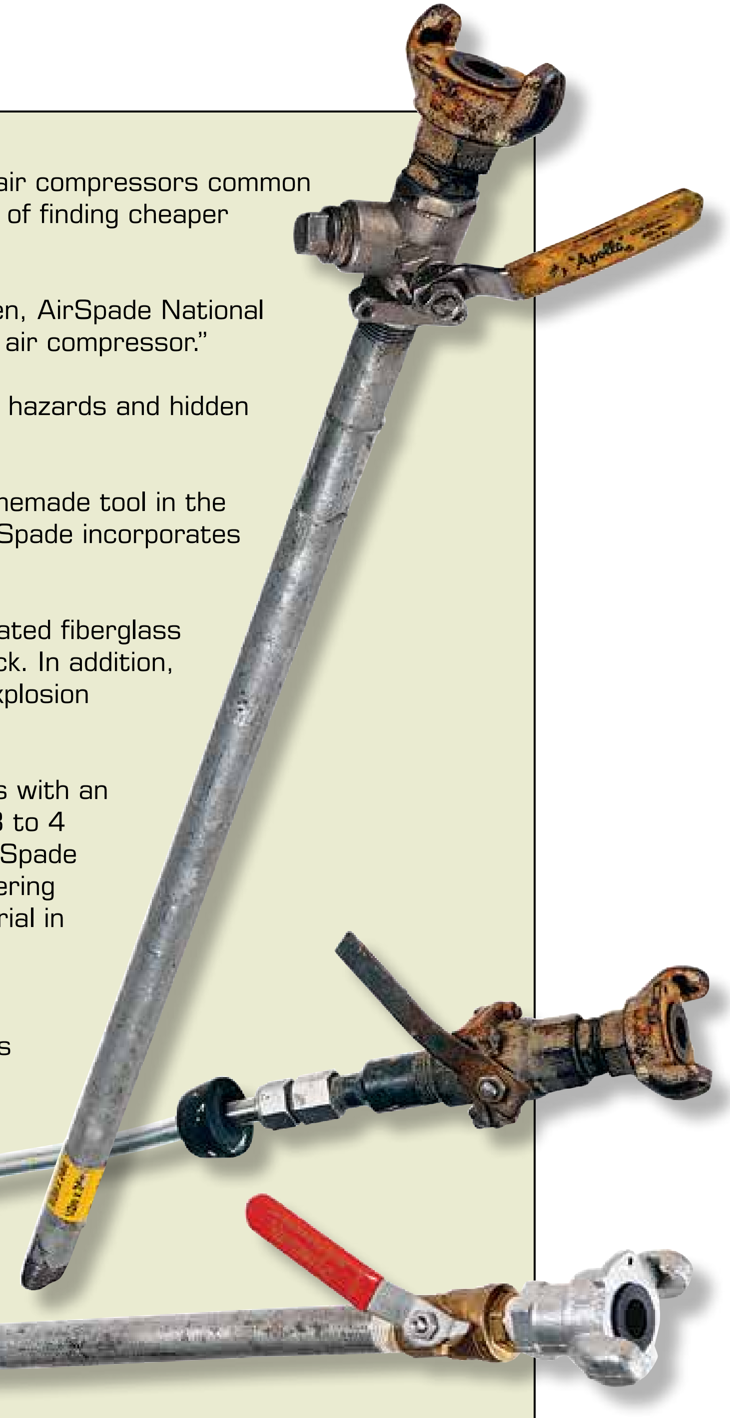
Homemade tools lack critical safety features such as a dead-man trigger. Dropping a homemade tool in the full-on position has the potential to "whip" and cause serious injury or damage. Utility AirSpade incorporates a dead-man trigger which immediately shuts off the air supply if released.

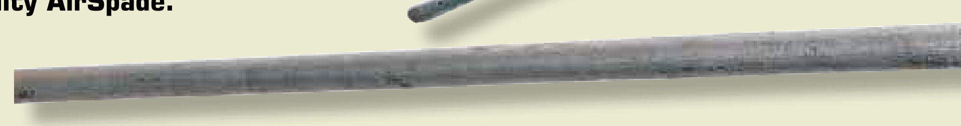
Imagine uncovering a live underground electric cable with a steel pipe? Featuring an insulated fiberglass barrel, the Utility AirSpade provides an important degree of protection from electric shock. In addition, the non-sparking nozzle and couplers featured on the Utility AirSpade lower the risk of explosion or fire when uncovering buried gas lines.

Besides keeping crews safe, the Utility AirSpade increases productivity. Homemade tools with an open end, or crimped orifice, disperse air in an unfocused, inefficient pattern - typically, 3 to 4 times wider than the air jet exiting the Utility AirSpade nozzle. Conversely, the Utility AirSpade supersonic nozzle focuses compressed air into a laser-like jet moving at 1200 mph, delivering significantly more kinetic energy and momentum. Thus, workers can excavate more material in less time compared to homemade tools. Less time also means lower air compressor fuel consumption.

Finally, homemade tools can get hot. Featuring a thermally insulated handle and fiberglass barrel, Utility AirSpade provides superior thermal protection, enabling workers to work longer and more effectively.

While it may be tempting to build a homemade tool on the cheap, the risks outweigh the temporary cost savings. "If you hit a utility line, the human and financial costs can be enormous," Schoen says. **"Work safer and smarter with the Utility AirSpade."**





Pre-Excavation Checklist Before **EVERY** Excavation

IN THE OFFICE

- ❑ Consult maps or field sketches of location.
- ❑ Review all drawings, plans & engineering blueprints for existing buried facilities.
- ❑ Call 811 at least 2-3 business days before excavation (check state One Call laws).
- ❑ Schedule onsite meeting with critical facility operators (gas/oil pipelines, high-voltage cables, fiber optics, etc.).

JOBSITE VISUAL INSPECTION

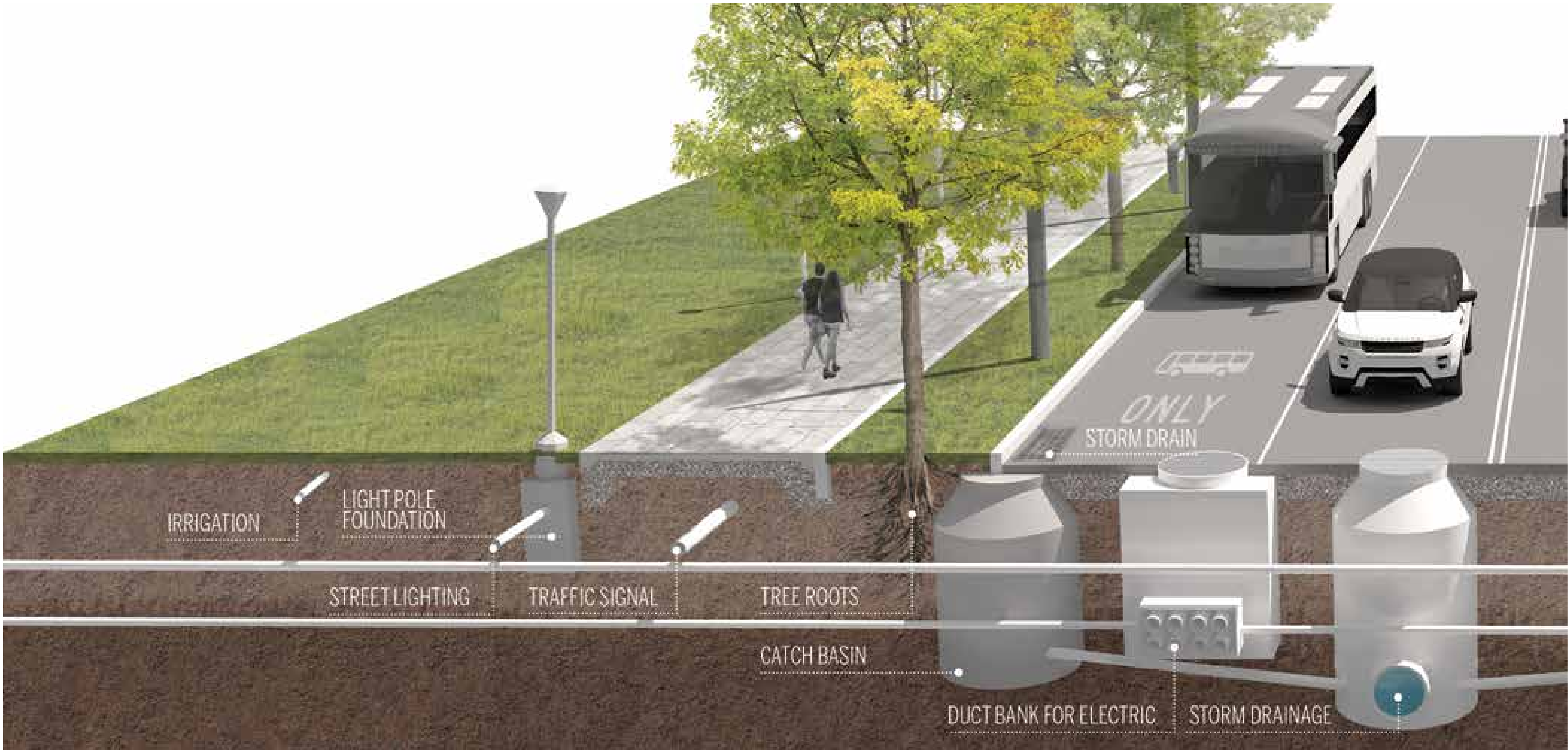
- ❑ Complete pre-excavation walkthrough of the entire jobsite and adjacent areas.
- ❑ Identify & confirm all:
  - Pavement markers (stamped nails, pavement decals, A-tags)
  - Surface markers
  - Surface signage
  - Locate marks
- ❑ Identify all services to buildings including:
  - Gas meters
  - Farm taps
  - Pipeline valves
  - Cable pedestals
  - Electric cables
  - Water valves
  - Telephone enclosures
- ❑ Look for cleared pipeline right of ways.
- ❑ Look for evidence of trenching from previous excavations.
- ❑ Talk with property owner or general contractor to identify potential unmarked private facilities:
  - Lighting
  - Out-buildings
  - Pools/Spas
  - Irrigation lines
  - Sewer laterals
  - Propane tanks
  - Communications lines
- ❑ Mark proposed excavation areas in white paint and/or with flags.

