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MANUAL FOR CONTROLLING AND REDUCING THE FREQUENCY OF PAVEMENT UTILITY CUTS

Final Report

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16. Abstract

At an alarming rate, pavement utility cuts are becoming a major problem in the pavement infrastructure of the United States. Not only is the number of overall utility customers increasing with the growing US population, new and widely variable types of utilities are being developed constantly. In the first half of the twentieth century, the major utilities included water, wastewater, electricity, telephone and natural gas. By the end of the twentieth century, the volume and variety of utilities have increased dramatically, including cable television, an unprecedented increase in telephone customers, fiber optics, internet-related technology and cabling, and others.

This report is intended as a manual to provide basic information regarding methods that government agencies can use to reduce, or at least to control, street cuts and minimize damage to public infrastructure due to the ever-increasing activity of new and existing utility companies. This report also describes the problems associated with extensive pavement utility cuts, and recommends potential solutions based on the policies and technologies discussed in the manual. Such recommendations include the implementation of incentive- fee- and requirements-based policies, and the promotion and advancement of trenchless technology applications. Recommendations in this manual can be used by cities, states, and other local governmental agencies to reduce or control the frequency of pavement utility cuts in the agency's pavements.

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MANUAL FOR CONTROLLING AND REDUCING THE FREQUENCY OF PAVEMENT UTILITY CUTS

PREFACE

This manual is intended to provide guidance and support for state and local rights-of-way (ROW) and public works agencies in developing policies and in promoting technologies for controlling or reducing the frequency of utility cuts in pavement infrastructure. The primary focus of this manual is the potential for policies that may be implemented and technologies that may be encouraged by individual agencies to control and reduce the frequency of utility cuts in pavements. Current and potential uses of trenchless technology are discussed to provide a basic technical background of, and to inform the users of this manual about, methods available to help reduce the frequency of pavement utility cuts.

The primary audience of this manual is the state and local utilities and ROW manager charged with the responsibility of protecting and regulating an agency's rights-of-way. With such a substantial responsibility, mixed with constrained resources yet ever-increasing demands from utility providers, state and local highway agencies must find ways to manage and control access to the ROW. By so doing, they attempt to preserve the functional life of ROW assets and minimize the life-cycle cost of the facilities.

This manual is organized into five chapters. The first two chapters give a general background of the problems that have arisen throughout the United States and preview potential solutions to these problems. Chapter 1 describes the policies that may be implemented by various local and state agencies to control the frequency of pavement utility cuts. Chapter 4 discusses the technology available for reducing the frequency of these cuts by encouraging trenchless technologies, where possible, and in reducing the impact to existing facilities (utilities or public assets) when using either open-trench or trenchless methods. Section 4.5 presents several innovations that may be used in the near future to reduce the requirements for open-trenching methods of utility construction and maintenance even further. Chapter 5 highlights recommended policies and practices for controlling and reducing the frequency of utility cuts in highways and streets throughout the Nation.

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
	AREA			
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
	VOLUME			
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 l shall be shown in m^3.				
	MASS			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
	ILLUMINATION			
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
	FORCE and PRESSURE or STRESS			
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
	AREA			
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
	VOLUME			
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
	MASS			
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
	TEMPERATURE (exact)			
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
	ILLUMINATION			
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE and PRESSURE or STRESS			
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

MANUAL FOR CONTROLLING AND REDUCING THE FREQUENCY OF PAVEMENT UTILITY CUTS

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CHAPTER 1 INTRODUCTION

This manual for controlling and reducing the frequency of pavement utility cuts was developed to provide information to states and municipalities as they try to protect their infrastructure and maintain control of access to their rights-of-way. The manual addresses two major topics: *Controlling Pavement Cuts by Implementing Policy* and *Reducing Pavement Cuts by Integrating Technology*. On the policy side, several different types of policies and regulations are presented, with case studies and sample ordinances and regulations. The technology portion of the manual gives a brief overview of various trenchless technology methods, their advantages and disadvantages, and other pertinent information about implementing this type of technology in utility construction. The information contained in this manual should be used as a starting point for an investigation into the types of policies and technologies available to the public sector to help control and possibly reduce the frequency of pavement utility cuts in the national and local infrastructure.

1.1 Background

Public policy developments to control pavement utility cuts in highways and streets, and to minimize damage to public infrastructure, evolved from requirements outlined in city and state codes for emergency rules to control the rights-of-way access demands of new telecommunication companies. The rush of new companies requesting access magnified the need for better control of utility street cuts and improved standards for how cuts are repaired.

Agencies began to realize that excessive utility cuts in pavements under their responsibility were causing premature deterioration of the pavement structures. They also realized that additional money was required to maintain these pavement structures at acceptable levels of serviceability. One method of recovering the cost of damaged pavements is to require the utility company performing the work to pay a fee commensurate with the damage done to the pavement. However, the agencies first had to find or develop a method of quantifying the damage done to pavements by utility trenching. These methods will be discussed briefly in a later chapter.

Another way that agencies have been resisting the increased requests for access has been to require the use of trenchless technologies, where possible. Such policies can reduce disruption to the pavement structure and to the traveling public. As interest in trenchless technology has increased, the technology itself has been advanced, and its overall cost reduced, to a point where it is becoming more competitive with traditional trenching methods for utility construction. Other related technologies and methods, such as subsurface utility engineering, in-place pipe inspection, and others have advanced significantly during the same period.

1.2 Objectives of Manual

The primary objective of this manual is to provide help to the state and local ROW and utility managers in controlling and reducing the frequency of pavement utility cuts. The two major chapters of this manual provide guidance in the areas of policy and technology, as each relates to the control and reduction of utility cuts. Secondary objectives of the manual include making information available to agencies, utility companies, and other organizations about such policies and technologies. Although this manual cannot address all the available information about the subjects, it includes references to other sources covering a very broad range of topics.

Information regarding potential policies that agencies may support in order to control the frequency of utility cuts in pavements is included in this manual, as well as sample ordinances and regulations that have been used successfully by other agencies. The manual also includes information regarding potential difficulties and complications that enacting agencies should avoid.

With respect to trenchless technologies, additional information is contained in this manual including additional technologies that are designed to reduce the risk involved in trenchless construction, methods of performing cost-benefit analyses, sources of technical and operational information, and suggestions on matching construction methods with conditions at the site.

1.3 Examples of Existing Problem

Many states, counties, and cities have seen the effects of excessive pavement utility cuts in their highways and streets. Potential problems that can arise from uncontrolled and frequent utility cuts include, but are not limited to:

- Excessive delays to the traveling public due to closed traffic lanes.
- Increased traffic congestion and related air quality issues.
- Damage to vehicles due to excessive road roughness.
- Rapidly deteriorating pavement structures in the vicinity of the cuts.
- Accelerated funding requirements to maintain, rehabilitate, and reconstruct prematurely failed pavement structures.

As an example, in 1996 alone, the District of Columbia, with about 2,092 center line km (1,300 mi) of pavement, (with an estimated value of over $3.4 billion allowed over 5,000 utility cuts, and the DC Department of Public Works (DCDPW) estimated over 6,000 cuts in 2000.[1] In 1996, the combined area of the utility cuts in the District was over one percent of the total pavement surface area. Permit fees for utility cuts in the District in 1996 were simply $24 per street, meaning that a single permit allowed the entire street to be cut as many times as the permittee deemed necessary. In addition to the permit fee, the permittee was required to provide a temporary patch, and to pay for a permanent repair by DCDPW, which at times was performed up to two years later. According to DCDPW, this two-year delay was generally necessitated due to lack of funds for street maintenance and rehabilitation. Had the District had the policies in place to recover adequate funds for maintaining the pavement structure, and the knowledge and encouragement to request the use of trenchless technologies (where appropriate), the number of cuts could have been reduced, and the quality and timeliness of the permanent repairs could have been improved.

Many other agencies have experienced similar problems with excessive pavement utility cuts. In the past, cities have experienced this type of problem primarily due to the large and concentrated demand for services. State and county roads located in urban areas, however, have also experienced this growth in access demands and problems related to it. Other cities that have conducted studies to quantify the damage to their streets from excessive utility cuts include San Francisco and San Diego, CA, Austin, TX, Cincinnati, OH, Burlington, VT, and others. (See references 2, 3, 4, 5, and 6.) These studies found that street cuts not only reduce the life of the pavements, but also cost millions of dollars to agencies in premature repair and street remediation expenses. Other financial impacts from utility cuts and poor repairs include traffic delays, increased congestion in urban areas, and damage to both public and private vehicles.

1.4 Impacts of Pavement Utility Cuts

Some of the potential impacts of pavement utility cuts were mentioned in section 1.3. Other impacts include the perception of the public, which often is of the opinion that the state or city is always working on the roads, and that road construction never ends. Additional impacts include other indirect costs, or those that cannot be directly quantified, localized air quality, and the financial impact to local businesses whose access is impeded due to construction work zones.

As demand for access to the public ROW increases, these impacts will become more prevalent as long as traditional trenching remains the predominant form of utility construction. The effect on

pavement deterioration is likely to become more pronounced as states, counties and cities continue to struggle with diminishing budgets and increasing pavement deterioration. Without means of repairing prematurely deteriorated pavements in a timely manner, these agencies expect greater backlogs in maintenance and rehabilitation requirements. A brief discussion of these impacts on the public infrastructure and the driving public is given in chapter 2.

1.5 Background of 1996 Telecommunications Act

On February 8, 1996, President Clinton signed the Telecommunications Act of 1996 (the Act) into law. Overall, the intent of the bill was the development of competition in the telecommunications marketplace by allowing local telephone exchange carriers to provide long distance telephone service, as well as cable television, audio services, video programming services, interactive telecommunications and Internet access. Similarly, long distance providers, cable operators and utilities are now permitted to offer local exchange telephone service. The legislation represents the first major rewrite of the Telecommunications Act of 1934. It is complex and the rules and regulations adopted to implement the Act have a significant impact on a state and/or local government's authority to manage access to, and use of, the ROW under its authority.

Nationally, state legislatures have passed legislation that limit the basis for which ROW rental fees can be charged. In some cases, state and local governments' rental and franchise fees have been limited to the actual cost for regulating access to ROW. Around the United States, state and local governments are taking steps to re-examine current ROW management policies subject to the 1996 Act. The proliferation of new technologies has resulted in additional demands being placed on the allocation of public property. As both the trustee and the landlord of the public ROW, state and local governments have an obligation to develop a framework that provides for efficient and cost effective management of the rights-of-way, protection of public safety; and maximizes revenue and recovers costs associated with the regulation and management of rights-of-way access.

Moreover, the framework adopted by state and local governments must establish a level playing field that will allow qualified providers within each classification of service to enter the market on a competitively neutral basis. Thus, jurisdictions need to examine existing rights-of-way access policies, fees and compensation methods to assure the proposed policies and fee structures are implemented on a fair and competitively neutral basis.

1.5.1 Section 253

The Telecommunications Act of 1996 effectively deregulated the telecommunications industry. Some of the effects of the Act include the following:

- Affects every provider of telecommunications services.
- Has numerous implications for local governments.
- Encourages new entrants into the marketplace to compete with incumbent providers in all aspects of telecommunications.
- Removes regulatory barriers to entry and allows existing providers to enter into new arenas to compete with each other.
- Encourages the proliferation of new technologies.
- Addresses the convergence in technology in the cable and telecommunications industries.
- Has resulted in additional demands being placed on the public rights-of-way and roadways.

Section 253 of the Act focuses on the Federal Communication Commission (FCC) and court decisions that directly impinge on the authority of local governments to regulate telecommunications providers. Significant issues discussed in this section follow. (In this and other chapters, legal citations are given as footnotes, numbered separately from references, and are shown at the bottom of

each page rather than at the end of the report. Footnote callouts are in superscript without parentheses, whereas reference callouts are superscript with parentheses.)

1. No state or local statute, regulation or other requirement may prohibit or have the effect of prohibiting the ability of any entity to provide interstate or intrastate telecommunication service. The FCC is authorized to preempt enforcement of state or local law, regulation or requirement that violates this provision.[1]
2. Nothing in Section 253 affects the ability of a state to impose, on a competitively neutral basis and consistent with provisions of the Act on universal service, requirements necessary to preserve and advance universal service, protect the public safety and welfare, ensure the continued quality of telecommunications services, and safeguard the rights of consumers. The FCC is authorized to preempt enforcement of state or local law, regulation or requirement that violates this provision.[2]
3. Nothing in Section 253 affects the authority of state and local governments to manage public ROW and require fair and reasonable compensation, on a competitively neutral and nondiscriminatory basis, for use of public ROW.[3]

1.5.2 Court Actions

Interpretation and implementation of provisions outlined in the Act has varied from state to state. Thus, numerous litigations have been prosecuted, resulting in precedent-setting US District Court rulings. The following details some of the significant cases and the result of their subsequent rulings that, in many cases, supports a jurisdiction's authority to manage its ROW. Additionally, the rulings on these selected cases can be referenced to develop franchise, license, and ROW agreement provisions (including compensation).

- ***TCG Detroit v. City of Dearborn*** District court first held that Section 253(c) grants TCG Detroit an implied private right of action against the City of Dearborn. In a subsequent decision, the district court upheld the city ordinance, noting, among other things: (i) the city has the right to charge "rent" for rights-of-way; (ii) four percent franchise fee is "fair and reasonable"; and (iii) the city does not violate Section 253 by imposing comparable, but not identical, agreements. On appeal, the Sixth Circuit Court of Appeals affirmed both district court decisions. Finally, the Court of Appeals interpreted Section 253 to imply a private right of action "for those claiming barrier-to-entry injury". The court also held that the fact that state law prohibits the city from charging the incumbent carrier a franchise fee does not mean that the city discriminated against other carriers by assessing such a franchise fee.[4]
- ***AT&T Communications of the Southwest, Inc. v. City of Austin*** Section 253 does not grant the FCC exclusive jurisdiction over AT&T's challenge to the City's ordinance that requires a telecommunications operator to obtain consent from the local government before offering telecommunications services. The court rejects the notion that a provider that does not install or own facilities in the city's rights-of-way is "using" the rights-of-way. In a subsequent related proceeding, the court issued permanent injunction against enforcement of the City's ordinance with respect to AT&T.[5]

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1 Section 253(a)

2 Section 253(b)

3 Section 253(c)

4 TCG Detroit v. City of Dearborn, 977 F. Supp. 836 (E.D. Mich. 1997); TCG Detroit v. City of Dearborn, 16 F. Supp.2d 785 (E.D. Mich. 1998); TCG Detroit v. City of Dearborn, 206 F.3d 618 (6th Cir. 2000)

5 AT&T Communications of the Southwest, Inc. v. City of Austin, 975 F. Supp. 928 (W.D. Tex. 1997); AT&T Communications of the Southwest, Inc. v. City of Austin, 40 F. Supp.2d 852 (W.D. Tex. 1998)