JOBSITE DOCUMENTATION

- ❑ Post the One Call Ticket number at the job site.
- ❑ Compare actual job site observations to One Call Ticket:
  - Proper scope of work
  - Valid "Work to Begin" date
  - Response from all utilities
  - Facility marks within excavation area
- ❑ Photograph at the jobsite:
  - All marks and flags from 360°, at varying distances for perspective.
  - Permanent signage and location relative to the dig area.
  - Overhead lines with notation of location, height, and operator.
  - All required safety signage.
- ❑ Produce sketches and/or additional video where pertinent.

BEFORE YOU DIG

- ❑ Review safety issues and information with all jobsite personnel.
- ❑ Confirm excavation schedule with owner of pipelines impacted.
- ❑ Note all locations for hand digging within the tolerance zones.
- ❑ Be sure representatives for all critical facilities are present.
- ❑ Have emergency equipment on-hand whenever hazardous atmospheres are potentially present.
- ❑ List all emergency contact numbers for assets in and adjacent to the dig zone.
- ❑ Ensure the location and route to the nearest hospital is known by jobsite supervisor.



UNDERGROUND UTILITIES – A Crowded Picture

Across the modern landscape, the proliferation of underground utilities has grown significantly as we have come to appreciate the improved visual aesthetics. While undergrounding is initially expensive, utility providers benefit from increased reliability and protection from the elements. However, the potential for service interruptions due to accidental strikes when uncovering underground lines for maintenance or during construction, is a growing concern. Per this illustration, as underground utilities continue to proliferate, the potential for accidental strikes on adjacent utilities increases.

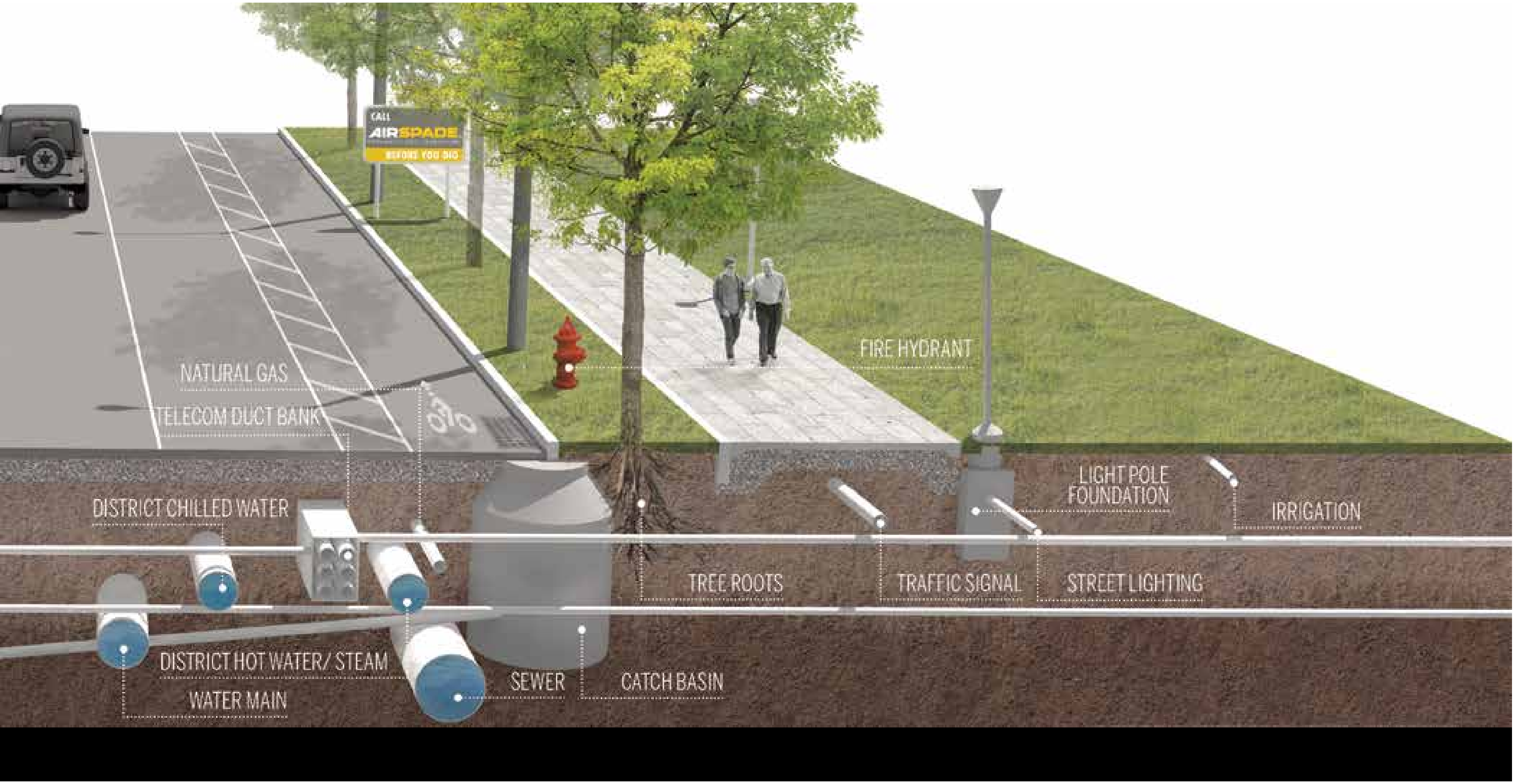
Dry excavation in conjunction with the Utility AirSpade facilitates the safe excavation of underground utilities and minimizes the chance of a service interruption. Unlike mechanical excavation techniques, airspading efficiently removes or loosens soil without damage to underground facilities. Underground utilities where accidental strikes commonly occur include:

Irrigation Lines: Water for lawns, shrubs and trees

Street Lighting Lines: A/C power for street lights

Traffic Signal Lines: Low voltage lines providing traffic signal synchronicity

Storm Drainage: Runoff from curbside storm drains



High Voltage Power Lines: High voltage A/C power

Water Main: Potable fresh water supply

District Chilled Water: Dedicated institutional or municipal system

Telecommunication Lines: Telephone, cable, and fiber optic lines

District Hot Water/Steam: Dedicated institutional or municipal system

Natural Gas: Gas for heating, cooling, cooking, and hot water

Sewer Lines: Wastewater routed to sewage treatment plants

Fire Hydrant Lines: Water for fire hydrants

Specialized Vacuum Excavation Techniques

Three primary methodologies are typically used in utility construction, locating and maintenance.

Trenching – excavation of a trench to accommodate an underground utility. Trenches vary in depth – typically shallow for seasonal irrigation lines, but can be several feet deep to avoid frost with water or sewer lines.

Potholing – excavation to pinpoint the location of an underground facility.

Keyholing – specialized potholing to locate & repair underground facilities. Typically performed on roadway surfaces to minimize pavement damage.