- ***AT&T Communications of the Southwest, Inc. v. City of Dallas*** US District Court upheld Dallas' requirement that AT&T obtain a franchise and pay a reasonable franchise fee based on the use of the city rights-of-way for company's planned use of its existing fiber optic facilities to provide a new service called "AT&T Digital Link." The court held that Dallas does not have power under state and federal law to require a comprehensive franchise application, to consider factors such as the company's technical and organizational qualifications, or to place conditions on the franchise unrelated to use of the city's rights-of-way. The court noted that Section 253 does not require a city to impose the same fee on all providers. In a related case, the court granted preliminary injunction against enforcement of the city's ordinance with respect to a telecommunications provider that does not install or own facilities in the public rights-of-way.[6]
- ***BellSouth Telecommunications, Inc. v. City of Coral Springs*** Issuing a declaratory judgment, the court held that under Section 253, state law preempts a local ordinance that (a) specified an amount of compensation for use of rights-of-way that exceeded the limit permitted by state law, (b) required the applicant to submit proof of its financial, technical and legal qualifications, and (c) required compliance with the municipality's universal service plan. Additionally, the court stated the decision to grant a franchise may not be left to the municipality's discretion; it may only be conditioned on the company's agreement to comply with reasonable regulations for managing the use of the municipality's rights-of-way.[7]
- ***Bell Atlantic-Maryland, Inc. v. Prince George's County*** The district court held that any process for entry that imposes burdensome requirements on telecommunications companies and vests significant discretion in local governments to grant or deny permission to use rights-of-way may have the effect of prohibiting the provision of telecommunications services in violation of Section 253. Also, the court held that local governments may not set franchise fees above a level that is reasonably calculated to compensate for the costs of administering franchise programs and of maintaining and improving public rights-of-way. Finally, the court held that unless a telecommunications company doing business in the county physically impacts the rights-of-way by installing, modifying or removing lines and facilities, it is not using the rights-of-way within the meaning of Section 253(c). On appeal, the Fourth District Court vacated and remanded the case directing the district court to address Bell Atlantic's state law claims before turning to the issue of federal preemption under Section 253. The circuit court did not discuss the merits of Bell Atlantic's Section 253 complaint.[8]
- ***Omnipoint Communications, Inc. v. The Port Authority of New York and New Jersey*** The District court denied the wireless communications services provider's motion for a preliminary injunction to mandate that the Port Authority allow installation of antennae at JFK airport and the Lincoln and Holland tunnels. Omnipoint failed to show a clear or substantial likelihood that it would succeed under Section 253 because negotiations regarding the fee for rights-of-way use had not concluded. Therefore, the court could not determine whether the fee was fair or reasonable. The court found that the proposed terms did not unreasonably discriminate against Omnipoint. Finally, the court held that the Port Authority's objections to installing antennae in the tunnels were permitted management functions under Section 253(c).[9]

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6 AT&T Communications of the Southwest, Inc. v. City of Dallas, 8 F. Supp.2d 582 (N.D. Tex. 1998); AT&T Communications of the Southwest, Inc. v. City of Dallas, 52 F. Supp.2d 756 (N.D. Tex. 1998)

7 BellSouth Telecommunications, Inc. v. City of Coral Springs, 42 F. Supp.2d 1304 (S.D. Fla. 1999)

8 Bell Atlantic-Maryland, Inc. v. Prince George's County, 49 F. Supp.2d 805 (D. Md. 1999); Bell Atlantic-Maryland, Inc. v. Prince George's County, 212 F.3d 863 (4th Cir. 2000)

9 Omnipoint Communications, Inc. v. The Port Authority of New York and New Jersey, No. 99 Civ. 0060(BJS), 1999 WL 494120 (S.D.N.Y. July 13, 1999)

1.5.3 FCC Actions

The FCC has oversight and responsibility for ensuring the provisions of the Act are properly interpreted and implemented. In many cases, disputes between a jurisdiction and utility are forwarded to the FCC first for opinion and/or ruling prior to pursuing litigation efforts. Some of the noteworthy actions taken by the FCC are detailed below.

- ***Petition of the State of Minnesota for a Declaratory Ruling Regarding the Effect of Section 253 on an Agreement to Install Fiber Optic Wholesale Transport Capacity in State Freeway ROW*** The State of Minnesota sought a declaratory ruling that its plan to grant a provider of wholesale fiber optic transport capacity exclusive access to State freeway rights does not violate Section 253 because the proposal requires the provider, on a competitively neutral and nondiscriminatory basis, to (1) install fiber capacity owned by third parties and (2) make capacity of its own system available through purchase and/or lease to all interested telecommunications service providers. The FCC declined to endorse the agreement because the exclusive nature of the agreement may have the effect of prohibiting the provision of a telecommunications service. The FCC held that Section 253 applied to the agreement but declined to preempt the States' authority to grant the exclusive rights. Instead, the FCC concluded that the provider's implementation of the agreement might mitigate the FCC's anti-competitive concerns. Therefore, the FCC warned that it would scrutinize the agreement's implementation in considering subsequent preemption petitions.[10]
- ***Public Utility Commission of Texas, Memorandum Opinion and Order*** The FCC did not preempt enforcement of a state statutory prohibition on provision of telecommunications services by a municipality. Additionally, the FCC held that municipalities are not separate entities from a state for purposes of applying Section 253(a).[11]
- ***Classic Telephone, Inc., Memorandum Opinion and Order*** The FCC clarified that to the extent authorized under state law, local governments have authority to require franchises from telecommunications service providers and exercise authority pursuant to Section 253(b). The FCC concluded that the manner in which certain franchise requirements were implemented by the cities in the Classic case was preempted by Section 253(a).[12]
- ***TCI Cablevision of Oakland County, Inc., Memorandum Opinion and Order*** The FCC held that the City of Troy, Michigan placed a telecommunications condition on its grant of cable permits in violation of Title VI. Therefore, the FCC declined to preempt the local ordinance pursuant to Section 253.[13]
- ***Petition for Declaratory Ruling of the Cellular Telecommunications Industry Association (CTIA), Public Notice*** The FCC tentatively concluded that unlimited moratoria on the siting of wireless telecommunications facilities may constitute an impermissible barrier into the local telecommunications market. The FCC further indicated that Section 253 does not preempt necessarily moratoria of short and fixed terms. Subsequently, the FCC's Local and State Government Advisory Committee and organizations representing the wireless telecommunications industry reached an agreement that (1) establishes guidelines for facilities siting implementation;

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10 Petition of the State of Minnesota for a Declaratory Ruling Regarding the Effect of Section 253 on an Agreement to Install Fiber Optic Wholesale transport Capacity in State Freeway Rights-of-Way, Memorandum Opinion and Order, 14 FCC Rcd. 21,697 (1999)

11 Public Utility Commission of Texas, Memorandum Opinion and Order, 13 FCC Rcd. 3460 (1997) review denied sub nom. City of Abilene v. FCC, 164 F.3d 49 (D.C. Cir. 1999)

12 Classic Telephone, Inc., Memorandum Opinion and Order, 11 FCC Rcd. 13, 082 (1996), appeal filed sub nom. City of Bogue, Kansas v. FCC, No. 96-1432, 1997 WL 68331 (D.C. Cir. Jan. 14, 1997)

13 TCI Cablevision of Oakland County, Inc., Memorandum Opinion and Order, 12 FCC Rcd, 21,396 (1997), partial recons. Denied, Order of Reconsideration, 13 FCC Rcd. 16,400 (1998)

and (2) adopts an informal dispute resolution process. As a result of this agreement, CTIA withdrew its petition.[14]

1.5.4 State and Local Efforts

Both state and local jurisdictions have exerted efforts to comply with provisions of the Act as it relates to policies and fees assessed for utilization of the ROW. States, for the most part, have implemented Shared Resource agreements which is a public-private arrangement involving the sharing of the public resource of ROW. State transportation departments are very knowledgeable about regulations on safety, utility accommodations and ROW management. However, the policies and fee structures vary from state to state. The same scenario exists for local governments who enter into either a franchise agreement or rights-of-way rental agreement with utilities who wish to utilize the ROW to construct their facilities or conduct maintenance on existing facilities. Fees that are assessed by either the state or local jurisdiction vary.

1.6 Overview of Methods

The two major areas of this manual for potentially beneficial methods for controlling or reducing the frequency of pavement utility cuts are *Implementation of Policy* and *Integration of Technology*. This section provides an overview of the methods that will be presented and the general format of the information that is included in this manual. Policy implementation focuses primarily on controlling the frequency of pavement utility cuts, whereas technology integration focuses on methods of reducing their number.

1.6.1 Implementation of Policy

Local governments today are implementing public policy initiatives that are designed to improve the quality of street cut repairs as well as encourage joint use of facilities. Strategies used by these agencies generally fall into three categories: incentives, fees, and regulations. Examples of incentive-based policies include providing financial incentives for:

- Using trenchless technology where technically suitable (and requiring justification for not using trenchless technology when the agency deems it suitable).
- Performing higher quality pavement cut repairs, or for making smaller or less-damaging cuts.
- Coordinating with other utility companies to share trenches or underground resources.

Examples of fee-based policies include:

- Assessing appropriate fees for pavement degradation.
- Assessing appropriate permit fees.
- Implementing a lane rental fee to encourage utility companies to restore traffic as quickly as possible.
- Requiring a deposit prior to beginning work to protect against poor repairs.
- Assessing penalties for non-compliance or for failed repairs within a specified period.

Examples of regulation-based policies include those that do not require fees nor provide incentives, but place requirements on the contractor regarding quality of work, and restrictions on when and where trenching can be done. Examples of this type include:

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[14] Petition for Declaratory Ruling of the Cellular Telecommunications Industry Association, Public Notice, 12 FCC Rcd. 11,795 (1997); Agreement of FCC Local and State Government Advisory Committee, the Cellular Telecommunications Industry Association, the Personal Communications Industry Association and the American Mobile Telecommunications Association, 1998 WL 442941 (Aug. 5, 1998)

- Establishing moratorium periods that restrict trenching in new and newly resurfaced pavements for a specified time.
- Requiring the pavement repair to encompass a larger area than simply the area of the trench.
- Enhancing inspections and enforcement of specification requirements.
- Requiring agency-owned utilities to meet repair quality standards and all other policies established for private utility companies.

These strategies, along with examples of in-place policies that have worked for various state and local agencies, will be described in more detail in chapter 1.

1.6.2 Integration of Technology

Just as state and local governments are facing the challenges of dramatically increased demand for access to the public ROW, new technologies are being developed and implemented to reduce the impact to the public and to the national infrastructure.

Chapter 4 in this manual provides a brief description of the technological applications and related methods available and that are currently used in utility construction and maintenance applications. This chapter introduces the various types of trenchless technology with advantages and disadvantages of each method, information on specifications, where applicable, and references to abundant existing information about each aspect of the technology. Chapter 4 also summarizes information obtained from other sources regarding the best application of technology for specific project conditions, and a range of unit costs for each method.

CHAPTER 2 DISCUSSION OF THE PROBLEM

This chapter of the manual describes the effects of excessive pavement utility cuts in the Nation's infrastructure. This discussion focuses on the degradation of the pavement and other public ROW infrastructure. In addition, this chapter considers the impacts on the public through user costs, traffic delay and business access, and the differences between state and local agencies in the methods of dealing with these impacts.

2.1 Degradation of National and Local Infrastructure

When utility companies, and others, make cuts into the pavement for utility installation or maintenance, not only does it affect the pavement structure itself, but also the other utilities which, with the pavement, are part of the national and local transportation infrastructure. This section includes a discussion on how utility cuts cause street pavements to deteriorate more quickly, and their potential effect on other utilities present in the highway and street system.

2.1.1 Untimely Pavement Deterioration

Utility cuts into the pavement of the Nation's highways and streets almost always increase the roughness of a pavement structure in both the immediate and surrounding areas of a cut. Not only do cuts increase pavement roughness, but they also introduce discontinuities in the pavement structure. Both of these can cause the pavement's expected life span to decrease. There are two types of degradation that can occur – structural and functional – both of which can cause early failure of the pavement, depending on the user's definition of pavement failure.

Structural Structural failure occurs when the pavement can no longer carry the loads for which it was designed without large deflections or deformations.[7]

Functional Functional failure occurs when the pavement no longer provides a smooth and safe riding surface for vehicles and passengers. A pavement can sometimes experience functional failure while remaining structurally sound. However, it is even less likely that a pavement that has experienced structural failure will remain functionally adequate.

Another aspect of pavement degradation is that a rough pavement can quickly lead to structural failure, through a synergistic effect. Rough pavements can cause vehicles to bounce, thus creating greater loads on the pavement, which can lead to more rapid advancement of structural failure, and by consequence, further functional failure, or roughness.

2.1.2 Congestion of Utilities

The chances of accidental rupture of existing underground utilities increase with increased congestion, or the density of utilities underground. This is not a problem solely associated with trenchless technology. Open trenching also poses a risk of disturbing existing utilities. In rural applications, the probability of encountering densely situated existing utilities is much lower. However, care should be taken to ensure any existing utilities are identified and located.

Public and private utilities are most often located in the public ROW, meaning that access to underground physical facilities often results in digging and backfilling trenches. Many times this means trenching into public roads: city streets, highways, and other public transportation facilities. While it is true that the utility companies' financial success depends on their ability to place facilities and provide services to customers as quickly as possible, the detrimental effects on the public transportation infrastructure has been largely overlooked in the past.

San Francisco, like many other cities in the Nation, confirmed its suspicion about the damage caused by utility street cuts after completing a study on the effects of cuts on the life of pavement.[2] The

cities of Austin, Cincinnati, and Washington, DC, also conducted similar studies within the past six years.[4,5,1] These studies found that street cuts not only reduce the expected life of the streets but consequently cost millions of dollars to agencies in premature repair and street remediation expenses. Other financial impacts from utility cuts and poor repairs include traffic delays, increased congestion in urban areas and damage to both public and private vehicles.

2.2 Public Impacts

There are several types of impacts that excessive trenching and utility cuts can have on the public. These include those that cause a direct cost to the public in terms of money, and those that have indirect, or intangible, costs. Direct impacts are generally those that the public pays individually or collectively, whereas indirect impacts include those which are paid by society as a whole, and to which a specific price cannot be easily affixed.

2.2.1 Public Perception

In the public's perception, the highways and streets seem to be under construction constantly. If the road network is improved as a result of this construction, the public perception could become more positive. However, a poor perception is often the result, due to the endless presence of utility cuts and other road construction.

The public quickly notices when a newly-paved highway or street is cut for utility work. In the absence of a moratorium on cuts, or in an atmosphere of lenient enforcement of such a moratorium, pavement utility cuts can occur in new pavements quite frequently.

The ability to reduce the number of pavement utility cuts would have the obvious effect of reducing the number of work zones and pavement roughness. If an agency can encourage more utility work to be done using trenchless technology, the public is likely to notice. With the ability to control pavement utility cuts more closely, improved inspection could lead to better and more timely repairs, more coordination and sharing of information and resources between utility companies, and a better public perception of the agency and the infrastructure.

2.2.2 Traffic Delay

When a lane of traffic is temporarily made unavailable, and especially in areas of heavy traffic, vehicles can be delayed due to decreased traffic capacity.[8] If utility cuts are coordinated with joint trenching requirements, traffic delays can be minimized. Other impacts associated with traffic delay include costs to local businesses, user costs, air quality, and others. These will be discussed in the next sections.

2.2.3 Local Business

Lane closures and other traffic control associated with utility cuts can impact local business by either limiting access to the business, or by deterring potential customers from navigating around the traffic control. Especially in conditions of heavy traffic, motorists may choose to visit businesses in another location rather than spend additional time in traffic congestion caused by a utility cut work zone.

These costs are rarely quantifiable, but can result in significant impacts to local businesses. The importance of this impact is evident by the fact that most state and local transportation agencies require local business access mitigation for road construction or utility work.