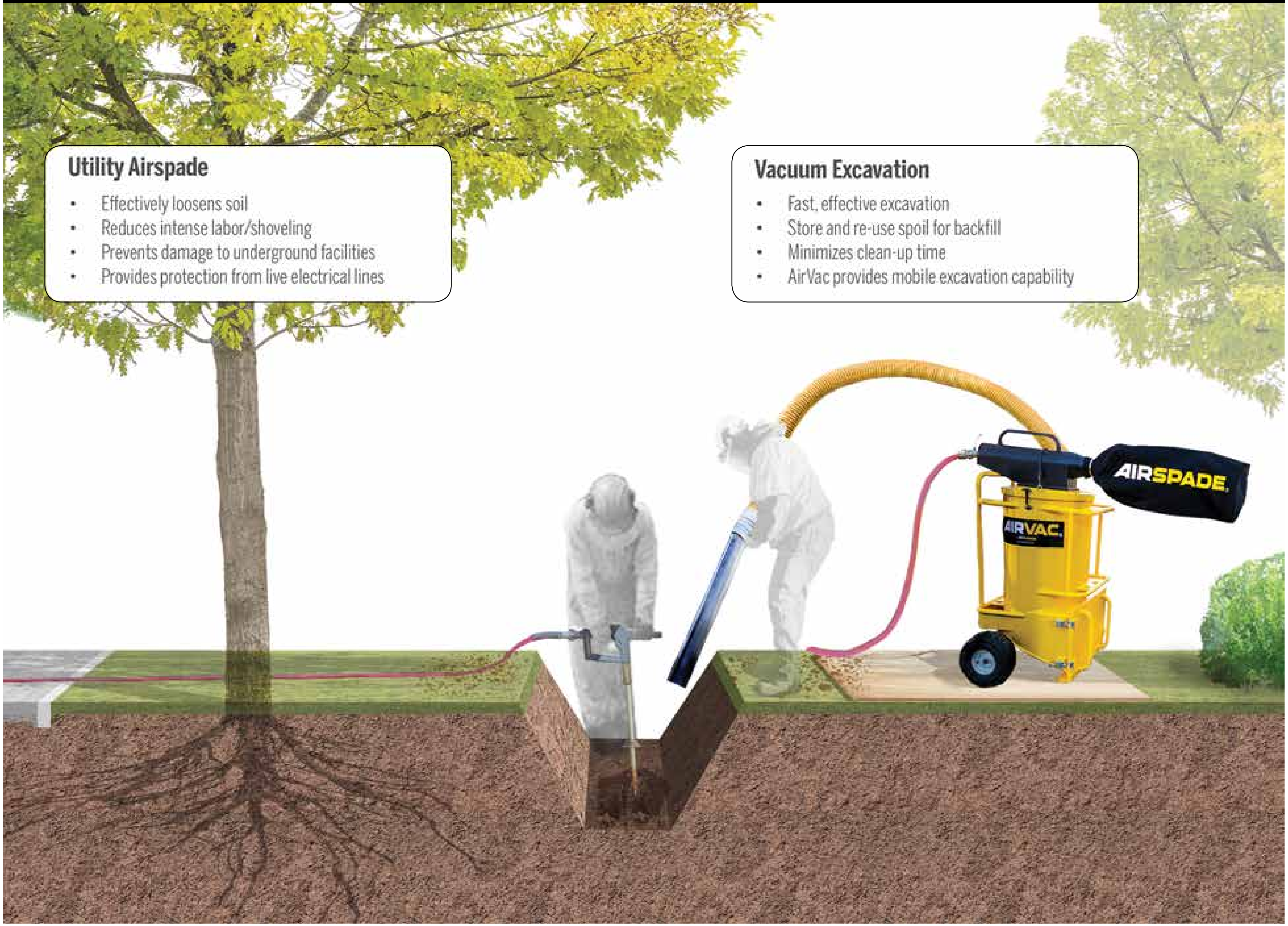
TRENCHING

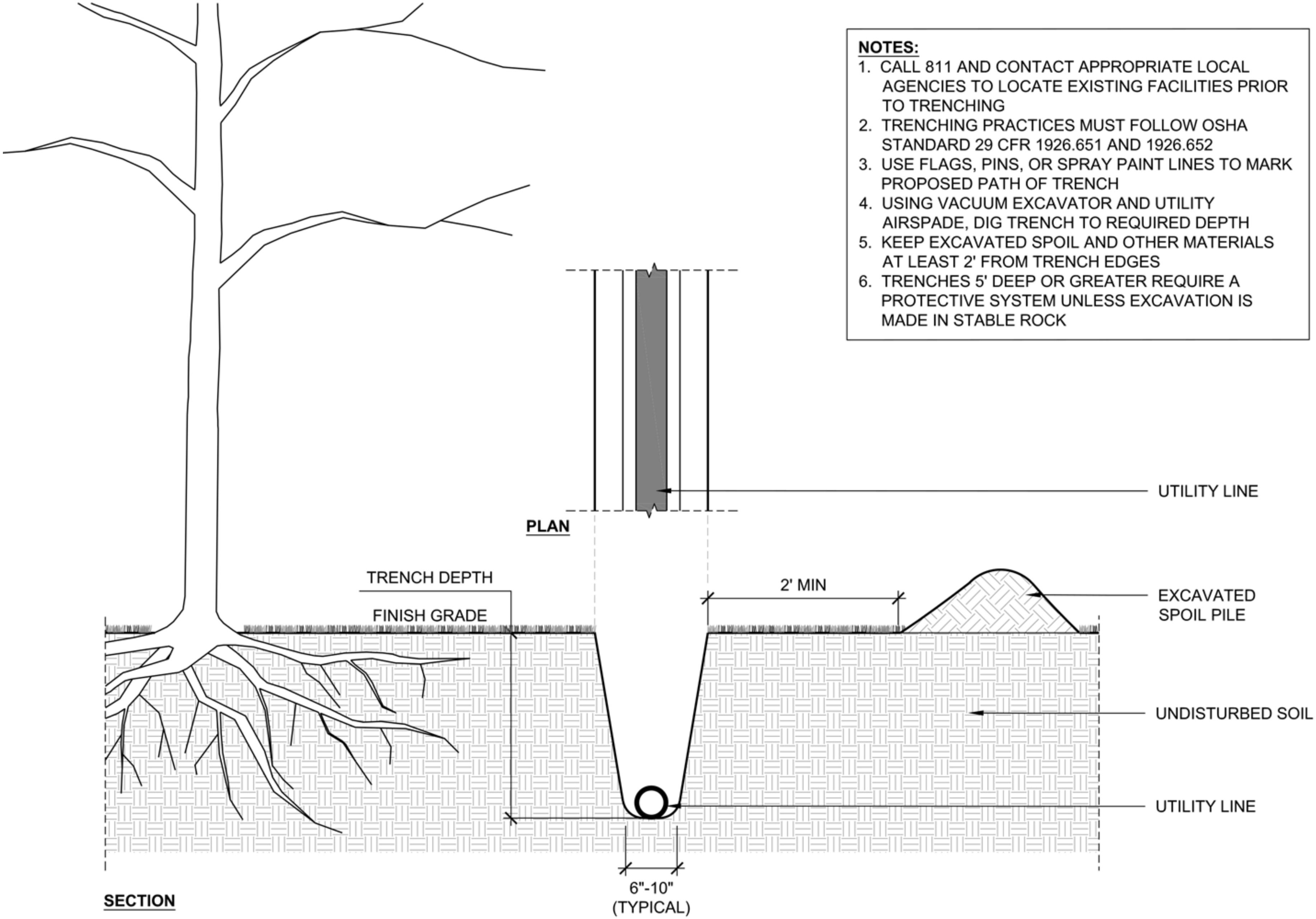
Utility Airspade

- Effectively loosens soil
- Reduces intense labor/shoveling
- Prevents damage to underground facilities
- Provides protection from live electrical lines

Vacuum Excavation

- Fast, effective excavation
- Store and re-use spoil for backfill
- Minimizes clean-up time
- AirVac provides mobile excavation capability





NOTES:

1. CALL 811 AND CONTACT APPROPRIATE LOCAL AGENCIES TO LOCATE EXISTING FACILITIES PRIOR TO TRENCHING
2. TRENCHING PRACTICES MUST FOLLOW OSHA STANDARD 29 CFR 1926.651 AND 1926.652
3. USE FLAGS, PINS, OR SPRAY PAINT LINES TO MARK PROPOSED PATH OF TRENCH
4. USING VACUUM EXCAVATOR AND UTILITY AIRSPADE, DIG TRENCH TO REQUIRED DEPTH
5. KEEP EXCAVATED SPOIL AND OTHER MATERIALS AT LEAST 2' FROM TRENCH EDGES
6. TRENCHES 5' DEEP OR GREATER REQUIRE A PROTECTIVE SYSTEM UNLESS EXCAVATION IS MADE IN STABLE ROCK

1 TRENCHING DETAIL

1/2" = 1'-0"