2.2.4 User Costs

Direct impacts to users of a facility are often called user costs. These costs can include tangible items such as excess fuel, oil, maintenance, and time expended while negotiating a work zone, and the associated traffic congestion that often accompanies lane closures. Several studies have been conducted to quantify user costs in various situations and work zone configurations.[9,10,11]

Many of these user costs are also borne by the traveling public after the work zone has been removed, when a rough pavement remains. Studies have shown the relative incremental increase in user costs due to pavement roughness.[8,12,13]

2.2.5 Air Quality

While users of a highway or street facility accumulate costs due to the presence of a work zone, their excess fuel and oil consumed is creating additional vehicular emissions that contribute to the deterioration of the air quality. This effect is most pronounced in the immediate area of the work zone, but in urban areas, the excess emissions also contribute to the detriment of the overall air quality.[14,15]

2.2.6 Untimely Pavement Deterioration

The public pays the cost of untimely pavement deterioration either directly through premature maintenance and rehabilitation, or indirectly through the effect of rough roads on their vehicles. It is very difficult, if not impossible, to repair a pavement that has been cut to its original state. More appropriately, it is very difficult, if not impossible, to make a repair match the *current* state of the surrounding pavement's physical properties. Any other condition other than the pavement's current state can result in a rough surface to some degree. At the time of the repair, the pavement surface may be very smooth across the patched utility cut. However, after vehicles load the patch material for a time, differential material deformation is inevitable, of which roughness is a direct effect.[4]

While improved inspection and quality control on the part of the contractor can reduce the ultimate pavement roughness due to the cut, it is almost impossible to prevent it completely. Only a reduction in the number of utility cuts can preserve the pavement in its current, original state.

CHAPTER 3 CONTROLLING PAVEMENT CUTS BY IMPLEMENTING POLICY

While policies alone may not reduce the frequency of pavement utility cuts, certain types of policies should be implemented to control such things as the quality of repairs, the timing of utility cuts, or the information concerning cuts and repairs. These and other topics have become matters of great concern for state and local agencies who wish to control the access to their ROW but receive an overwhelming amount of requests from numerous entities.

This chapter discusses the types of policies available to state and local agencies; issues at the local, state and federal level regarding their implementation; several examples of successful policies and their implementation; and a survey describing the current state of practice among state highway agency policy.

3.1 Definitions

Some basic definitions with respect to right-of-way management, regulations, ordinances and policies are included in this section.

Adjacent Land Value - To establish the ROW rental value based on the market value of its adjacent property value. In this ROW compensation method, the market value of adjacent property (land only) per square foot is assigned to the related rights-of-way.

Combination Gross Revenue/Linear Foot Fee - A right-of-way compensation methodology that is adopted with certain telecommunications providers who may not generate significant revenues for a period of time. In this case, the local jurisdiction will implement the linear foot fee assessment until the company generates a mutually negotiated level of revenues. Upon achievement of the agreed upon revenue level, the percent of gross revenue methodology would then be implemented for the life of the franchise.

Degradation Fee - The estimated fee established at the time of permitting by the local government unit to recover costs associated with the decrease in the useful life of the right-of-way caused by the excavation.

Excavation - Any work in the surface or subsurface of the public ROW, including, but not limited to opening the public ROW; installing, servicing, repairing or modifying any facility(ies) in or under the surface or subsurface of the public right-of-way, and restoring the surface and subsurface of the public right-of-way.

Facility - Any tangible asset in the public right-of-way required to provide utility service. Includes any and all cables, cabinets, ducts, conduits, converters, equipment, drains, handholds, manholes, pipes, pipelines, splice boxes, surface location markers, tracks, tunnels, utilities, vaults, and other appurtenances or tangible things owned, leased, operated, or licensed by an owner or person that are located or are proposed to be located in the public right-of-way.

Fee per Access Line - The right-of-way compensation methodology that is rapidly replacing the percent of gross revenue formula historically used in franchise/rental agreements for local exchange telephone companies where a fee is assessed per access line.

Flat Annual Fee - Right-of-way compensation that many local jurisdictions are adopting to ensure receipt of a known revenue amount annually. Typically, franchise agreements that require this type of compensation will also include a provision allowing for a yearly escalator or inflation factor to adjust the annual fee for increases in service provided by the effected utility.

Franchise Agreement - An agreement executed to manage the occupant of public right-of-way. This document includes the rules, rights, and fees associated with using public property for private purpose and are applicable for those right-of-way occupants that provide services to the local, county and state jurisdictions.

In-kind Service - In-kind services received that can be negotiated in addition to or in lieu of cash to be used over a period of time, or infrastructure to be specified and installed.

License Agreements - Written for firms that are simply traveling through the area with facilities that serve other communities.

Linear Foot Fee - Rights-of-way compensation methodology that is typically utilized when the rights-of-way occupants require space along a specific route or for a limited purpose within the public rights-of-way.

Percentage of Gross Revenue - The most common method of compensation for use of the ROW when the utility requires ubiquitous access to the ROW.

Public Right-of-Way - The area across, along, beneath, in, on, over (above), under, upon, and within the dedicated public alleys, boulevards, bridges, courts, freeways, highways, lanes, parks, parkways, rivers, roads, sidewalks, spaces, streets, tunnels, viaducts, and any other place, area, or real property, other than real property owned in fee by a jurisdiction.

Restoration - The process by which an excavated public right-of-way and surrounding area, including pavement and foundation, is returned to the same or better condition that existed before excavation.

Trench - An excavation in the pavement, with the excavation having a length equal to or greater than the width of the pavement.

Utility Excavator - Any owner whose facility or facilities in the public right-of-way are used to provide electricity, gas, information services, sewer service, steam, telecommunications, traffic controls, transit service, video, water, or other services to customers.

Utility Service - Includes 1) those services provided by a public utility as defined in respective State Statutes; 2) service provided by, or the transporting of voice or data information by, a telecommunications right-of-way user as defined in respective State Statues; 3) service provided by cable communications systems as defined in respective State Statutes; 4) natural gas or electric energy or telecommunications service provided by a local government unit; 5) service provided by a cooperative electric association organized under the provisions of respective State Statutes; and 6) water, sewer, district cooling or heating systems.

3.2 Legislative Issues Regarding Policy Implementation

There are many issues regarding the ability of states and local municipalities to enact legislation and ordinances concerning utility construction and maintenance. Possibly the most important is the Telecommunications Act of 1996. This, and other aspects of the regulatory climate must be considered by agencies when developing policies, and when implementing them with regulations and ordinances. This section provides some basic information and points to consider regarding these issues.

3.2.1 Federal – 1996 Telecommunications Act

Implementation of the Act has had a major impact on jurisdictions. Some of the issues they have faced concerning telecommunications and cable television in the legislature are: [14]

- *Restrictions on a jurisdiction's right to control its rights-of-way*
  In many states, the telecommunication industry has supported legislation that requires standardized franchise agreements. Such legislation has taken the form of preventing cities from requiring telecommunications providers from making limited street cuts, or providing acceptable bonds or insurance or burying their cables in certain instances.

- *Limits on franchise fees, property taxes and other revenue*
  A number of states have limited the ability of local governments to collect franchise fees and property taxes, requiring that they all be collected and imposed at the state level. Proposals in other states have limited the right of local governments to charge as a franchise fee anything more than the actual cost to the jurisdiction associated with administering the franchise and/or managing the rights-of-way.

- *Prohibition on a jurisdiction's right to provide telecommunications or cable television service*
  Numerous jurisdictions have elected to provide communications services to their citizens. This is particularly true in communities that provide electric service. In some states, the telecom and cable industries have sought and won legislation that would prohibit or restrict cities from getting into the business or providing such service. For existing providers of telecommunications and cable service this ensures they will have no real competition since markets are small enough that it is unlikely that another privately owned provider would compete with the existing provider.

- *Siting of cellular towers*
  The Act imposed a number of conditions on jurisdictions regarding the size and location of a cellular tower in a community. First, jurisdictions cannot unreasonably discriminate among providers competing in the delivery of similar wireless services. Additionally, jurisdictions are not allowed to impose different setback, height, or safety restrictions in residential and commercial zones. Second, jurisdictions must act on all wireless tower permit requests within a reasonable time, taking into account the nature and scope of the request. Third, any decision denying a request must be in writing and substantiated by evidence contained in the written record of the decision-making body. Finally, fourth, jurisdictions can no longer be able to make zoning decisions based on the environmental effects of radio frequency emissions unless the facility is not in compliance with FCC emissions regulations.

- *Depriving cities of recourse to local circuit court*
  In some states, efforts have been made to require that all disputes between cities and telecom providers be settled by an arbitrator or the Public Service Commission rather than the local circuit court that is closest to the people.

3.2.2 At the State Level – Right of Way Compensation and Regulatory Limitations

State regulations must also adhere to provisions of the Telecommunications Act of 1996. Some states are faced with the challenge of developing and implementing rights-of-way policies and appropriate compensation methodologies for submerged lands in addition to uplands. Utilization of shared resourced agreements continue to be the growing mechanism states have identified as the best approach to allow utilities and other companies access to available rights-of-way. Some examples of this include:

- Some fixed administrative/application fees are outdated and need to be revised more regularly (perhaps once every three years) in order to recover the cost of the permitting process.
- The Consumer Price Index can be used as a means to adjust fees to current conditions.
- States that require the state-owned land to return a fair market value for their easement fees generally rely on independent appraisal. Another method is to use property tax roll valuation of adjacent property to make their determination of market value.
- State fees based on a per linear foot charge for fiber optic vary considerably from one state to another and additional investigation is needed to document the methodology behind the numbers.

3.2.3 At the Local Level – Right of Way Compensation and Regulatory Ordinances

Local governments may receive reasonable *rental* compensation from private commercial entities for their use of local public property for private economic gain, even where federal statutory law restricts local governments from denying access to ROW for telecommunications services. Their regulatory authority over their rights-of-way emanates from state constitutional or statutory authority. In most states, the state itself initially has title and authority to regulate the public streets and ROW, as the property is dedicated for public use. A majority of states delegate the authority to municipalities by statute, while a minority of states grant franchises to the telecommunications provider directly. While the majority of states do allow cities to be compensated, several do not. The statutory law in each state should be reviewed to determine a given city's authority to grant franchises and impose any limitations on them.

Execution of a franchise agreement or ordinance is the common process used to grant utilities permission to utilize the ROW for private economic gain. Typically, the utility pays the city for the use of the public streets in the form of franchise fees. The franchise fees that are paid to a city as compensation for using the public streets are sometimes called street rentals – not taxes. A franchise fee is the consideration paid for the rights granted by the franchise, and serves as compensation for use of the public property. The payment of franchise fees is a contractual obligation of the utility or franchisee.[15]

Some of the factors considered when negotiating the franchise fee are:

1. The burden created by the franchisee's occupancy of the ROW.
2. The inconvenience to citizens created by the franchisee's construction and use of the ROW.
3. The damage caused to the ROW by the franchisee's construction.
4. The diminution of the useful life of ROW caused by construction within it.
5. Hazard to public safety occasioned by the franchisee's occupancy of ROW.
6. Costs of monitoring and administering the franchisee.
7. The value of the ROW affected by the franchisee's occupancy.
8. Location of ROW sought to be occupied by the franchisee in their limited and finite capacity.
9. Rates paid by franchisee under existing franchises.
10. Any other criteria the municipal jurisdiction may deem appropriate.

3.3 Types of Policies

This section outlines the types of polices used to minimize utility street cuts and encourage the use of other methods, such as trenchless technology. This section also discusses specific regulations de-

[15] West, The Information Highway Must Pay Its Way Through Cities: A Discussion of the Authority of State and Local Governments to be Compensated for the Use of Public Rights-of-Way, 1 Mich.Tel.Tech.L.Rev.2(1995)

signed to use fees or construction standards to discourage utility construction and encourage shared use of facilities where possible.

3.3.1 Incentive-Based Policies

Selected states and cities were surveyed to determine what policies exist to monitor utilities and other companies' use of a jurisdiction's alleys, sidewalks, streets, tunnels, poles, conduits and ducts to provide their customers service and transact business. The results of this survey have helped identify incentives utilized to encourage use of trenchless technology and other incentive-based policies that attempt to minimize the impact of street cuts on state and local roads.

Trenchless technology is becoming more commonly used to meet underground construction needs. Trenchless technology provides an alternative to open trench construction in many cases and conditions. It is being used in many communities to lessen environmental and traffic impacts of open trench work. Other benefits include lessening the loss of revenue to businesses along the utility alignment and avoidance of differential settlement in trench restorations. The types of policies discussed in this section describe ways of encouraging utility companies and others seeking access to the public right-of-way to consider methods other than trenching.

Incentives to Encourage Use of Trenchless Technology

One method of implementing this type of incentive is in the form of permit or inspection fee waivers in return for the use of trenchless technology. Since in many cases trenchless technology is still more expensive than traditional trenching, especially in urban and suburban areas, financial incentives can encourage utility contractors to try the technology. Other methods of providing incentives for utility contractors to use trenchless technology is to reduce some of the administrative and regulatory processes necessary under traditional trenching operations. Obviously, any pavement degradation fee that applies to traditional trenches will not be applicable in most trenchless applications. Where limited excavation in the pavement area is necessary to a trenchless operation, the pavement degradation fee can be waived to provide an additional incentive. This should be done while maintaining adequate control over the ROW and the construction to ensure that the pavement, existing utilities, and other ROW components are not damaged.

Incentives to Encourage Less Damaging Types of Cuts

Some jurisdictions are strengthening and monitoring the type of excavations being made, the quality of excavation repairs and the effect of excavations on pavement life. While it is true that better utility cut repairs result in less pavement damage than poor-quality repairs, there is always some damage to the pavement structure. A method of incentive for contractors to put forth more effort to making better-quality pavement cut repairs is to decrease or eliminate any fees associated with the repairs. This could be in the form of waived degradation fees, reduced inspection fees, or others.

Encourage Coordination – Shared Trenching

Whenever possible, the use or formation of a Utility Coordinating Committee (UCC) is most helpful for new major utility installations. The permitting jurisdictions should always be represented at the committee's meetings. Utility coordination requires participation of privately-owned utility companies, jurisdictions, regulating bodies, public works agencies, highway departments and other interested groups. Since it is in the public interest to share the right-of-way, government and private industry must join in some sort of mutual planning action to protect the public interest. This action should include establishment of uniform regulations and a mutual liaison effort such as the Utility Coordinating Committee that will ensure a continuous formal interchange of information covering regulations, planning, designing, and scheduling of all major construction projects within the public right-of-way including the need for utilities to participate in joint trenching efforts. Failure for jurisdictions to perform this function adequately can result in liability to the jurisdictions and additional cost to the utilities. Typical problems addressed by UCCs include utility excavations in newly paved

roads, disruption of essential utility service, injuries caused by inadvertent severing of utility facilities, location of utility poles, and environmental impacts of damaged facilities.