POTHOLING

Utility Airspade

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- Prevents damage to underground facilities
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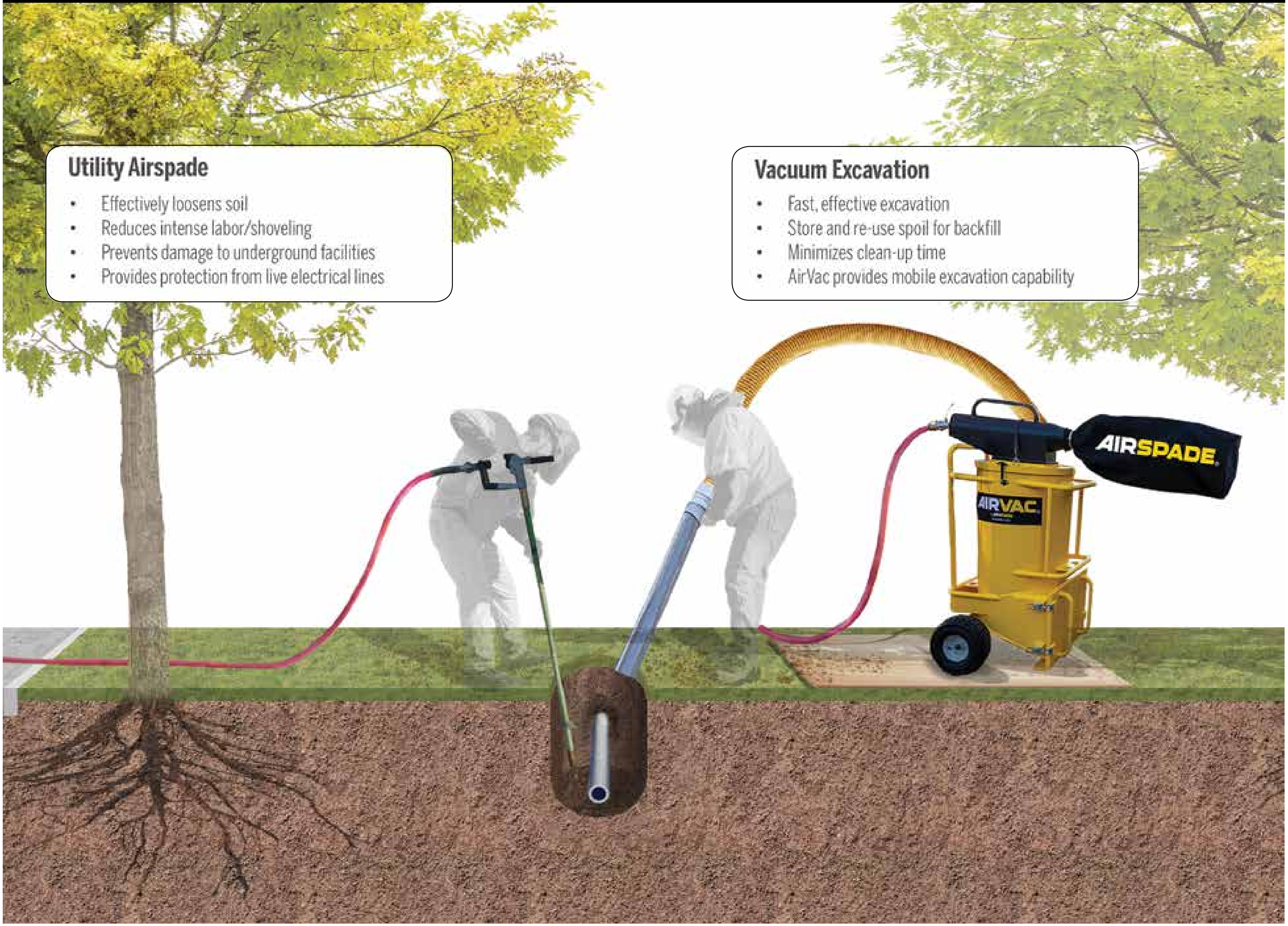
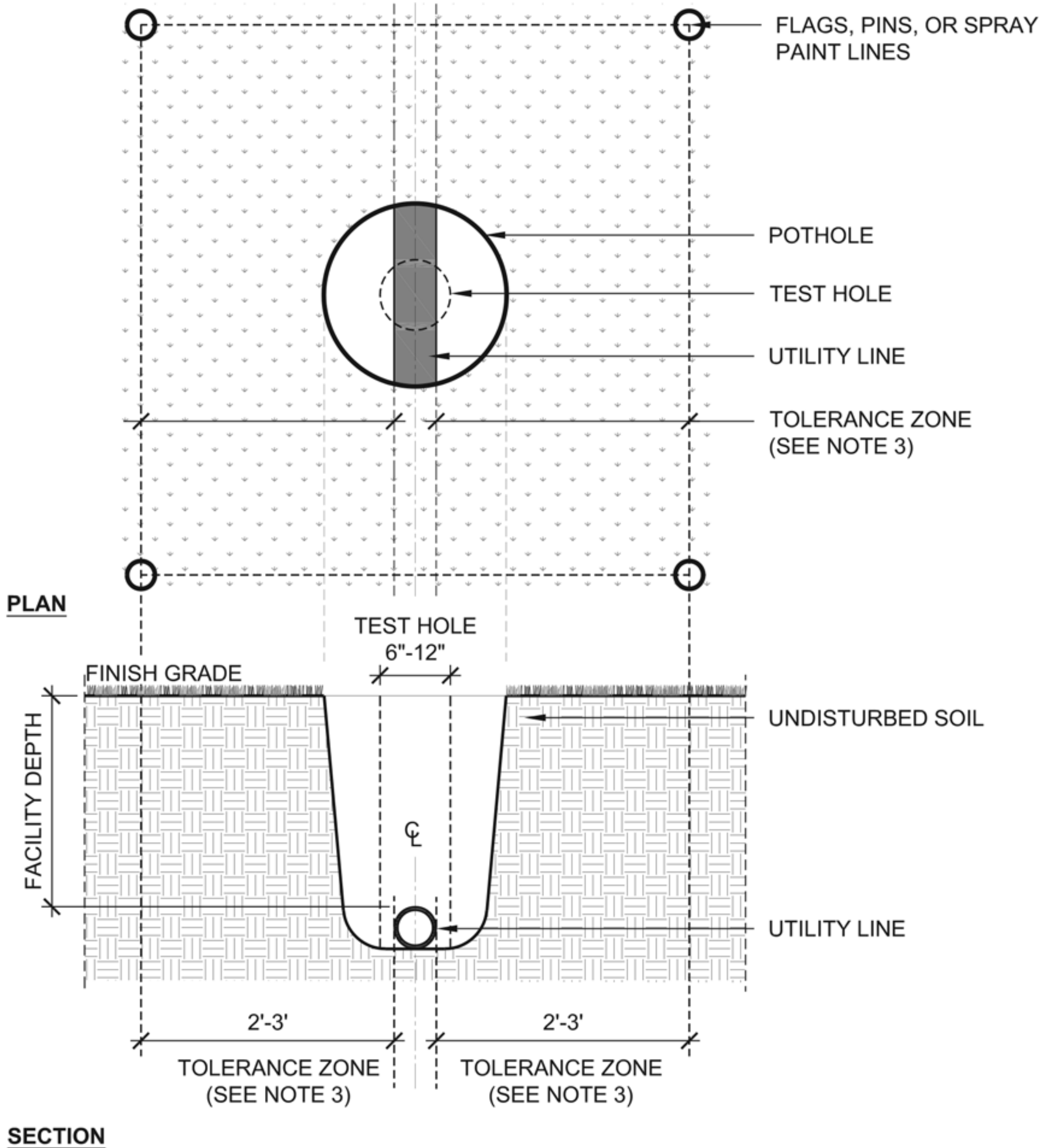
- AirVac provides mobile excavation capability





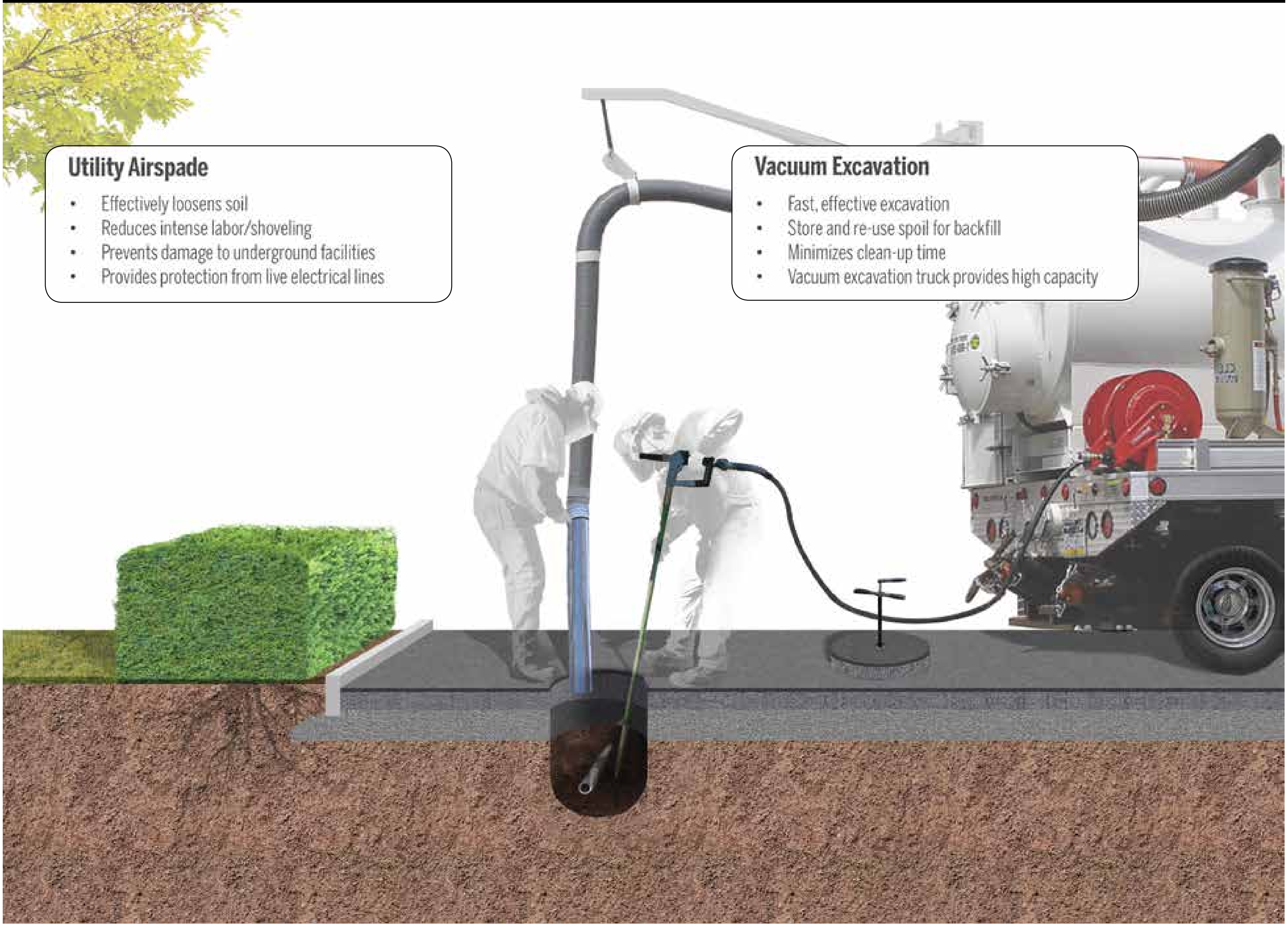
NOTES:

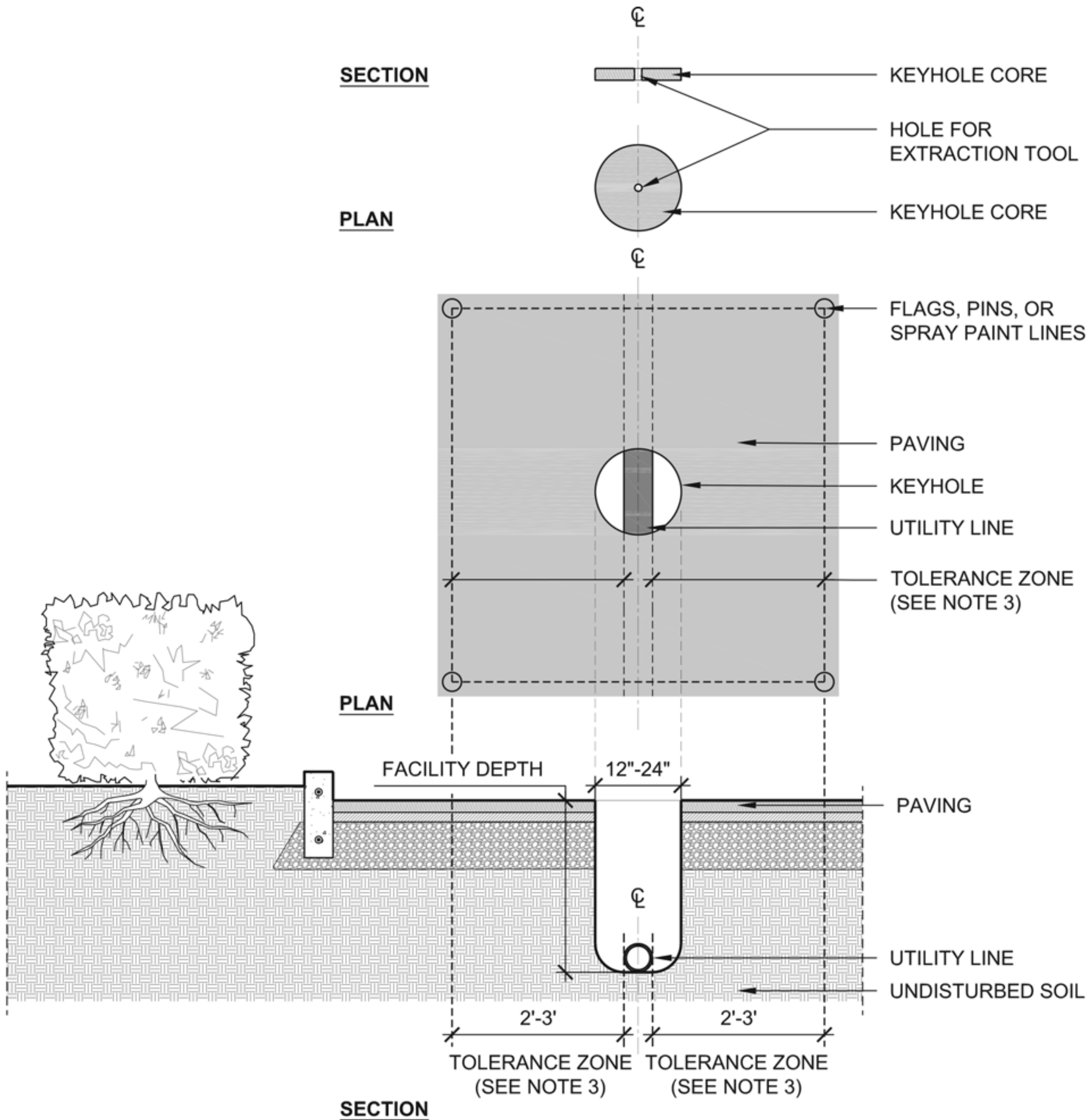
1. CALL 811 AND CONTACT APPROPRIATE LOCAL AGENCIES TO LOCATE EXISTING FACILITIES PRIOR TO POTHOLING.
2. EXCAVATION PRACTICES MUST FOLLOW OSHA STANDARD 29 CFR 1926.651 AND 1926.652.
3. USE FLAGS, PINS, OR SPRAY PAINT LINES TO MARK UNDERGROUND FACILITY AND TOLERANCE ZONES. TYPICALLY 2'-3'.
4. USING VACUUM EXCAVATOR AND UTILITY AIRSPADE, DIG TEST HOLE. TYPICALLY 6"-12" DIAMETER UNTIL FACILITY IS FOUND PRIOR TO FULL EXCAVATION OF POTHOLE.
5. TIE HORIZONTAL AND VERTICAL POSITION OF EXPOSED FACILITY TO SURVEY BENCHMARK OR PERMANENT ABOVE-GRADE FEATURE.

2 POTHOLING DETAIL

1/2" = 1'-0"

KEYHOLING


Utility Airspade
• Effectively loosens soil
• Reduces intense labor/shoveling
• Prevents damage to underground facilities
• Provides protection from live electrical lines
Vacuum Excavation
• Fast, effective excavation
• Store and re-use spoil for backfill
• Minimizes clean-up time
• Vacuum excavation truck provides high capacity



NOTES:

1. CALL 811 AND CONTACT APPROPRIATE LOCAL AGENCIES TO LOCATE EXISTING FACILITIES PRIOR TO KEYHOLING.
2. KEYHOLING PRACTICES MUST FOLLOW OSHA STANDARD 29 CFR 1926.651 AND 1926.652.
3. USE FLAGS, PINS, OR SPRAY PAINT LINES TO MARK PROPOSED KEYHOLE AND TOLERANCE ZONES.
4. USING PORTABLE CORING DEVICE, CUT A CORE OUT OF THE PAVEMENT - TYPICALLY 12"-24" DIAMETER.
5. DRILL CENTER PILOT HOLE COMPLETELY THROUGH THE CORE. INSERT CORE PULLER TOOL THROUGH PILOT HOLE AND EXTRACT THE CORE. SET THE CORE ASIDE.
6. USING VACUUM EXCAVATOR AND UTILITY AIRSPADE, REMOVE SPOIL TO DEPTH OF FACILITY.

3 KEYHOLING DETAIL

3/8" = 1'-0"

SAFE PRACTICES WHEN EXCAVATING AROUND UTILITIES

OSHA 1926 Subpart P spells out safety requirements for excavation and trenching operations. These include measures to protect workers from cave-ins, falls, hazardous atmospheres, and underground utility-line strikes.

OSHA's 2015 "Trenching and Excavation Safety" guide highlights key elements of this standard, and recommends that employers emphasize the following safe work practices to minimize the risk of injuries:

- Locate underground utilities before digging.
- Keep excavated spoil and work materials at least 2' from trench edges.
- Keep heavy equipment away from trench edges.
- Identify equipment or activities that could affect trench stability.
- Test for low oxygen, hazardous fumes, and/or toxic gases in trenches more than 4' deep.
- Inspect trenches at the start of each shift, following rainstorms or other water intrusion, or after occurrences altering trench conditions.
- Ensure that personnel wear high-visibility clothing when working near vehicular traffic.

Additional recommended safety practices when operating the Utility AirSpade:

- Wear personal protective equipment including:
  - Cut and puncture resistant gloves
  - Safety glasses with side shields and/or face protection complying with ANSI Z87.1-1989
  - Earplugs or earmuffs providing noise-reduction > 20 decibels.
- Wear electrically insulated footwear, insulated gloves, and employ rubber ground mats where appropriate when working near underground high-voltage electric lines.
- Wear respiratory protection when working in extremely dusty conditions.
- Ensure that personnel are aware the Utility AirSpade is in use.
- Protect adjacent surfaces and personnel from flying rocks or soil with drop cloths, screens, or barriers.
- Check the tool for loose or damaged parts. Tighten, repair, and/or replace as necessary.
- Inspect air hoses for leakage, kinks, abrasion, or other signs of wear or damage. Replace if necessary.
- Check that the air compressor is delivering 90 psi to the Utility AirSpade.
- Anticipate that use of the 45-degree angled adaptor produces a force opposite the exiting compressed air. Grip the barrel tightly and brace accordingly.


MTS

ADDITIONAL CONSIDERATIONS

AIR COMPRESSOR BASICS

SIZE

Air compressors are sized by air pressure and air flow. In the US, pressure is measured in pounds per square inch (psi). Flow is measured in cubic feet of air per minute (cfm). Virtually all air compressors nominally operate at approximately 90 - 100 psi while air flow capacities vary from model to model -- from a few cfm for small electric piston units, to hundreds of cfm for gas or diesel driven portable screw compressors. However, by far, the most popular tow-behind air compressors are rated 185 cfm. At larger job sites, or where more air flow is required to run multiple air tools, 375 cfm air compressors are often preferred.

Utility AirSpade is available with three, off the shelf Supersonic Nozzles to match commercially available, tow-behind air compressors.

Model	Nozzle Flow (cfm)	Recommended Min. Compressor Size (cfm)
Utility AirSpade 4000	105	125
	150	175
	225	250

Note that a lower flow (cfm) nozzle may always be used on a higher capacity compressor, but not the reverse. Running a nozzle with a higher flow rating than the capacity of the compressor will result in noticeably diminished performance.

What's SCFM and PSIG?

Some manufacturers list air compressor capacity in "SCFM" which is short for "Standard Cubic Feet per Minute." Others use the layman's term "CFM" for short. Both measures are identical.

Manufacturers also list air compressor output pressure in "PSIG" or "Pounds per Square Inch Gauge." "PSI" is also a layman's term and the identical measurement.

AIR PRESSURE

Utility AirSpade Supersonic Nozzles are designed to operate optimally at 90 psi in order to produce a Mach 2 air jet. Since the vast majority of portable air compressors deliver compressed air in the 90 to 100 psi range, these nozzles are well-matched. Keep in mind that increasing the air pressure above 90 psi delivered to the Supersonic Nozzle does not lead to a proportional gain in excavation capability.