All states that responded to the survey stated that shared trenching was not a requirement but was encouraged. These same states agreed the number of excavations definitely could be reduced. The American Public Works Association (APWA) has published the following actions to support highway/utility coordination.[16]

Coordinating Actions for Highway Agencies

- Develop and share a highway improvement program.
- Include all construction and maintenance work in the highway improvement program planned for at least the next two years with longer time frames (5-6 years) desirable.
- Hold regular meetings between utility company personnel and highway personnel to discuss upcoming project development and construction activities.
- Notify utilities of projects prior to the design phase.
- Route plans of highway projects to utilities for comment during the design phase.
- Determine the impact of all projects on other facilities in or adjoining the ROW.
- Convene meetings of highway and utility personnel involved in project planning and development prior to each major phase of a project (planning, design and construction).
- Identify and resolve conflicts before construction.
- Share construction schedules with utilities.
- Develop one point of contact in the highway agency to work with utilities on a project from inception to completion.
- Publish maps each year showing municipality, county, state highway agency and utility projects.
- Publish detailed descriptions or directories of projects and list project schedules, managers, and telephone numbers.

Coordinating Actions for Utilities

- Develop a utility master plan in conjunction with other public planning efforts.
- Provide capital improvement programs to highway agencies.
- Update utility system plans every two to five years and provide them to public works and highway agencies.
- Meet with local or state agencies to discuss projects, determine impacts, and explore alternatives to avoid potential conflicts.
- Develop one point of contact to work with the highway agency on resolution of potential conflicts.
- Seek to minimize the impact of utilities on highways with high traffic volumes, few alternative routes, or limited right-of-way.

While there are additional procedures that can be implemented, the aforementioned steps are imperative for a UCC to yield effective, positive results.

Encourage Coordination – Shared Resources

The term *shared resource* is used to describe a new partnership approach to obtaining a different form or compensation/value from the public ROW. These are public-private arrangements where each party taps the special resources of the other. The private partner gains access to public ROW and the public partner gains access to some form of compensation, whether in-kind telecommunications facilities or services, cash, or both. Shared resource projects have three distinct features:

1. Public-private partnership.
2. Private longitudinal access to public property (primarily roadway ROW) for telecommunications facilities.
3. Compensation to the ROW owner above administrative costs.

Shared resource programs have been facilitated by the Federal Highway Administration's (FHWA) delegation of authority to states to determine their own utility accommodation policies and by the American Association of State Highway and Transportation Officials (AASHTO) Board of Directors' resolution that recognized fiber optics as distinct from other utilities and sanctioned their longitudinal installation in freeway rights-of-way.

Survey data revealed that six states have already begun shared resource projects with significant benefit to their state and local communities. Other states have taken slightly different approaches. For example, New York has an open request for proposals (RFP) that continuously seeks applicants to use their right of way for telecommunications. Minnesota and others have issued an RFP with a closing date and awarded the contract to a single company who in turn will install, operate and maintain a telecommunication facility for state and private use. The telecommunication provider usually is responsible for subleasing conduit space and fiber to others at fair and non-discriminatory rates. There does not appear at this time to be a single best model, but the shared resource approach appears to be a new tool that states can use to increase the valuation of the highway rights-of-way.

The following is a list of some pros and cons of the shared resource approach:

Pros:

- Flexible compensation provides telecommunication facilities, services, cash or all of the above.
- Avoids out-of-pocket cost of the state for installing telecommunications infrastructure.
- Speeds up installation of telecommunications throughout the state.
- Maximizes use of state assets (interstate ROW) not previously available.
- Facilitates telecommunications service to previously un-served areas such as rural communities.
- Ensures that states' telecommunications needs are met.
- Successful partnerships may lead to other mutually beneficial projects.

Cons:

- Lack of technical knowledge to implement new approach.
- Limited time – market conditions dictate private vendor interest.
- Determining the value of a bartered arrangement to the state is complicated.
- If compensation is similar to a barter arrangement, it is difficult to determine if proposed compensation is appropriate.
- May attract more telecommunication companies than can be supported in limited ROW space.

3.3.2 Fee-Based Policies

Another type of policy that can be considered is the implementation of fees and other economically-based measures to reduce and/or control the utility cuts made in the right-of-way. Generally, fees are assessed to recover administrative costs such as managing the permit process, inspecting utility cut repairs, and other activities conducted by the agency due to right-of-way access. The compensation received should generally be over and above administrative costs. Such fees that are beyond administrative costs can be in the form of pavement degradation fees, lane-rentals, and penalties for poor repairs.

Compensation can be goods and services, cash or a combination of both. The choice is determined by legal restrictions on cash revenues or the jurisdiction's need for communication infrastructure and services. If the jurisdiction receives cash, the receipts can be earmarked for identified telecommunication or transportation projects. It is important for the jurisdiction to identify how cash revenues would be used since the allocation could possibly eliminate any negative actions by utilities and/or telecommunication companies that are assessed the rental fee. In-kind services received can be negotiated in addition to cash to be used over a period of time, or infrastructure to be specified and installed. Examples of such in-kind goods and services are described in table 1. It is believed that in-kind compensation is easier to achieve with wireline versus wireless providers because wireline projects are more extensive and cover a wider geographic territory whereas wireless projects tend to be very site specific.

Table 1. Examples of In-Kind Goods and Services.

Type of Communication Provider	**Type of In-kind Goods and Services that can be Provided**
Wireline	Fiber optic conduit, inner ducts, dark fiber, equipment to "light" the fiber, equipment maintenance and/or upgrading; operations of communications equipment, future upgrades, cost-free or reduced fee communications service, etc.
Wireless	Space on private towers for equipment, installation of public sector antennae, construction of equipment sheds and installation of support equipment, back-up service or redundancy, wireless call box installation, cost-free or reduced fee communications services on private system, etc.

Assess Appropriate Rights-of-Way Fees

Assessing ROW rental or franchise fees is most common for local utilities, cable companies and competitive local exchange companies (CLEC). Local utilities include local exchange telephone companies, electric, gas, water and steam. CLECs are companies that compete with local exchange carriers in the area of providing access to long distance carriers, private line and local telephone service. A review of the types of franchises or licenses granted by the cities surveyed revealed that there are three general categories of utility users of public ROW, described in table 2. Research into local governments' ROW compensation arrangements for these categories indicates ROW fees are generally assessed in the manner described in table 3. Table 4 details the comparison of gross revenues derived from rights-of-way fees for selected cities.

Gross receipts based franchise agreements generally permit utilities to have unlimited access to public space and ROW for a specific purpose such as providing electric or gas service within the City. These franchises typically regulate pole placement, conduits, buried cable and all other aspects of the utility's activities in public ROW. In return for ROW access, the franchised utilities agree to pay the City based on a percentage of all gross receipts from operations within the City. Utilities are typically required to pay property, utility and other taxes such as sales, use, special taxes and assessments for public improvements, in addition to gross receipts franchise fees.

Table 2. Utility Users of Public Rights-of-Way.

Type	Category of Use	ROW Valuation Method
Franchise	Local Distribution Networks (i.e. local exchange carrier, competitive access provider, water, steam, chilled water, electric, gas service and solid waste)	Percentage of Gross Revenues
License	Interstate Carriers (i.e. long distance telephone, gas pipe interstate)	Linear Foot Fee
License	Private Networks (i.e. hospitals, universities, private companies and non profit agencies)	Linear Foot Fee

Table 3. Rights-of-Way Assessment.

Type	Compensation Method	Fee Range
Local distribution networks	Percent of gross revenue or receipts	.05% to 10%
Local distribution networks	Linear foot, Fee per access line	$0.001 to $5.50 per ft
Interstate carriers	Flat fee / linear foot	$0.30 to $5.50 per ft
Private networks	Flat fee / linear foot	$0.30 to $5.50 per ft

Table 4. Gross Revenues from Rights-of-Way Fees.

City	Electric Franchise Fee		Telephone Franchise Fee	
	Revenue	% Gross Receipts	Revenue	% Gross Receipts
Chicago	$ 63,000,000	4%	$29,580,000	3%
Houston	$ 60,000,000	4%	$26,900,000	Flat Fee
St. Louis[1]	$ 26,000,000	10%	$12,000,000	10%
New Orleans	$ 9,000,000	2.5%	$3,000,000	3%

[1]St. Louis has a gross receipts tax instead of a franchise fee.

Once implemented, it is important to monitor fee assessments to ensure companies are in compliance with negotiated terms; but most importantly to determine if the arrangement is working or if there should be contractual changes. Things to consider during this phase are:

1. Is the jurisdiction recouping all of its direct and indirect costs associated with management of the applicable land or public utility easement? If not, the jurisdiction may consider increasing the fee assessed.
2. Are the construction and maintenance activities being conducted in accordance with established jurisdiction rules and guidelines?
3. Is there resale or sublease activity occurring that did not exist during the application phase?

Additional reasons for monitoring existing fiber optic fee arrangements include:

Unanticipated Challenges. Certain aspects of the relationship may be different in practice than anticipated, for example, the State may find that legal challenges to earmarked cash revenues argues for in-kind arrangements.

Change in Communications Needs. The State's communications needs may be different than forecast, arguing for a greater or lesser reliance on in-kind compensation.

Shift in Communications Design. The State's communications blueprint may change such that less communications capacity of a particular type in one area and more in another area than originally planned. This might be the case if there were a shift from wireline to mixed wireline-wireless systems coupled with increased demand for wireline capacity in adjacent areas.

Increase in Demand for Communications. Both public and private demand for communications capacity may be greater than originally forecast and the public sector would benefit from increased capacity.

The fiber optic fee process adopted by the State is very important. Issues addressed in this section of the report highlight some of the steps that should be considered. Establishment of an overall telecommunications policy is critical as such a policy ensures consistent handling of state-owned land users and ROW access users.

Linear Foot Fee

Generally, the linear foot charge is used for limited access to public ROW as in the case of a telecommunications operator building a limited network in a downtown urban area. Many of the cities surveyed used this method for fiber optic local loop, interstate long distance carrier and interstate pipeline companies. For example, Atlanta and Chicago use the percentage of gross receipts model for utilities such as local exchange, electric and gas companies. Philadelphia, on the other hand, only charges a linear foot fee.

Table 5. Survey of Selected Cities.

City	Population	Company	Fee, $/lf
Albuquerque, NM	384,736	AT&T	0.60
Atlanta, GA	394,017	AT&T	5.00
		Western Union	5.00
Baltimore, MD	736,014	Bell Atlantic	0.06
Birmingham, AL	265,968	AT&T	2.00
Boca Raton, FL	61,492	Telecommunication services	2.00
Chicago, IL	2,783,730	Lightnet	5.50
Des Moines, IA	193,187	Teleph, telegr, communications sys	1.00
		Other	1.00
Flint, MI	140,761	AT&T Communications	1.00
Fort Worth, TX	447,619	AT & T	1.00
		MCI	1.00
		Other	1.33
Philadelphia, PA	1,586,000	Aerial/Electric	0.0011
		Telecommunications	0.0007
Pittsburgh, PA	369,879	Telecommunications	1.00
Phoenix, AZ	983,403	City Signal	0.60
Richmond, VA	202,798	Bell Atlantic	0.02
St. Louis, MO	396,685	Other	1.50
St. Paul, MN	272,235	Any Franchise	1.00
Tulsa, OK	367,302	US Sprint	0.75
		Average Linear Foot Fee	$ 1.50

In addition to the cities below, the rate charged by a public transit authority to telecommunication providers for the use of their facilities is included. The Washington Metropolitan Area Transit Authority uses the public ROW to operate the public mass transit rail system within DC. ROW is leased for the installation of fiber optic cables ranging from $1.60 to $3.80 per linear foot per year.

The City of Atlanta charges certain ROW tenants a $5.00 per linear foot for the usage of the City's rights-of-ways and the City of Pittsburgh charges $1.00 per linear foot (See table 5).

Over time, the term of franchise agreements has decreased. Initially, agreements were made for extensive periods of time, such as 30, 40 or 50 years. The recent trend has been for the agreement to have a term of 10 or 15 years, with incorporation of a provision outlining the city's right to renegotiate and a clause for inflation factors. Based on the information obtained from the survey, the average agreement term is approximately 18.3 years. Franchise agreements normally specify the compensation basis and method of calculating the franchise fee. Additionally, the franchise agreements are normally initiated through an application process that includes review(s) by the city, coordination of different city departments and/or localities, and approval by the City Council (or an applicable legislative branch).

Research of State Fees and Process for Fiber Optic Facilities

The research for this section focused on the national market to evaluate what other states charge for access to ROW, excavations, proposed methodologies for valuing corridors, negotiation guidelines for easements, fiber optic use of both uplands and submerged, and how they process requests. A survey was developed that identified listed states to be contacted. The survey was designed to gather the following information. Although this survey was directed at fiber optic facilities, the results may be applicable to many other types of utilities as well. This survey is different from that discussed in section 3.4.

- Fees charged for use of state-owned land (upland and submerged).
- How the state processes requests.
- Fees charged for use of highway ROW.
- The state's current methodology for valuing corridors (business costs, revenues, land values, etc.) and negotiating with fiber optic companies.

The following is a listing of the initial states chosen for the survey with their respective estimated populations:

Table 6. Initial States Selected for Fees Survey.

State	Population	State	Population
Alabama	4,351,999	New York	18,175,301
Alaska	614,010	North Carolina	7,546,493
California	32,666,550	Oregon	3,281,974
Georgia	7,642,207	South Carolina	3,835,962
Louisiana	4,368,967	Texas	19,759,614
Maryland	5,134,808	Virginia	6,791,345
Mississippi	2,752,092	Washington	5,689,263

Survey Results

The following observations were made either as a direct response from survey respondents, or as part of the analysis of survey results regarding state land and rights-of-way permits and fees:

- All states surveyed have a permit process in place to allow fiber optic companies to use state land to install fiber optic cable.
- Most states (70 percent) have established a fee for that purpose. Some states do not charge any fees for the permit.
- Most states (5 of 7 responding) charge an easement or encroachment fee that ranges from $0.61 to $3.50 per linear foot.
- Other states charge an administrative fee or application fee that is designed to recover a portion or full cost of administering the permitting process ranging from $50 to $400.
- Only one state (California) appears to have a mechanism in place to recover the full actual cost of each encroachment permit.
- Two states (Texas and North Carolina) charge both an administration/application fee and easement fee.
- There does not appear to be significant difference in fees charged for uplands or submerged lands. Some states charge different fees but others do not.

The observations below address the states' procedures to process requests to access state land or ROW.

- Most states rely on the fiber optic company to submit a request for a permit – a reactive process.
- Only three states (New York, Maryland and Virginia) have a proactive process in place where the state seeks vendors/companies to propose how they can better use or share the ROW. Most of these are initiated by the state highway agency rather than state ROW offices.

Finally, the following observations relate to the states' current methodologies for valuation.

- Some states' fixed administrative/application fees are outdated and need to be revised more regularly (ex. once every three years) if they want the fee to recover the cost of the permitting process.
- Only one state used the Consumer Price Index as a means to adjust fees to current conditions.
- States that require the state-owned land to return a fair market value for their easement fees generally rely on independent appraisal. Only one state used property tax roll valuation of adjacent property to make their determination of market value.
- State fees based on a per linear foot charge for fiber optic vary considerably from one state to another and additional investigation is needed to document the methodology behind the numbers, if any.

Case Studies

This section highlights selected states as examples of state practices for lease of land and highway ROW. Short summaries of the experiences from Maryland, New York, and Oregon follow.

Maryland The State's Natural Resources department has negotiated two land licenses with two interstate gas pipeline companies who have current gas pipeline easements and are adding fiber optic facilities in same ROW corridor. The first license charge was $3.50 per linear foot of conduit and capped the installed fiber strands at 200. Adding fiber stands over 200 would require the company to request Natural Resources to approve an increase. The second land license was set at $3.50 per linear foot of conduit times the ratio of strand of fiber installed over 200. This was done to address changed technology that increased the number of fiber strands in the bundle.

The license is for 10 years with two 10-year renewal options. Natural Resources has not encountered the submerged land issue but would not envision a different fee structure. Submerged lines only increase complexity of work and raise environmental restrictions that may increase company costs.

Normally, each department owning state land receives and processes land license requests related to use of their land. However, these two licenses were processed differently because they qualified as high tech projects, and the state had passed a new law to focus its efforts on high tech and established a separate review and approval process.

In both cases, companies submitted requests to Natural Resources to use fiber on state-owned lands using previously granted gas line easements. After the company's request was reviewed and processed, Natural Resources sent them to Budget and Management and a Special Legislative High-Tech Review Committee for approval. Furthermore, to fund high-tech investment, the state created a "high-tech fund" in which proceeds from all licenses of state lands from high tech ventures would be deposited (rather than to individual departments) and then made these funds available to improve the technological capabilities of state agencies.

The State Highway Administration (SHA) negotiates all fees for fiber optic use of the ROW under a new approach begun recently. The SHA has prepared an RFP for Resource Sharing of any Maryland's public ROW and state-owned land and released it this year. The RFP is good for five years and requests fiber optic companies to submit proposals on how best to utilize the state land and highway ROW. The SHA then evaluates each proposal as it is submitted and negotiates compensation based on Maryland's fiber optic needs for that specific project. The proposal follows the high-tech review process previously mentioned.

Compensation for a corridor ranges from cash to bartered fiber infrastructure or a combination of both. The SHA uses some of the following benchmarks to evaluate each proposal: past usage fees collected, what other states charge or what railroads charge, and also consider the current fiber facility needs for Maryland state government, the intelligent highway system or Network Maryland (extending fiber to all schools, libraries, etc.). Each compensation package will be different because timing and needs change.

New York No fee is charged for a permit, but an extensive permit review process is in place to protect state-owned land especially for wetlands and environmentally sensitive areas of the state. The company submits a standard application for a permit to use state-owned lands to the department that owns the land. Assistance is available to assist in developing the least disruptive corridor in a pre-application conference. All requests for use of submerged lands (wetlands, protected bodies of water and streams) must be reviewed by Environmental Conservation and General Services Departments and potentially the US Corps of Engineers. No permit fees, administrative fees or fixed fees are charged. Compensation is negotiated based on each company's proposal and use of public highway ROW for the benefit of the State. A rule of thumb is to recover approximately $1.00 per linear foot of fiber installed – assumed to be an industry standard about ten years ago. Fees and terms will vary depending on the company's proposal.

The State Department of Transportation (DOT) continuously advertises in the NY Contract Reporter and seeks Requests for Proposals from fiber optic companies to use state highway ROW based on the State's Accommodation Plan for Fiber Optic Facilities. Each quarter, the DOT Property Management Division receives and reviews proposals, negotiates terms and approves use of ROW for fiber.

Oregon The State land office charges a fee for each crossing of state land (with the least impact), the greater of: 100 percent of fair market value (FMV), $250, or the highest comparative compensatory payment. Permits for use of submerged land under State control such as "navigable rivers" are granted at no cost except in cities. In cities, the land use compensation is tied to adjoining appraisal property value of land on each side of the river at the access corridor. The company completes an application, provides local plans and zoning compliance sign off; state land office processes application and coordinates with adjoining owners and other properties of interest. Any altering of state waterway requires a special permit. The DOT does not charge a permit, administrative or application fee for use of the conventional highway ROW for fiber optic cable; however, companies must apply for and be granted a permit to install fiber optic cable in the ROW.

Companies submit a letter of request to the DOT district office in which the project is located and include plat maps detailing starting and ending points, scope of work, traffic control plans, and engineering drawings certified by an engineer. The DOT reviews, coordinates and approves plans, and issues permits. Fair market value is determined by use of real estate property tax roll (assumed to be market values) for adjoining property adjusted for placement; surface use: 100 percent of fair market value, and aerial and underground use: 1/3 of fair market value.

Assess Appropriate Pavement Degradation Fees

Jurisdictions around the US are conducting studies to determine the effects of utility cuts on the service life of pavements. Many of these jurisdictions accumulate data using pavement management systems to quantify the effects of the cuts and study current cuts practices. The results of these studies have confirmed that a city's streets are a valuable public asset, which the government agency holds in trust for its citizens. Therefore, it is reasonable and in the public interest to impose pavement degradation fees to be paid by excavators in order to recover the increased repaving and reconstruction costs caused by excavation which are currently borne by taxpayers. It is also reasonably in the public interest to structure the fee, and any exclusions, in a manner that discourages excavation in newly-paved streets and encourages excavators to minimize excavation and to coordinate necessary excavation with the city's repaving schedule. For the most part, these types of fees are higher for newer streets and lower for older streets including those scheduled for imminent repaving. It is recommended that proceeds from pavement degradation fees be allocated to a dedicated fund or account, instead of the general fund, that will be used solely for repaving and reconstruction of the city's streets. A sample calculation to determine an appropriate pavement degradation fee is given in Appendix A.

The City and County of San Francisco enacted a street damage restoration fee, ranging from $1.00 / ft^2 for streets between 15-20 years old (since last reconstruction) to $3.50 / ft^2 for streets less than five years old.

Assess Appropriate Permit Fees

The permit fee is intended to capture the administrative costs of approving, monitoring, tracking, and inspecting pavement utility cuts. Sometimes the inspection fee is a separate item. For example, the City and County of San Francisco charges a $25 administrative fee for each block in which excavation is proposed. Also, a fee of $8.61 / m^2 ($0.80 / ft^2) for inspection is assessed. The administrative fee is to compensate the "Department [of Public Works] for the cost incurred to administer provisions of the code".

Violations of the permit and/or the code can result in fines. Normally, an agency will provide for a certain amount of time, such as 24 – 72 hours to remedy the situation and become compliant once

again. These penalties are often high, on the order of $1,000 per day per violation. Most codes also specify civil and/or criminal penalties for extreme cases of violation.

Some specific violations, usually enumerated in a regulation or ordinance, are:

1. Excavation without a permit.
2. Excavation without proof of the permit issuance on site.
3. Excavation without proper notice to the Underground Service Alert (One Call System).
4. Excavation without proper public notice.
5. Excavation that violates the traffic code.
6. Excavation that violates the regulations concerning excavation sites that include, but are not limited to, protection of the excavation, housekeeping and removal of excavated and hazardous material.
7. Excavation that does not meet restoration requirements concerning backfill, replacement of pavement base and finished pavement.
8. Excavation that exceeds the scope of the permit, including, but not limited to, obstructing the path of automobile or pedestrian travel in excess of the permitted area.

Assess Lane-Rental Fees

A method used extensively to limit the time during which a contractor will have traffic lanes closed to traffic is to rent the lane to the contractor. This practice is most often implemented in one of two ways. The first is for the contractor requesting a cut permit to be given a certain amount of time in which to complete the work. Beyond this amount of time, each impacted lane must be rented from the agency until the repairs are complete to the satisfaction of the agency. The second method is that the contractor must rent the lane from the agency throughout the entire duration of the construction work.

Require Deposits to Protect Against Poor Repairs

In addition to permit fees and inspection costs, some jurisdictions also may require deposits and/or performance bonds to ensure the public right-of-way, where the work occurred, is restored in accordance with the jurisdiction's requirements. Pavement excavation costs taxpayers additional money annually in increased street maintenance because of damage caused to the original life of the pavement. Some of this money could be obtained through deposits and other charges to the utility contractors for future repair of the street. This type of requirement could be considered similar to the pavement degradation fee. The difference is that the degradation fee is never returned to the contractor, whereas a deposit would be returned after a specified amount of time, provided that the repair performs satisfactorily during that time. The City of San Francisco ordinance in Appendix B contains a deposit requirement.

Assess Penalties for Non-Compliance or Failed Repairs

The City and County of San Francisco has one of the most stringent trench restoration requirements in the country. Permits for street excavations are required; the permitted backfilling materials and procedures are prescribed; and there is a three-year moratorium on excavation in newly surfaced or reconstructed streets.[(2)] When pavement cut repairs fail, often the agency is left to cover the costs of additional repairs. By implementing a policy of penalties for failed repairs, an agency can recover some of the costs for these activities. An important consideration for this and other policies such as requiring deposits, etc., is that each repaired cut must be tracked and associated with the utility contractor that made it. In the future, if a repair fails, the appropriate contractor must be approached for payment of the penalty.

Implementation of San Francisco's excavation ordinance was intended to have the effects of improving the smoothness of city streets, preserving taxpayers' investment in the streets, and minimize the impact of failed repairs on neighborhoods and the streets they must use every day.

3.3.3 Requirement-Based Policies

Many jurisdictions have developed and implemented regulations to preserve the life of streets within their jurisdiction. Rather than attempt to provide incentives or to implement direct fees for pavement utility cuts, many state and city agencies have implemented regulations or ordinances that require certain actions or prohibit others. This type of policy sets forth actions that must or must not be done. This section describes some of the policies that can be instituted by state regulation or city ordinance to require or prohibit certain activities in the ROW.

Require Agency-Owned Utilities to Meet Repair Quality Standards

Often, agency regulations and ordinances specifically exempt from the standards those utilities that are owned by the agency. However, most agency-owned utilities are water and wastewater. Sometimes these types of utilities require more excavation and pavement cuts, and to a greater extent than other utilities. In addition, when such utilities rupture, much greater damage is done to the pavement structure than if an electrical or telephone line is severed. In addition, in environments where agency-owned utilities are exempt from such requirements, and in order to save money for the agency, the cut repairs are sometimes made to a lower quality level than those required of private contractors.

Require Justification for Not Using Trenchless Technology

Upon receiving an application to excavate, many jurisdictions are discussing the use of trenchless technology with utility applicants. Often, trenchless may not be the feasible nor practicable from an engineering or economic standpoint. However, in areas where an agency is encouraging or requiring the use of trenchless technology, a contractor can be asked to justify his reasons for not using it. The reasons can then be reviewed by the public works director or state utilities engineer, who will then either approve the request or ask for further justification. If the reasons submitted are not adequate to the agency's authorized representative, the request can be denied and the trenchless technology can be required. In situations such as this, however, the agency then takes much more responsibility for disruptions to the pavement, existing utilities, or other components of the ROW if problems arise.

Establish Moratorium Periods for New Pavement

A pavement utility cut moratorium can be implemented by an agency to protect newly-built or rehabilitated pavements for a period after construction. In establishing such a policy, the agency must provide opportunities for the utility companies to perform their necessary work in the area prior to construction. There must also be a clause that allows utility cuts in cases of emergency. This type of requirements-based policy is likely the most common among city agencies today.

Require Repaving Area Larger than Cut to Mitigate Pavement Damage

Many studies have indicated that a utility cut damages an area of pavement larger than the actual area of the excavation, and state and city agencies often require contractors to repave an area larger than the immediate area of the cut. The City of Houston, for example, requires the utility contractors reconstruct the street from curb to curb wherever a utility cut is made between them. Policies such as this must clearly describe the method of determining the area of pavement that must be reconstructed. One drawback to this approach may be that since making a utility cut damages the pavement, reconstructing the street in a larger area may not improve the situation, but may simply enlarge the affected area. Such reconstructions must be performed with an attempt to match the current elevations and conditions existing in the pavement structure. This type of reconstruction is easier to do in portland cement concrete pavements, since the new material can be tied into the existing material and can match the existing elevations more easily.

Enhance Inspection and Enforcement of Specification Requirements

Often the inspection procedures in a city or state are less effective than they could be. Additional or enhanced regulations on the repair quality and inspection standards can greatly improve the overall quality of pavement utility cut repairs. The extra cost of such improvements to the inspection work force can be offset by fees established or adjusted to recover those costs.

3.4 Survey of the State of Practice

In addition to the aforementioned survey, each state highway agency, and many cities and state leagues of cities in the United States were requested to complete a survey to determine the type of rights-of-way practices and policies that are utilized to manage access by utilities and other companies. Another objective of the survey was to determine how these agencies encourage the use of alternative methods for installing and maintaining underground facilities. Surveys were sent to 138 state agencies, selected cities, and municipal leagues. Responses were received from the following 28 state highway agencies, shown in table 7. The remainder of this section describes the responses given to the survey.

Table 7. ROW Practices and Trenchless Technology Usage Survey Respondents.

Alabama	Idaho	Michigan	Pennsylvania
Alaska	Illinois	Minnesota	South Dakota
Arkansas	Indiana	Missouri	Tennessee
Colorado	Iowa	Montana	Texas
Florida	Kansas	New York	Virginia
Georgia	Louisiana	North Carolina	West Virginia
Hawaii	Maine	Ohio	Wisconsin

3.4.1 Franchise/Permitting Process

Approximately 93 percent of the respondents have an established formal process in place to allow utilities and other companies to utilize the rights-of-way.

3.4.2 Franchise/Model Agreements

While the majority of the respondents have a formal franchise/permitting process in place, only Louisiana, New York, Alaska, Missouri, North Carolina, Pennsylvania, South Dakota, Texas and Wisconsin actually require utilities to execute franchise, permit, encroachment, ROW access or occupancy agreements to utilize ROW. The same states have also drafted model agreements for services provided by certain utilities to ensure consistency of the application process and methods of compensation.

3.4.3 Franchise Agreement Requirements for ROW Access

Alaska, Georgia, Illinois and Indiana assess and receive franchise fees and/or utility taxes as described in table 8.

Table 8. Assessment of Franchise Fees by State.

Question	Alaska	Georgia	Illinois	Indiana
How is fee or tax calculated?	Basis not provided	Based on administrative costs	FMV of lease	Basis not provided
ROW access initiated by whom?	DOT/PF Regional Utilities Engineer	PSC approves certificate; GDOT issues agreements	No response	INDOT
How does this work with other departments	Established formal review process	Done verbally	No response	Informal routing
How much revenue received from each franchise?	Electric - $150,000 Telecommunication -$100,000 CATV - $50,000 Sewer - $50,000 Water - $50,000	Approximately $2.5 million per year from telecom companies only	Information not provided	Not provided

3.4.4 Permit Required Before Access

Ten of the agencies require utilities to pay permit fees for construction, maintenance, pole attachment, bridge attachment and other type of permits. The required fees vary from as little as $20 to over $5,000 per permit or project. These same agencies have inspection policies in place to ensure pavement repairs are conducted in compliance with established agency policies.

3.4.5 Underground Conduit Owned

None of the respondents own any conduit.

3.4.6 License Fee Assessments

Illinois, Iowa, Louisiana, Missouri, New York, Pennsylvania and Wisconsin have license fee assessments for bridges, tunnels or poles.

3.4.7 Jurisdiction Tax Revenues

This information was not readily available for any of the DOT's.

3.4.8 Cell Tower Construction

Only 39 percent of the agencies have experienced cell tower construction, primarily by wireless telecommunication providers. The number of sites varies from 1 to 85 as detailed in the following table.

Table 9. Cell Tower Construction in State ROW.

Agency	Number of Sites
Colorado	10-20
Florida	70
Hawaii	6
Indiana	A few
Louisiana	1
Michigan	MDOT only
Minnesota	MNDOT lease
New York	5
Virginia	85
South Dakota	1 or 2
Wisconsin	1

3.4.9 Antenna Attachments

Only Georgia, New York and Virginia have agreements involving antenna attachments. The users involved primarily are Metricom and Ricochet Wireless.