For example, increasing the compressor output pressure (by say 30 percent to 117 psi) increases the air-jet force and exit momentum flux (stress seen by the soil) but only nominally. Supplying higher pressure to a supersonic nozzle designed to work at 90 psi actually de-focuses the air-jet thereby degrading performance. In addition, operating the air compressor at higher pressures will dramatically increase energy (fuel) consumption.

TIER 4 MAINTENANCE

Most typical 185 cfm/90-100 psi tow-behind air compressors feature diesel engines small enough that they do not require diesel exhaust fluid, or a diesel particulate filter to clean exhaust emissions. But be sure to understand specific diesel engine maintenance requirements before heading down the highway.

For systems that require diesel exhaust fluid, the reservoir will probably need to be filled once for every few tanks of diesel fuel burned. Diesel particulate filters may need periodic regeneration to burn off the accumulated soot inside the filter. On some models, this may require ceasing work until the regeneration is complete.

AIR COMPRESSOR SAFETY

HOSE WHIP PREVENTION

Potentially hazardous links in any compressed air system are the connections between the air compressor and the air hose, connections between lengths of air hose, or the connection between the air hose and the air tool. Should a coupling blow apart under pressure, the loose end of the hose can whip around in a dangerous manner. People have been killed this way.

Air hose restraint systems, such as WhipChek®, hold the two couplers together, preventing them from flailing around should a break occur. OSHA requires "positive means" such as these to secure the air tool to the air hose. See OSHA Standard 29 CFR 1926.302 (b) (1).

SAFETY EXCESS FLOW CHECK VALVES

Another way to prevent hose whip is to install a safety excess flow check valve, sometimes called an air fuse. OSHA requires an air fuse on any hose with an inside diameter (ID) greater than 1/2-inch. See OSHA Standard OSHA 29 CFR 1926.302 (b) (7).

Installed at the output of the air compressor, should the air fuse detect a sudden drop in pressure, it closes shut and prevents additional compressed air from entering the hose. Once tripped, air fuses automatically reset once the fault in the air hose has been corrected.

Air fuses are sized for the pressure and flow rate required by the air tools in use. One-size does not fit all. Consequently, air fuses are not a standard feature supplied on tow-behind compressors.

NOISE

Due to their gas or diesel engines, tow-behind air compressors contribute to high noise levels when running on the job site. Most compressors nominally operate in the 90 to 100 dBa range, with some units generating up to 110 dBa. To keep noise levels safe and within OSHA standards, under these conditions hearing protection is mandatory. See OSHA Standard 29 CFR 1910.95.

In addition to mechanical noise, crack the output valve of any tow-behind air compressor not connected to an air hose and the noise generated by escaping air can be in excess of 120 dBa – a noise level equivalent to a commercial jet at takeoff. Products such as the *Guardair Quiet-Test*, attach to the output of the compressor and allow for testing the air compressor at full flow, while reducing noise levels by 20 dBa.

AIR HOSE BASICS

AIR HOSE

The Utility AirSpade features a ¾" FNPT inlet equipped with ¾" Universal Coupling. To provide adequate air flow to the tool, Guardair recommends air hose no smaller than ¾"ID. Make sure the air hose is rated at least 150 psi and is operating within its temperature rating. Never exceed the air hose manufacturer's specifications.
See OSHA Standard OSHA 29 CFR 1926.302 (b) (5).

Air hoses should be inspected before everyday usage. Spending most of their time on the ground, air hoses get stepped on constantly and are routinely run over by vehicles. Look for signs of abrasion, punctures, and wear. Use care when transporting and storing an air hose. Minimize abuse and avoid storage adjacent to hot exhaust mufflers or turbochargers.

Standard weight air hose with Universal Couplers.

Light weight air hose stores flat.

CONNECTORS AND FITTINGS

Be sure that connectors and fittings do not restrict the air flow in any manner. Employ fittings that are rated the same size, or larger, for a given air hose ID. AirSpade recommends the use of Universal Couplers – sometimes referred to as "Chicago-style," or "Air King" fittings. Always use the safety pins supplied with these couplers.

AIR HOSE PRESSURE LOSSES

Compressed air flowing through an air hose will lose pressure from friction and constrictions. Friction loss is proportional to the length of the air hose. Operating pressure, flow rate, air hose inner diameter, and air hose smoothness also determine the pressure loss.

The table below shows the pressure loss for 50 feet of common air hose (including couplings) as a function of air hose diameter (ID) and air flow.

Pressure Loss (psi) for 50 Feet of Common Air Hose

Model	Air Flow (cfm)	Air Hose (ID)		
		3/4"	1"	1-1/4"
Utility AirSpade 4000	105	5.6	1.2	0.4
	150	12.2	2.9	0.8
	225	29.9	8.0	1.9

This table can be interpreted with the following example. Assume a Utility AirSpade is equipped with a 150 cfm Supersonic Nozzle connected to an air compressor via a 50 ft long, ¾" ID air hose. From the table, the air hose will see a 12.2 psi pressure loss over its length. In order to deliver 90 psi at the Supersonic Nozzle (for optimal performance), the compressor output should be set at 102.2 psi (90 + 12.2) to make up for the pressure loss.

Alternatively, with the same Utility AirSpade and air compressor, a 1" ID air hose will see only a 2.8 psi pressure loss over its length. Thus, the air compressor should be set at 92.8 psi (90 + 2.8) – only a negligible increase.

Pressure losses also result from kinks and bends in the hose. Using a hose coiled up on the ground increases inefficiency. Guardair recommends placing the compressor as close to the work area as possible to minimize the air hose length.


Bobcat
ZTS

APPENDIX

Appendix A: Call 811

Prior to starting any underground excavation always contact Dig Safe first. Dial 811 or contact the local (statewide) Dig Safe One Call Center (see adjacent tables).*

Calling Dig Safe is simple and free. After being contacted, facility representative(s) will visit the job site and identify the location of underground facilities in the immediate area. Failure to contact Dig Safe could result in serious injuries, damages to existing underground facilities, and/or costly fines.

STEP 1: Mark desired digging location at jobsite.

STEP 2: Call 811 or local Dig Safe One Call Center with all locate information (dates, scope of work, etc.).

STEP 3: Dig Safe notifies all underground facility owners requesting locate.

STEP 4: Wait requested time (48-72 hours depending upon state law).

STEP 5: Facility representatives arrive at jobsite and mark underground facilities.

STEP 6: Perform excavation. Note all location marks and respect the state mandated tolerance zone(s).

STEP 7: Maintain location marks within Dig Safe ticket period. Ticket expiration is state specific (30-60 days).

STATE	PHONE	WEBSITE
Alabama	800-292-8525	Al811.com
Alaska	800-478-3121	Akonecall.com
Arizona	800-782-5348	Arizona811.com
Arkansas	800-482-8998	Arkonecall.com
California NORTH	800-642-2444	Usanorth811.org
California SOUTH	800-422-4133	Digalert.org
Colorado	800-922-1987	Colorado811.org
Connecticut	800-922-4455	Cbyd.com
Delaware	800-282-8555	Missutility.net
Florida	800-432-4770	Sunshine811.com
Georgia	800-282-7411	Georgia811.com
Hawaii	866-423-7287	Callbeforeyoudig.org
Idaho	800-342-1585	Digline.com
Illinois	800-892-0123	Illinois1call.com
Indiana	800-382-5544	Indiana811.org
Iowa	800-292-8989	Iowaonecall.com
Kansas	800-344-7233	Kansas811.com
Kentucky	800-752-6007	Kentucky811.org
Louisiana	800-272-3020	Laonecall.com
Maine	888-344-7233	Digsafe.com
Maryland	800-257-7777	Missutility.net

STATE	PHONE	WEBSITE
Massachusetts	888-344-7233	Digsafe.com
Michigan	800-482-7171	Missdig811.com
Minnesota	800-252-1166	Gopherstateonecall.com
Mississippi	800-227-6477	Ms811.com
Missouri	800-334-7483	Mo1call.com
Montana	800-424-5555	Montana811.org
Nebraska	800-331-5666	Ne1call.com
Nevada	800-642-2444	Usanorth811.org
New Hampshire	888-344-7233	Digsafe.com
New Jersey	800-272-1000	Nj1-call.com
New Mexico	800-321-2537	Nm811.org
New York	800-962-7962	Digsafelynewyork.com
North Carolina	800-632-4949	Nc811.org
North Dakota	800-795-0555	Ndonecall.com
Ohio	800-362-2764	Oups.org
Oklahoma	800-522-6543	Okie811.org
Oregon	800-332-2344	Digsafelyoregon.com
Pennsylvania	800-242-1776	Paonecall.org
Rhode Island	888-344-7233	Digsafe.com
South Carolina	800-721-7877	Sc811.com
Tennessee	800-351-1111	Tn811.com

STATE	PHONE	WEBSITE
Texas	800-344-8377	Texas811.org
Utah	800-662-4111	Bluestakes.org
Vermont	888-344-7233	Digsafe.com
Virginia	800-552-7001	Va811.com
Washington	800-424-5555	Washington811.com
Washington, D.C.	800-257-7777	Missutility.net
West Virginia	800-245-4848	Wv811.com
Wisconsin	800-242-8511	Diggershotline.com
Wyoming	800-849-2476	Onecallofwyoming.com
GulfSafe-Federal Waters	888-910-4853	Gulfsafe.org

CANADA	PHONE	WEBSITE
Alberta	800-242-3447	Albertaonecall.com
British Columbia	800-474-6886	Bconecall.bc.ca
Manitoba	800-940-3447	Clickbeforeyoudigmb.com
Ontario	800-400-2255	On1call.com
Quebec	800-663-9228	Info-ex.com
Saskatchewan	866-828-4888	Sask1stcall.com

* Be aware that Dig Safe phone numbers and web sites are subject to change.