3.4.10 Trenchless Technology Use

Almost all of the respondents utilize or require trenchless technology, and overall report favorable results. Details of this part of the survey are described in section 4.4.1. The major obstacles mentioned are:

- Accurately locating other utilities in the bore path (congested rights-of-way).
- Limited ROW for set up, costs, soil impediments and equipment.
- Local contractors still using the old wet bore machines.
- Location of buried lines and quality control of the operation.
- Soil conditions and contractor experience.
- Operator training and the use of vacuum excavation.
- Lack of guidelines or specifications.
- Cost on larger applications.
- Space to set up and the safety aspects of the operation.
- Too much infrastructure in shallow areas.
- Minor pavement damages to riding surfaces.
- Constrained by heavily traveled areas.
- Large pipe bends.

The major attitudes that inhibit the use of trenchless technology focused on cost, damage to existing facilities, knowledge of contractors and effective use of equipment.

3.4.11 ROW Management Systems Used

The majority of the agencies do not claim to have effective tracking systems in place to monitor construction and other activities in the ROW. While degradation fees are not being assessed, some agencies do require construction bonds for certain projects. Moratorium policies on newly paved roads average 5 – 7 years. Most agencies enforce One Call Damage Programs and penalties for violation of excavation policies.

3.4.12 Use of Jurisdiction-Owned Land

As previously mentioned, agencies are now entering into Shared Resource Agreements for use of state-owned land by telecommunications, fiber optic and other companies. The compensation provision included in these types of agreements varies from state to state.

3.5 Additional Policies

This section summarizes new and innovative approaches for managing utility cut activities and to minimize such cuts. Inspection and enforcement activities using computer tools for tracking and monitoring street cut activities, and measuring compliance with city or state construction standards are among those included.

3.5.1 GIS Implementation

Geographic Information Systems (GIS) are being utilized by jurisdictions more every year. Currently, these systems have become more important as the General Accounting Standards Board continues to develop and implement accounting policies that require jurisdictions to record and monitor the value of rights-of-way infrastructure and other activities. Some jurisdictions are also taking advantage of these enhanced requirements to incorporate tracking systems within developed GIS programs to monitor utility construction and maintenance activities more effectively.

3.5.2 Cut Repair Warranties

Most state and local jurisdictions require utilities to guarantee, or to be responsible for, the condition of excavation permanent repairs for at least 2 years, and as many as 5 to 10 years. In case utilities fail to adhere to this obligation, construction deposits may be required until expiration of the warranty period to ensure availability of appropriate funds to repair pavement deterioration not handled by utilities in a timely manner. In order to make a system or policy such as this work for to the benefit of the agency, however, a system must be in place to track the individual utility cuts and the contractor or utility company that made the cut and repair. Without this information, it would be impossible to establish a claim against the responsible party.

The City of Modesto, CA, instituted an ordinance that gives utility contractors a choice when trenching in the city streets. Essentially, if the contractor signs a warranty requiring the cut to be maintained by the contractor for the remainder of the pavement life, the contractor would be exempt from paying a pavement degradation fee. If not, a pavement degradation fee is assessed at the time of the permit application. Certain exemptions are allowed, depending on the current condition of the street, and the time until the city plans to reconstruct the street. Horizontal Directional Drilling (discussed in section 4.1.1 of this report) is also exempt from the degradation fee.

3.5.3 Automated Permit System

In addition to enhancing existing GIS systems, jurisdictions are eliminating the manual processing of permitting and inspection activities. The automation of these tasks has allowed jurisdictions better to monitor issued permits from the beginning to the end of a given project. Additionally, automation of these tasks has:

- Reduced the length of time taken to process a submitted permit application.
- Enhanced the accuracy of processed permit data.
- Provided up-to-date historical and current information for management reports.
- Streamlined number of staff required to process and inspect permits.
- Allowed online capability for submitting permit applications and associated required support electronically.

See the discussion in section 4.4.2 for information on how this has worked for the City of Houston and the utility companies requesting permits.

3.6 Implementation

This section briefly discusses the methods and models for implementing the policies described throughout chapter 1. These include procedures for developing franchise agreements and permitting processes, establishing the level of fees and penalties for various activities, and developing and passing regulations and ordinances to implement the policies.

3.6.1 Franchise and Permitting Procedures

At a minimum, an established ROW policy or franchise/permitting procedure should include:

- Provisions requiring the telecommunication provider or utility to indicate the specific location the company wants to access.
- Requirement for providers to state reason for access.
- Type and level of compensation required for access.
- Type and costs of permits required.
- Length of time land or ROW is needed.

Additional provisions that should be included are:

- Provision that addresses denominating compensation in generic or equivalent-value terms to allow revisions in type and placement of equipment, or shifts between barter and cash.
- Provisions that deal with capacity expansion.
- Provisions that describe the type and degree of changes that can be re-negotiated when leases are renewed.

Several options available for permit application methods are shown in table 10.

Table 10. Application Options.

Approach	Pros	Cons
One-time Window of Opportunity	Imposes time limit on administrative involvement with telecommunication provider; construction on specific land or easement segments minimized by installing infrastructure at one time.	Total number of applicants and therefore total compensation to the State may be restricted; possibly interpreted as barrier to entry.
Limited Window of Opportunity	Imposes time limit on administrative involvement with telecommunication provider; construction on specific land or easement segments minimized by installing infrastructure at one time; allows expansion later at the State's discretion.	Total number of applicants and therefore total compensation to the State may be restricted; possibly interpreted as barrier to entry, though planned "reopening" of window may address barrier issue.
Open Application Period	Clearly, a non-discriminatory and no-barriers approach; probably enhances total compensation received by the State.	Extends period of construction and installation on land, thus poses safety concerns and possibility of damage to existing infrastructure; ongoing administrative burden.
Planned Excess Physical Capacity	Easy to accommodate subsequent applicants without disruptive construction on land.	Can impose some financial burden on initial applicants, though costs of incremental capacity are a fraction of total costs, may discourage primary tenants if perceived as threat to their customer base.

3.6.2 Methods for Developing Level of Fees

There are at least six key ways to determine the value of land or rights-of-way to be used by utilities. However, no single approach will yield a completely accurate value. These approaches are:

1. Competitive Auction – High bid(s) in competitive bidding situation assumed to reveal market value of access.
2. Valuation of Adjacent Land – Proximate real estate values used as a guide to value.
3. Cost of Next Best Alternative – Cost of communications infrastructure on highway ROW or other public property compared with total cost of next best alternative site (installation plus access and transactions costs using privately held parcels, railroad or utility ROW, etc.).

4. Needs-Based Compensation – Target level of compensation for barter compensation based on public sector communications needs, rather than independent estimates of private willingness to pay or market value.
5. Historical Experience – Data on documented shared resource and commercial lease agreements used as a guide to value of access to public property, adjusted to account for differences in property characteristics.
6. Market Research – Potential private sector applicants are contacted to determine interest, partnership conditions, and approximate willingness to pay.

The common methodologies used to establish appropriate fees are:

- ***Percentage of Gross Revenue***
  This is the most common method of compensation for use of the ROW when the utility requires ubiquitous access to the ROW.

- ***Linear Foot Fee***
  This methodology is typically utilized when the ROW occupants require space along a specific route or for a limited purpose within the public ROW.

- ***Combination Gross Revenue/Linear Foot Fee***
  Often, this methodology is adopted with certain telecommunications providers who may not generate significant revenues for a period of time. In this case, the local jurisdiction will implement the linear foot fee assessment until the company generates a mutually negotiated level of revenues. Upon achievement of the agreed upon revenue level, the percent of gross revenue methodology would then be implemented for the life of the franchise.

- ***Fee per Access Line***
  This compensation methodology is rapidly replacing the percent of gross revenue formula historically used in franchise/rental agreements for local exchange telephone companies where a fee is assessed per access line.

- ***Flat Annual Fee***
  Many local jurisdictions are adopting this methodology to ensure receipt of a known revenue amount annually. Typically, franchise agreements that require this type of compensation will also include a provision allowing for a yearly escalator or inflation factor to adjust the annual fee for increases in service provided by the affected utility.

- ***Adjacent Land Value***
  To establish the ROW rental value based on the market value of its adjacent property value. In this method, the market value of adjacent property (land only) per square foot is assigned to the related rights-of-way.

- ***In-kind Service***
  In-kind services received can be negotiated in addition to cash to be used over a period of time or infrastructure to be specified and installed. Examples of such in-kind goods and services are given in table 1. It is believed that in-kind compensation is easier to achieve with wireline versus wireless providers because wireline projects are more extensive and cover a wider geographic territory whereas wireless projects tend to be very site specific.

- ***Impact Cost-Based Fee***
  A fee structure that includes components that cover the cost of making the permanent pavement repair and the increased life cycle cost (takes into account pavements that have not received utility cuts compared to identical pavements that have received utility cuts) resulting from permanently damaged pavement.

- ***Acquisition Cost***
  This approach to valuing the rental value of public ROW incorporates the use of the estimated cost of acquiring and developing the ROW based on a jurisdiction's acquisition costs. There are not many local governments that utilize this approach because simpler methodologies are available to calculate a fair compensation for rental of ROW such as the percent of gross receipts model.

3.6.3 Model Ordinances (Rulemaking Documents)

Franchise and license agreements are powerful tools in managing the occupants of public ROW. These agreements outline the rules, rights, and fees associated with using public property for private purpose. By definition, franchise agreements are applicable for those ROW occupants that provide services to local, county and state jurisdictions. License agreements are written for firms that are simply traveling through the area with facilities that serve other communities. The power that jurisdictions have is regulated through state law. Federal law may dictate who may have access to ROW, but on what condition this occupancy occurs is clearly under local control. The franchise and license agreement serves as the device to set these conditions.

There are certain elements that should be included in all franchise agreements. The following is a general outline of the provisions and standards in a franchise or license type of agreement.[16]

1. *Parties to the Agreement*
   This section outlines the corporations that are involved in the agreement. It should also explain what the franchise plans to do and any other information pertinent to the parties address and other information. There should be a clause that requires occupants to "register" on a given timeline or when business / ownership conditions change. In an age when mergers and divestitures seem common place, ROW managers are frustrated by not knowing who is in charge. Who in the company has authority over the capital planning, engineering, and construction activities?

2. *Purpose and Rights of the Agreement*
   This section points out the goals and objectives of the franchise agreement. It outlines the need to protect and manage the ROW authority to assure adequate utility and communication services; all in relation to protecting the public health, safety, and welfare. State in this section that you plan to cover costs and receive fair compensation for ROW use.

3. *Definitions*
   The franchise agreements should contain a clear set of terms, phrases, words and other meanings that are clear to the jurisdiction and franchisee.

[16] American Public Works Association, Utility and Public Right-of-Way Committee, Model Franchise and License Agreement

4. *Scope of Agreement*
This section outlines the branch of authority for the use of the ROW by the franchisee. The following items are important to this section:

   a. The franchise given is a non-exclusive right to the franchisee.
   b. Outline clear authority as to what the franchisee can do in the ROW. It is common practice with some occupants of the ROW to rent their facilities to others. In most cases, there should be clear direction that sharing facilities, such as, attachments to poles, is not allowed without a franchise agreement from the jurisdiction.
   c. Outline what the franchisee can construct and how they should coordinate activities with other utilities. If a jurisdiction requires that additional facilities be installed for use by the municipal corporation or others, that should be outlined in this section.
   d. Include general information about obtaining permits and review of all construction documents by the jurisdiction. More detail on this subject is found in subsequent parts of the franchise agreement.

5. *Term*
The franchise agreement should outline the effective term limits of the agreement. This is normally done for a period of years with agreeable extensions from both parties. The jurisdiction must retain the right to modify or re-write ROW ordinances. New ordinance conditions will apply even if the effective term of the agreement has not expired.

6. *Compensation*
There are numerous ways to compensate the municipality for the right to occupy the rights-of-way. Compensation is comprised of three parts: Administrative fees, reimbursement (inspection, designation of facilities, etc.) and property rental.

   There are two different schools of thought on what and how much the jurisdiction can charge. Some claim municipalities are compensated only for reimbursement of costs. Others support the right to assess a fee based on the value of the property occupied. There is precedence for occupancy fees for cable service and the newer telecommunications firms (wireless and fiber optic firms). The challenge is coming from the established landline companies and other utilities (gas, water, etc.). Many of these companies were regulated by state legislation to warrant a *public benefit* statute much like government agencies. These regulations require firms to expand service as broad as possible. The new start-ups often choose only the profitable corridors (business centers, etc.) to extend service.

   If a jurisdiction wishes to structure a franchise agreement to include both types of compensation, then there is precedent to proceed in that manner. There is ample argument to support treating incumbent users offering traditional services (established under government regulations) differently from new entities with no obligations to the public at large. When establishing rate schemes, consider the service more than the company. Telephone, water, sewer, electric and gas may be thought to be essential public services much like transportation services. However, cable TV, data services, video and internet services are not essential for public welfare. Compensation structures can be totally difference for these different classes of services.

   This section should also include any request or requirements that the franchisee provide facilities for jurisdictional use. This can be done in addition to or in lieu of actual franchise fees.

It is not uncommon for a franchisee to provide numerous services such as cable TV, telephone and broad band internet services. There should be clauses within the franchise agreement that require that the services be *unbundled* (separated) and presented to the municipalities for complete verification that fees were calculated appropriately. As noted previously, a company may be assessed fees for only certain services.

7. *Permits and Construction Standards*
   Franchise agreements should include permitting requirements and the approval process for construction. Applicants should submit all plans for approval and provide as-built drawings as necessary. It may be best to have construction standards included within the ROW ordinance and have the franchise agreement refer to that ordinance. Many communities are concerned about the plight of numerous wires attached to power poles. If the community requires undergrounding of facilities, then that should be clearly stated within this section.

8. *Security and Performance Bonds*
   If a jurisdiction requires performance bonds or other financial guarantees during the performance of the work, this should be clearly outlined in the franchise agreement. Avoid the use of bonds whenever possible. Court action is required to release any money. It's better to establish bank letters of credit or hold cash in an agency account.

9. *Relocation of Facilities*
   The jurisdiction should protect itself by requiring the franchisee to relocate facilities whenever the jurisdiction requires such relocation. It may also be necessary that some facilities be moved because a third party wishes to gain entrance to the ROW. Under those circumstances, it should be clear that the third party should pay for the relocation of the occupants. The best way to prevent the need to relocate is to have proper planning of the initial location of all occupants. Try to keep all private companies at the extreme edges of the rights-of-way so that it allows the jurisdiction the clear use of rights-of-way for road, sewer, water, and drainage facilities. Situations are constantly encountered where ROW is full. No law exists mandating access when such approval will affect system reliability or increase the potential for catastrophic failures or repair costs. Simply put, if the only space available is over top of the sewer main, just say no. Most utilities will push to have old facilities abandoned in place. This is happening in the natural gas industry because of the environmental restrictions on disposing of old mains. Often these facilities are not mapped nor are they marked during stake out requests. A municipality needs to determine whether an abandoned facility should be removed as part of this franchise agreement.

10. *Replacement Franchise*
    At this time many communities are writing ROW ordinances or other types of codes. These codes are also being upgraded on a continuing basis as the utility industry changes. There should be a clause within the franchise agreement that requires the franchisee to remain consistent with applicable requirements of any amended or new regulatory ordinances.

11. *Assignment and Transfer*
    The industry is going through extensive de-regulation and mergers. It is often difficult to determine exactly who is the owner of the facilities. There should be a section that clearly requires the franchisee to inform the municipal owner and to seek approval for the assignment or transfer of the franchise agreement terms. The goal is not to prohibit this transfer but to clearly understand who is taking over the company and the applicable persons to contact should problems arise with the maintenance and/or coordination of the ROW.

12. *Indemnification and Waiver*
    Include a section that indemnifies the municipality against all claims and/or losses and liabilities because of the franchisee's having occupancy within the ROW.

13. *Insurance and Bonds*
    In this section, the franchisee should be made aware of exactly all limits and conditions required by the jurisdiction. Certificates and endorsements should be filed with the jurisdiction. There should also be a clause that states if there is a change in the insurance that a notice should be given directly to the municipality.

14. *Termination*
    There should be a clause that outlines all the conditions of which this agreement could be terminated by either of the parties. Should termination occur, there should be clauses that indicate that all facilities shall be removed at the expense of the franchisee.

15. *Miscellaneous Provisions*
    Most jurisdictions have various clauses that are to be included in agreements or contracts. These may include some or all of the following:

    a. The agreement should be binding on both parties.
    b. Choice of law should be clearly stated where any disputes should be presented to the courts. Generally that should be within the state of the municipality.
    c. Severability of provisions. Some provisions of the agreement may be considered invalid or illegal. This type of clause generally states that should this occur, other provisions shall stay in force.
    d. Consent requirements. This generally says that approvals pursuant to this agreement shall not be unreasonably withheld or delayed.
    e. Representation and warranties. This statement warrants that each of the parties in this agreement have authority to enter into and perform the obligations under this agreement.
    f. Financial review. This provision allows the municipal auditor to look at the books of the company to make sure that the revenues and other calculations are consistent with the agreement.
    g. Gratuities, kickbacks and conflicts of interest. Generally, there are clauses that cover that no gratuities shall be offered to municipal employees. Kickbacks are of course illegal, and those conflict of interests are avoided.

3.6.4 Summary

The policies described in this chapter – primarily to control the frequency of pavement utility cuts – can be implemented beginning with the methods of establishing appropriate fees and following model rulemaking documents such as the outline presented in section 3.6.3. In addition, several appendices to this report contain sample regulations and ordinances that have been in use by states and municipalities for several years.

The next chapter discusses the application of developments in technology to reduce the frequency of pavement utility cuts. However, conditions may often arise where policies are needed to encourage the use of this technology. Many of the types of policies described in this chapter may be of use in implementing and encouraging climate for trenchless and other technologies.

CHAPTER 4 REDUCING PAVEMENT CUTS BY INTEGRATING TECHNOLOGY

The previous chapter discussed methods that state and local agencies can implement to control the frequency of pavement utility cuts in highways and streets. While controlling these cuts can help maintain order, ensure that the repairs are done in an orderly manner, and encourage utility companies to share resources and trenching operations, it is also desirable to decrease the number of utility cuts necessary. This chapter presents information that can help transportation agencies effect this reduction while maintaining access for all those legitimate and responsible parties that request it. This chapter also contains the results of the survey conducted for this project as they pertain to the use and perceptions of trenchless technology by various state transportation agencies.

As technology advances, the ability to perform trenchless utility installation and maintenance will also advance, allowing a progressively greater proportion of such work to be completed without trenching through the pavement structure. To this end, this chapter presents basic information about the methods, equipment, and applications available for use in trenchless utility construction, and provides insights into conditions and situations where trenchless applications would not be appropriate, thus requiring trenching operations. It should be recognized that there are many conditions where trenchless applications are not appropriate, such as emergencies, where immediate trenching of the pavement is necessary, and advanced planning simply cannot be done. In other cases, conditions such as the nature of the soils and rocks below the surface, or the presence and/or uncertain location of existing utilities preclude the use of trenchless technology.

Rather than attempt to restate and capture the large amount of information regarding this continually advancing technology, this chapter summarizes the basic aspects of the capabilities, and provides extensive references to other, more detailed, sources of information. Throughout the sections that follow, references are given where additional information can be found regarding specifics on the various trenchless technology methods, their application, relative cost, and other information. Comprehensive glossaries of terms used in this and other literature on trenchless technology can be found in references 17, 20, and other guidelines with respect to the various types of trenchless technology.

4.1 Available Technology

This section discusses some of the available trenchless technologies and how agencies, engineers, and contractors are using this technology to reduce the number of pavement cuts. The methods discussed in this section include:

- Horizontal Directional Drilling (or Guided Boring).
- Auger and Slurry Boring.
- Pipe Jacking and Microtunneling.
- Impact Moling and Ramming (or Thrust Boring).
- Pipe Bursting.

It is not the purpose of this manual to provide detailed information on all aspects of each method, but instead to provide basic information on the following topics for each, including:

- Method.
- Equipment.
- Practical Applications.
- Specifications and Guidelines.

Additional information regarding advantages and limitations, and relative cost of trenchless technology as a whole, as well as for individual methods will be discussed in section 4.2. The relative cost comparisons will be made both among the different methods and compared to trenching methods.

4.1.1 Horizontal Directional Drilling (or Guided Boring)

The original application of horizontal directional drilling (HDD) originated in oil fields in the early 1970s. It was used to access deposits of oil near, but not directly under, the drill rig. HDD was first used successively in a river crossing where a 183-m (600 ft) distance was bored using a modified rod pushing tool which had no steering capability.[17] The process was soon modified to drill pipelines under rivers, achieving individual placements of 107-cm (42-in) diameter pipe over 1220-m (4000-ft) lengths. The first use of what is called guided boring was for electrical cable installation under obstacles such as airport runways, highways and rivers.[18] The technology has been used on a limited basis for public utilities in urban and suburban locations since the late 1980s. During that decade, the Electrical Power Research Institute and the Gas Research Institute sponsored research into the installation and construction of conduits and gas pipelines.

As recently as 1995 many contractors and utility companies were reluctant to use trenchless technology due to problems (both perceived and real) with locating existing underground utilities and the accuracy and precision with which the operators and equipment worked. Utility companies, government agencies and contractors were hesitant to embrace the technology because of these potential problems, as well as the much higher cost of directional drilling.

As HDD and guided boring technology has advanced, primarily in the tolerances for vertical alignment, their applications have expanded from pressurized pipes and conduit to gravity-driven systems. In addition to the advances in technology, the cost of directional drilling has dropped significantly in the past decade. The International Society of Trenchless Technology estimates that the relative cost of HDD has fallen below that of traditional trenching for many applications.[18] Horizontal directional drilling has been used on large, high-profile projects such as airports, ship channels, rivers, and others.

Methods

Horizontal directional drilling is generally divided into three classifications based on the typical application, and technical parameters including pipe diameter, depth of bore and bore length. The three classifications are mini-, midi-, and maxi-HDD, corresponding to small, medium and large diameter installation.[17] Table 11 provides typical technical data for the three classifications. A complete description of HDD procedures and methods is given in *Horizontal Directional Drilling – Good Practices Guidelines*, by the HDD Consortium.[19]

The HDD process typically consists of two stages: boring an initial pilot hole along the proposed alignment, and subsequently enlarging the hole to the diameter of the pipe.[17] Figure 1 and figure 2 illustrate the two stages of this process. The first stage is to drill the pilot hole, which is generally of a small diameter. The process begins with a small, portable boring rig set up near the point of entry to which a hollow drill string with a cutting head is attached. The rig pushes the cutting head into the ground at a shallow angle. When a change of direction is required, the rotation of the cutting head is stopped, and the drilling action on a single side creates an eccentricity which steers the head in the appropriate direction. The direction of the bore and the location of the cutting head is monitored by a beacon (or sonde) mounted in the drill head, which emits a signal that is received at the surface. In this way, the depth, direction, and other parameters of the boring process can be monitored and modified throughout the operation. Once the pilot bore exits at the appropriate location, as indicated in figure 1 as *Reception Pit*, the backreaming device and pipe product are fitted to the drill string and

pulled back to the original entry location, shown in figure 2. This is accomplished by a rotating reamer and pipe.

Table 11. Comparison of Main Features of Typical Maxi-, Midi-, and Mini-HDD Systems.[17]

System Description	Product Pipe Diameter	Depth Range	Bore Length	Torque	Thrust / Pullback	Machine Weight (including truck)	Typical Application
Maxi-HDD	600-1200 mm (24-48 in)	≤ 61 m (200 ft)	≤ 1500 m (5,000 ft)	≤ 108.5 kN-m (80,000 ft-lb)	≤ 445 kN (100,000 lb)	≤ 267 kN (30 ton)	River, Highway Crossing
Midi-HDD	250-600 mm (10-24 in)	≤ 23 m (75 ft)	≤ 274 m (900 ft)	1-9.5 kN-m (900-7,000 ft-lb)	89-445 kN (20,000 – 100,000 lb)	≤ 160 kN (18 ton)	Under rivers and roadways
Mini-HDD	50-250 mm (2-10 in)	≤ 4.5 m (15 ft)	≤ 183 m (600 ft)	≤ 1.3 kN-m (950 ft-lb)	≤ 89 kN (20,000 lb)	≤ 80 (9 ton)	Telecom and Power cables, water and gas lines

This drilling process is relatively quick, and there is minimal disruption around the launch area, service connections, and reception pits. There is always a danger of striking existing utilities, and power lines in particular, so it is important to use strike-protection equipment.[18] In addition to such protection, a subsurface utility engineering (SUE) study should be completed prior to construction. This type of study is discussed in section 4.3 of this report.

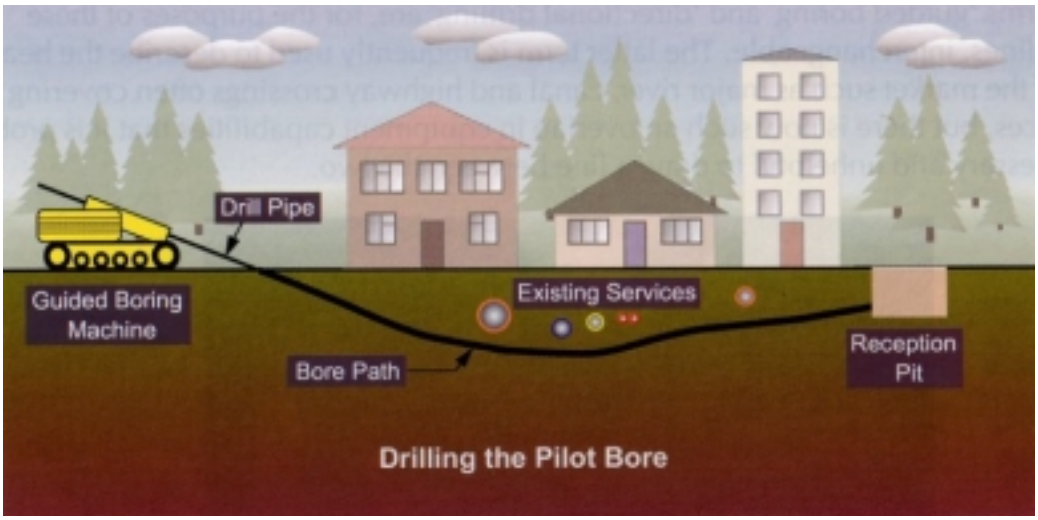

Figure 1. Drilling the Pilot Bore.[20]

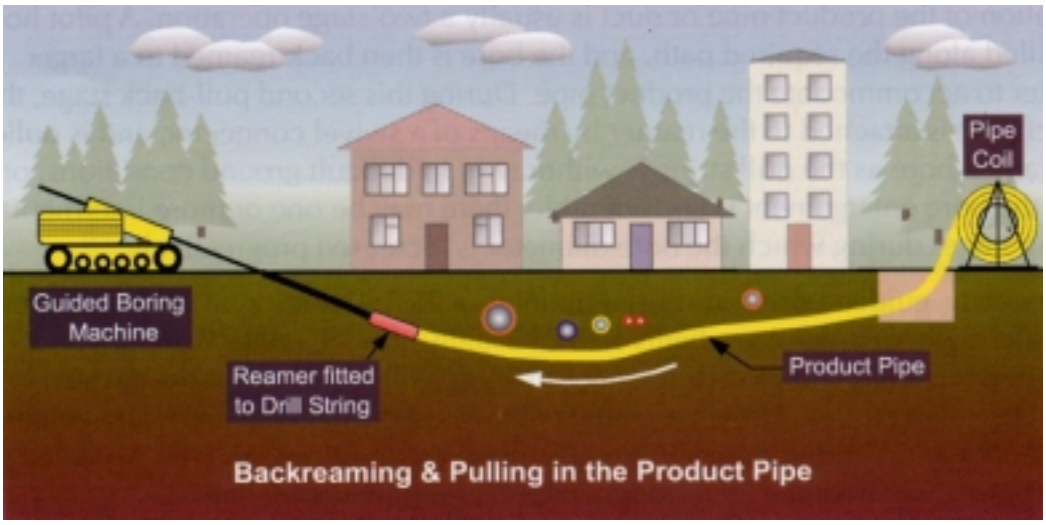

Figure 2. Backreaming and Pulling the Pipe.[20]

Several types of HDD methods are in use today. These include fluid-assisted mechanical drilling, high-pressure fluid jetting, and dry boring.

Fluid-Assisted Mechanical Drilling

Fluid-assisted mechanical drilling utilizes mechanical drill bits with an angled head. In order to make a straight bore, the entire shaft and drill head is rotated, thus providing alternating eccentric pressure on all sides of the bore hole. Steering is achieved by ceasing the rotation of the drill head, which concentrates the eccentric force to one side. Thus, a curved path can be bored through the soil. The mechanical drill bits commonly used include slim cutting heads with slanted faces for short or small diameter bores, and diamond-mounted roller/cutters with mud motors for long or large diameter bores. A mixture of bentonite and water is normally used for the drilling fluid, sometimes called *mud*. This fluid carries the spoils in suspension, and can be filtered and reused with a recirculation system. The mud also stabilizes the bore hole during backreaming.

High-Pressure Fluid Jetting

This type of HDD uses high-pressure fluids to erode the bore hole rather than drill it with a cutting head. In most cases, the fluid used is a bentonite-water mix or some other polymer-based slurry in order to stabilize the bore hole and prevent its collapse.[17] Steering is effected by offset jets and other steering devices in the system. The energy of the high-pressure fluid dissipates quickly after the fluid exits the jets and after eroding a small amount of soil, thus problems of soil overcutting and damage to existing utilities are unlikely.[17]

Dry Boring

Dry boring is rarely used, except in instances where mini-HDD systems utilize compressed air in hard, dry soils and calcified or soft rock formations.[17]

To ensure the correct cutting head or method is used, a series of ground investigations must be conducted prior to construction. Clay and other cohesive materials are best suited for HDD operations. Other materials that are less cohesive but consist of smaller particles that can remain in the drilling fluid suspension for an adequate time can also be used with HDD methods. If the investigation reveals granular soils and gravels, then HDD generally should not be used. With such material, there is a greater potential for a collapse of the bore hole during both the pilot drilling and back reaming, and steering accuracy may not be adequate. However, according to Iseley and Gokhale, today's

technology enables large drilling operations to be conducted in soil formations consisting of up to 50 percent gravel.[17]

Equipment

There are two major types of HDD rigs: surface-launched and pit-launched. Figure 3 shows a typical surface-launched HDD rig. Each type has its advantages and disadvantages. Surface-launched machines do not require entry and exit pits, although some type of excavation is normally required to make the pipe connections below the surface. Surface-launched machines generally use somewhat flexible pipe since at least two curves are made (surface entry to horizontal and horizontal to exit at the surface). The pipe segments can be relatively long, and thus the cost of extra connections is reduced.