Appendix B: Soil Characteristics

SOIL CLASSIFICATIONS

The effectiveness of airspading largely depends upon the type of soil present. Although hundreds of soil types exist, the Occupational Health & Safety Administration (OSHA) classifies soils into four categories (in decreasing order of strength):

- Stable Rock
- Cohesive Soil Type A
- Cohesive Soil Type B
- Cohesive Soil Type C

Relative strengths of the four soil classifications are measured using the metric Unconfined Compression Strength, expressed in tons per square foot. Data on these soils are contained within the three tables to the right.

STABLE ROCK
Unconfined Compressive Strength by Rock Type

Rock Type	Unconfined Compressive Strength (tons/sq ft)	
	Minimum	Maximum
Schist	84	1,729
Sandstone	104	2,455
Shale	358	2,412
Limestone	369	3,894
Granite	505	3,383
Gneiss	882	2,620

COHESIVE SOILS
Unconfined Compressive Strength by Soil Type

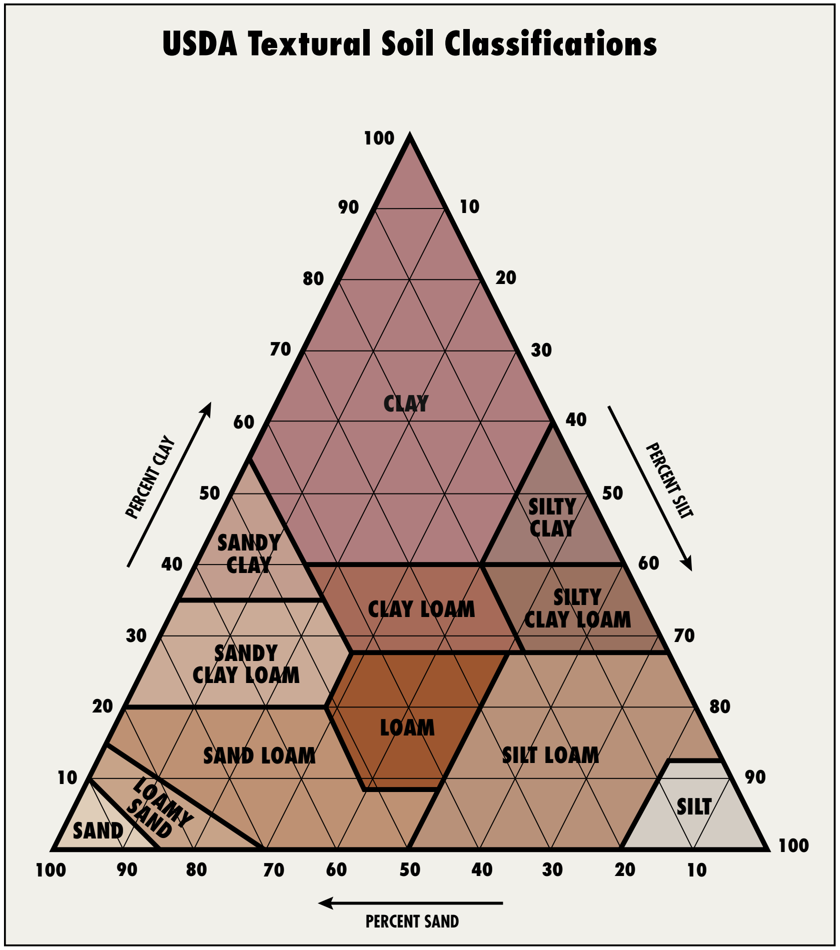
OSHA Cohesive Soil Type	Soil Description	**Unconfined Compressive Strength** (tons/sq ft)
A	Clay, silty clay, sandy clay, clay loam, caliche, hardpan Some silty clay loam, sandy clay loam	≥1.5
B	Granular cohesive soils such as angular gravel, silt, silt loam, sandy loam	0.5 - 1.5
C	Granular soils such as gravel, sand, loamy sand, submerged soil Soil from which water is freely seeping	≤0.5

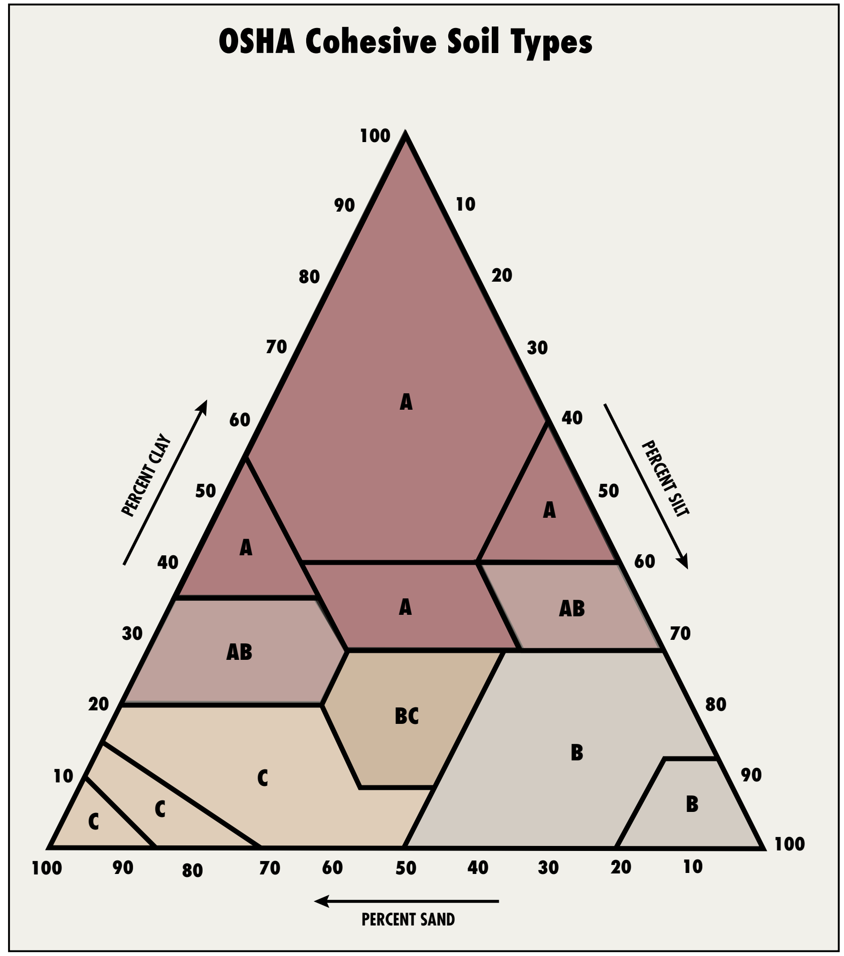
CLAYS
Unconfined Compressive Strength by Consistency

OSHA	**Unconfined Compressive Strength** (tons/sq ft)
Very Soft	0 - 0.25
Soft	0.25 - 0.5
Medium	0.5 - 1
Stiff	1 - 2
Very Stiff	2 - 4
Hard	>4

SOIL TEXTURES

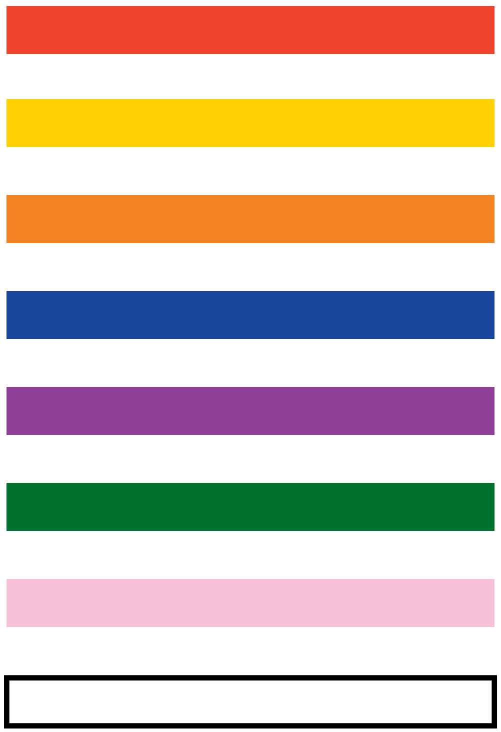
OSHA Cohesive Soil Types (A, B, or C) can be identified by the texture of a given soil. Shown below on the left is the U.S. Department of Agriculture Textural Soil Classification Chart. This chart plots soil classification as a percentage of sand, silt, and clay and classifies each unique combination. The chart on the right contains the same information with OSHA Cohesive Soil Types superimposed.





In summary, understanding the soils at a given jobsite is the key to determining the effectiveness of digging with the Utility AirSpade.

Appendix C: Color Code for Marking Underground Utility Lines



- **Electric**
- **Gas-Oil-Steam**
- **Communication CATV**
- **Potable Water**
- **Reclaimed Water**
- **Sewer & Drainage**
- **Temporary Survey Markings**
- **Proposed Excavation**

1-888-DIG SAFE
1-888-(344-7233)
digsafe.com

Appendix D: Utility AirSpade Technical Specifications

Utility Air Spade 4000 Technical Specifications	
Part Number: ASU4150G4 – 150 cfm Nozzle with 4 Ft. Barrel	
Handle	
Material:	Aluminum
Pressure Gauge:	0 to 160 psi
Compressed Air Inlet:	¾” FNPT
Threaded Barrel Couplers	
Material:	Non-sparking bronze
Barrel	
Outer Sleeve	
Material:	Pultruded Fiberglass-Reinforced Polyester
Length:	4 Feet
Conforms To:	ASTM F711 SECTION 12.2.5
Dielectric Strength:	100 kV per ft.
Inner Hose	
Material:	Insulated Thermoplastic
Length:	4 Feet
Conforms To:	SAE J517 100R7
Dielectric Strength:	75 kV per ft.
Nozzle	
Type:	Supersonic
Material:	Non-sparking bronze
Air Flow:	150 cfm
Overall Unit	
Dimensions:	56.3” x 5.5” x 13.4”
Weight:	10.3 lbs.

Appendix E: Further Reading

Common Ground Alliance, http://call811.com/before-you-dig/risk-reduction

Stacy Cummings, “Do You Know What’s Below? Call 811 Before You Dig!”, U.S. Department of Transportation “Fast Lane” blog, Aug. 6, 2015, https://content.govdelivery.com/accounts/USDOT/bulletins/1132ec1

National Transportation Safety Board, pipeline accident brief, http://www.ntsb.gov/investigations/AccidentReports/Reports/PAB1302.pdf

Washington State Department of Labor & Industries,http://www.lni.wa.gov/safety/research/face/files/711362015laborerelectrocuted.pdf

Cynthia Quarterman, “An Easy Call to 811 Could Prevent a Call to 911,” U.S.Department of Transportation “Fsne” blog, https://www.transportation.gov

Common Ground Alliance, 2017 DIRT Report

U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, “Safe Digging Testimonial: A Call to 811 Could Prevent a Call to 911,”April 21, 2014, https://www.youtube.com/watch?v=_VaTOg-76bI#t=21

OSHA “Trenching and Excavation” Web page, https://www.osha.gov/SLTC/trenchingexcavation/

OSHA, “Trenching and Excavation Safety” guide, 2015, https://www.osha.gov/Publications/osha2226.pdf

U.S. Bureau of Labor Statistics, “Nonfatal Occupational Injuries and Illnesses Requiring Days Away from Work, 2014,” http://www.bls.gov/news.release/pdf/osh2.pdf

Appendix F: Online Resources

AirSpade Website
AirSpade > Markets > Utility/Construction
http://www.airspade.com/pages/utility-construction

Common Ground Alliance
DIRT Annual Report
http://www.commongroundalliance.com/dirt

OSHA Standards
United States Department of Labor
Occupational Safety and Health Administration
http://www.osha.gov/law-regs.html

This booklet is available to download as a PDF online at:
www.airspade.com/utilityguide

Glossary

Airspading: Soil excavation techniques utilizing a proprietary compressed air-powered tool incorporating a supersonic nozzle.

Approved Contractor: Operator with sufficient education, training, and experience in vacuum excavation and airspading.

Backfill: Refilling the void created by excavation.

CFM: Cubic Feet per Minute (cu ft/min). Measurement of the rate of flow of air passing through an orifice.

Compressed Air Excavation: Non-mechanical, non-destructive process utilizing compressed air and paired with a vacuum to simultaneously excavate and evacuate soil.

Damage: Impact or exposure that results in the need to repair an underground facility due to weakening, or partial or complete destruction of the facility. This includes, but is not limited to, the protective coating, lateral support, cathodic protection, or housing for the line, device, or facility.

Damage Reporting: Immediate report of damage caused or discovered in the course of excavation or demolition work to a One Call Center, occupants of premises, or emergency responders.

Emergency: Sudden or unforeseen occurrence involving a clear and imminent danger to life, health, or property. Interruption of essential utility services or blockage of transportation facilities requiring immediate action.

Excavate or Excavation: Operations using non-mechanized or mechanized equipment, demolition, or explosives in the movement of earth, rock, or other material below existing grade.

Excavator: Person(s) or companies engaged in excavation or demolition work.

Facility: Underground or submerged conductor, pipe, or structure used to provide electric, telecommunications, gas, oil or oil products, sewage, water, storm drainage, or other services.

Finish Grade: Elevation of surfaces after completion of construction or excavation.

Hand-Digging: Soil excavation using hand tools such as shovels and picks to expose facilities.

Hydro Excavation: Non-mechanical, non-destructive process utilizing pressurized water and paired with a vacuum to simultaneously excavate and evacuate soil.

Joint Trench: Trench containing two or more facilities that are buried together by design or agreement.

Keyholing: Specialized version of potholing using soft excavation where the objective is to minimize pavement disruption.

Locate: Confirm the existence of lines or facilities by establishing a mark through the use of stakes, paint, flagging, whiskers, or some other customary manner that determines the location of that line or facility.

Locator: Person or company with the job of locating underground lines or facilities.

Muck: Waste material consisting of soil and water as a byproduct of hydro excavation.

Near Miss: Event where damage did not occur, but a clear potential for damage was identified.

Planning: Gathering information before the start of a project to aid in decision-making regarding the route or location of a proposed excavation based on constraints, including the location of existing facilities, anticipated conflicts, and costs of relocating existing facilities or construction of proposed facilities.

Potholing: Excavation method creating a test hole to expose underground infrastructure to determine the location and/or repair the facility.

Pre-Marking or Positive Site Identification: Marking of the proposed excavation site/work area consistent with APWA guidelines.

PSI: Pounds per Square Inch (lbs/sq in) measurement of air pressure.

Root Cause: Primary reason an event occurred.

Safety Excess Flow Check Valve: Automatically closes if a downstream air hose is cut, ruptures, or accidentally uncouples, thus preventing the hose from whipping. Automatically resets, after repair to the air system. Also referred to as an “Air Fuse.”

SCFM: Standard cubic feet per minute (SCFM) Flow rate of air corrected to "standardized" conditions of temperature and pressure.

Soft Excavation: Excavation by dry (compressed air) or hydro (high-pressure water) in conjunction with a powerful vacuum.

Slurry: Semi-liquid mixture of soil particles suspended in water.

Spoil: Waste material including earth and rock uncovered during the excavation process.

Subsurface Utility Engineering (SUE): Engineering process to identify underground utility information needed for excavation plans, and for acquiring and managing information during project development.

Supersonic Nozzle: High-efficiency, proprietary nozzle design and technology unique to AirSpade.

Test Hole: Exposure of underground facilities to determine the horizontal and vertical location.

Tolerance Zone: Space immediately surrounding a facility where special care is taken.

Trenching: Method of digging a trench to install, maintain, or inspect pipes, conduits, or cables underground.

Utility AirSpade: Pneumatic soil excavation tool with safety features required by the utility and construction industries.

Vacuum Excavation: Means of soil extraction using a powerful vacuum.

Contributors and Bios

Guardair Corporation

Thomas C. Tremblay, contributing author
President

With a rich history dating back to 1942, Guardair Corporation is a world-class manufacturer of industrial/commercial pneumatic tools and accessories, including the AirSpade. In 1994, Tom led a group that acquired the company and has guided and grown the business since that time. Before Guardair, Tom was a Vice President at New England Capital, the venture capital arm of the Bank of New England. Prior, he held the position of Senior Consultant at Technology Consulting Group in Boston. Tom holds a BS in Electrical Engineering from Lafayette College, as well as a dual Masters in Business Administration and Manufacturing Engineering from Boston University.

Craig M. Schoen, contributing author
National Sales Manager, AirSpade Division

Craig's goal is to provide end-users with the safest and most effective air excavation tools on the market. He enjoys educating new customers on the benefits of AirSpade and working in the field with end-users. Prior to AirSpade, Craig held the position of Northeast Sales Manager for Makita Power Tools where he worked extensively within the utility market. Craig received his BA in Corporate Communications and Public Relations from Bridgewater State University.

STIMSON

Ngoc Doan, project manager
Marketing Coordinator

Ngoc is a designer at STIMSON in the Cambridge, MA studio. Ngoc has worked on multiple awarding winning institutional and public projects such as Pulaski Park and award winning UMASS Design Building. Ngoc holds a Master of Landscape Architecture from the University of Massachusetts Amherst and a Bachelor of Arts from Boston College. As a student, Ngoc received multiple awards and recognition: University Olmsted Scholar, BSLA Honor Award, ASLA Merit Award, James Rose Suburbia Transformed 2.0 Exhibition, BSLA Scholarship, and UMass MLA Scholarships. After completing her Masters degree, Ngoc pursued photography while working as a landscape designer and became fascinated with documenting built landscapes. She works as a marketing coordinator, landscape designer and office photographer.

Stephen Stimson, FASLA, reviewer
President

Born and raised on a dairy farm, Stephen's agrarian heritage has inspired and shaped the landscapes he has created across New England and the country. He received his education from the University of Massachusetts and the Harvard Graduate School of Design and has been practicing landscape architecture for over twenty years, founding the firm in 1992. His work has been widely recognized with numerous awards from the Boston Society of Landscape Architects and the American Society of Landscape Architects. He has taught at the Harvard Graduate School of Design and lectured and served on design juries at the University of Massachusetts, Rhode Island School of Design, and Roger Williams University. Stephen was elected as a Fellow of the American Society of Landscape Architects in 2004 for his outstanding achievements in the field of landscape architecture. For the past five years, he has been cultivating Charbrook Nursery for project use and field research related to native plant propagation, collected species, planted forms, and soil specifications.

Utility AirSpade Technical Applications Bulletin

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