Figure 3. Surface-Launched HDD Rig (Courtesy of Purdue University).

Pit-launched machines are lowered into an excavated pit large enough for the machine and the pipe segments. Often, this restricts the length of the pipe segments, and the additional pipe connections can add cost to the project. Pit-launched operations are often suited for restricted spaces, and can be used in areas where horizontal space or ROW is limited. This type of HDD machine is generally intended for straight bores, and often uses much stiffer pipe than the surface-launched pipes. This can significantly limit the ability to steer around obstacles.

There are many different equipment manufacturers that produce variations on the standard HDD equipment. Typical equipment used in a basic HDD drill head includes, as shown in figure 4.[21]

1. Drill bit.
2. Fluid nozzle.
3. Beacon housing.
4. Beacon.
5. Beacon housing plug.
6. End cap.
7. Screen sub plug.
8. Screen.
9. Screen sub.
10. First segment of drill pipe.

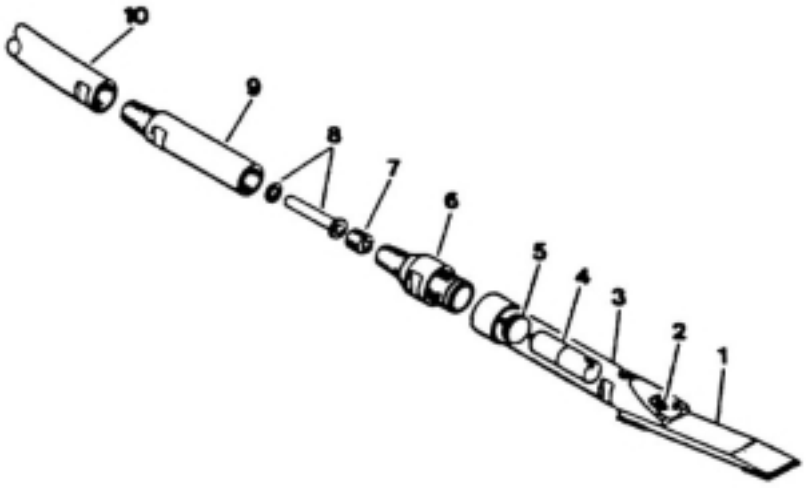

Figure 4. General HDD Drill Head Assembly.[21]

Other components not shown in figure 4, but that are required in most HDD operations, include:

- Drilling frame.
- Rods and drill shoes.
- Mud motor.
- Percussive drilling assembly.
- Reamers and pullback attachments.
- Tracking instrumentation.
- Hydraulic controls and gauges.
- Cable or pipe pulling devices (see figure 5).
- Drilling fluid delivery, filtering, recirculation, and containment.
- Power source.
- Transport trailer.

Figure 5. Towing Heads for Directional Drilling Applications.[20]

Another important component that is not part of the actual HDD operation itself, but is indispensable, is bore tracking equipment. This equipment receives the signal sent by the beacon indicated by Item 4 in figure 4. In order for the tracking equipment to perform properly, it must be free from both

active and passive interference. Active interference could be magnetic fields and radio frequencies, while passive interference may originate from adjacent structures, buried metals, salts, etc. A *walk-over* tracking system employs a handheld receiver and an operator who "walks over" the drill head, monitoring its progress and steering it in the appropriate direction. Non-walkover systems are used where the depth of the drill head exceeds the range of a walkover system. In such cases, a steering tool and survey probe within the drill head must be used to navigate the bore through the underground soil.

Practical Applications

As shown in table 11, HDD can be used in a wide range of applications, from 50 – 1200 mm (2 – 48 in) in diameter, and for bore lengths of up to 1500 m (5000 ft), depending on the pipe size. HDD applications can also be used at depths up to 61 m (200 ft), again depending on pipe size. HDD applications are used to install cable, conduit, gas, and water pipes under roadways, railways, rivers, lakes, and environmentally sensitive areas. A typical installation rate is about 100 m/day (328 ft/day) using a skilled crew.[17] The latest equipment is reported to allow installation of gravity pipelines demanding close tolerances in vertical alignment.[18] A comprehensive troubleshooting table listing potential problems, probable causes, and possible solutions can be found in reference 17.

Specifications and Guidelines

Several states and cities have developed standards for HDD applications. The state highway agencies of California, Florida, Indiana, Michigan, Minnesota, New York, Oregon and others have developed variations on HDD specifications.[17] A sample specification from the Florida Department of Transportation is included in Appendix C. The City of Los Angeles, California has also developed specifications for HDD applications, which is also included in Appendix C. In addition to specifying the fluid, accuracy and precision of the drill head, turning radius, and limiting surface subsidence and distortion, such specifications should address at least the following, from reference 17:

- Nature and extent of subsurface exploration.
- Procedures for approving alternate drilling fluids such as polymers.
- Minimum depth of cover.
- Qualifications of contractors and crews.
- Contingency planning in the event of roadway surface disturbance, including subsidence or upheaval, a drill bit breaking the surface, or drill fluid escaping to the surface.
- Backfilling requirements for abandoned, off-target pilot holes.

Many state highway agencies specify the types of pipe to be used, the method of construction, methods of quality control and testing, location and tracking, and documentation requirements for HDD. As the technology becomes more widespread, as expected both by state highway agencies as well as the HDD industry, the agencies will be required to place more controls on the methods and uses of the technology in order to maintain the integrity of the existing utility and pavement infrastructure.

4.1.2 Boring

Two types of boring methods are most commonly used: auger boring and slurry boring. Both methods have been in use to install steel pipe encasements beneath roadways since the 1940s. These systems are commonly un-steered, and thus their course may be altered by unexpected objects such as large boulders or other obstacles. Slurry boring is quickly being replaced by the HDD methods, due to their similarities, and HDD's location and guidance capabilities.

Methods

The auger boring method forms a horizontal bore hole through the ground using a cutting head attached to a helically-wound auger flight. The auger rotates the cutting head and removes the exca-

vated soil from the bore by the rotation of the auger. The auger flight is typically contained in steel casing, since it must resist the action of the auger. Most auger boring systems are equipped with pipe-jacking machines to move the casing forward as the cutting head advances. This ensures stability in the hole. The product pipe is inserted into the casing once it has been installed.[18] If the casing pipe is not jacked along with the auger head, the pipe diameter should be small, or the soil conditions should adequately support an unstabilized hole. The hole is typically bored straight through the underground material from an entry pit to a reception pit. In some machines, vertical directional control is possible, but horizontal directional control is not generally used. A diagram of a typical auger boring setup is shown in figure 6.

To setup and operate the auger boring machine, the following steps need to be performed:

- Construct the shaft with adequate foundation and thrust block.
- Place the tracks on the foundation.
- Place the auger boring machine on the tracks.
- Place the casing with the auger inside, between the front of the shaft and the machine.
- Install the cutting head.
- Attach the auger and casing to the machine.[17]

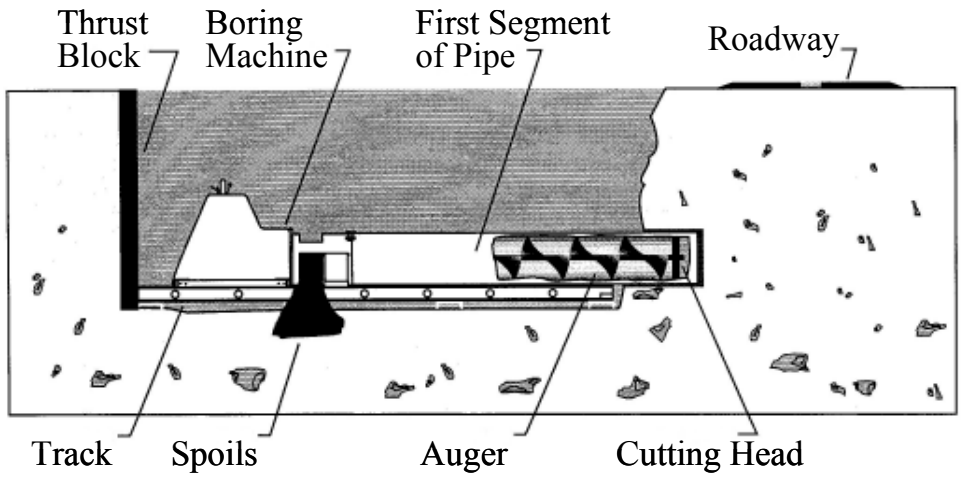

Figure 6. Typical Auger Boring Operation.[17]

Slurry boring utilizes a cutting head and drilling fluid, similar to that used in HDD, to assist in the boring process and to aid in removal of the spoils. This type of boring generally is not steered, but beacons or sondes are often used to locate the boring head. Slurry boring is sometimes called *wet boring* or *fluid-assisted mechanical drilling*. Slurry boring differs from HDD in that there are lower fluid pressures and higher flows. Slurry boring does not only rely on fluid for cutting; the hole is also cut mechanically. The drilling fluid used can be water, a bentonite slurry, or a polymer slurry. As with HDD, the bore is cut in a two-stage process. The first is the installation of a pilot hole, followed by the cutting of the bore hole along the pilot alignment which will accept the casing pipe. Iseley and Gokhale provide more details about the process.[17]

1. Construct the drive and reception shafts.
2. Drill the pilot hole.
3. Check accuracy of the pilot hole.
4. Ream the hole to the bore hole diameter,
5. Insert the casing in the bore hole.

6. Grout between the casing and the bore hole.
7. Insert the desired carrier pipe.
8. Construct the casing / carrier pipe bulkheads.
9. Backfill and restore the shaft areas.

After the setup process, the following procedure is typical, again from reference 17:

10. Excavate the material ejected through the shaft.
11. Install the first casing.
12. Disconnect the casing and auger, and move the machine to the back of the pit.
13. Place the next casing and auger, and connect it to the previous casing.
14. Repeat the process until installation is complete.

Equipment

There are two types of auger boring equipment: track- and cradle-type. The components required for a track-type system include the track system, boring machine, casing pipe, drilling / cutting head, and the auger. Additional equipment could include a casing lubrication system, a cutting head locating system, and a casing leading-edge band. A track-type setup is shown in figure 7. The casing is advanced by hydraulic jacks in a continuous motion, simultaneously with soil excavation, spoil removal, and casing installation. A stable foundation and adequate thrust block are necessary. The tracks must be in line with, and on the same grade as the bore hole. Accuracy can be affected if the track settles, which could cause binding forces in the bore hole. If the base of the entry pit can support the boring machine and other component of the system adequately, the tracks can be set upon the base of the pit, or on a bed of crushed stone or even portland cement concrete for support. The thrust block distributes jacking forces over a sufficient area so that the soil behind the block is not disturbed. If the thrust block moves in any direction, accuracy of the bore hole could be compromised.

The cradle-type method is not used as extensively as the track-mounted system. The machine and casing system are suspended by a crane, as shown in figure 8. This type of equipment is generally used for gas and oil pipeline construction.[17] The equipment necessary for the cradle-type system is almost identical to the track-mounted system, without the tracks, and with the addition of a crane and a frame capable of lifting the entire boring machine and casing system. The cable, winch and jacking lug provide the propulsion needed to drive the head and casing through the ground.

Figure 7. Track-Type Auger Boring Operation (Courtesy of Purdue University).

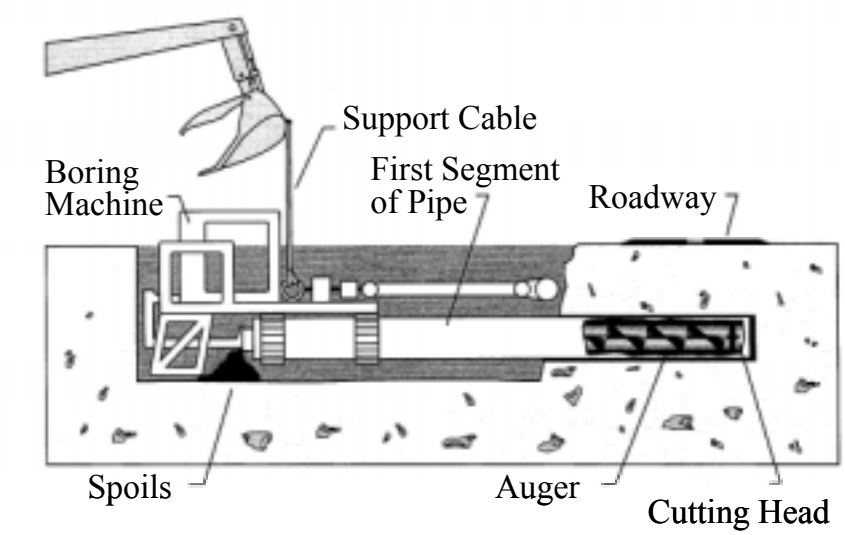

Figure 8. Cradle-Type Auger Boring System.[17]

The second method of boring is slurry boring, and is associated with non-tracking and non-steering operations. Slurry boring equipment is either surface or pit launched. Similar to auger boring, the drill tubing is rotated and pushed forward, while a drill bit mechanically cuts the bore hole. The drilling fluid is introduced in to the drilling tube using a water swivel tee. As shown in table 12, the typical diameter hole is between 51 and 305 mm (2 and 12 in). Most times, slurry boring involves an uncased bore hole, making it suitable for small diameter applications in stable ground. With proper installation, only minor subsidence will occur. Because of the use of water, the operator does not have control of the excavation volume. An experienced operator is needed in the event of unexpected situations.

Table 12 provides technical information about these two major methods of boring. The vertical and horizontal accuracy listed in the table for auger boring can be maintained using a grade-controlled steering system. Without the steering head, accuracy depends on groundwater conditions, drive length, initial setup and operator skill. It should be noted, however, that the data in table 12 was recorded in 1997, and further advancements in the technology have been made. For example, some boring contractors have reported performing slurry bores up to 2.5 m (96 in) in diameter.[22]

Table 12. Typical Ranges for Auger and Slurry Boring Systems.

System Description	Bore Length	Diameter	Drive Shaft Length	Vertical Accuracy	Horizontal Accuracy
Auger Bore	≤ 270 m (890 ft)	100-1500 mm (4-60 in)	9.1-10.7 m (30-35 ft)	± 13 mm (0.5 in)	1% of bore length
Slurry Bore	15-100 m (50-328 ft)	50-300 mm (2-12 in)	4.5-6.1 m (15-20 ft)	< 2% of bore length	< 2% of bore length

Practical Applications

Auger boring may be used in almost all applications where curves and horizontal alignment do not present a great issue. It is especially suited for large-diameter bores such as water and wastewater applications, where precise adherence to grade is important. Auger boring can be used in most soil conditions, including wet sand, dry clay, and solid rock. It is best suited for cohesive soils or stable,

non-cohesive soils. When selecting the auger boring equipment, ground subsidence and soil heave should be considered. Subsidence is the most common problem, caused by over-excavation when the bore hole is too large or when soil enters the end of the casing pipe.[17] An experienced operator can feel, or detect the changing ground conditions and take corrective actions.

The construction rate for auger boring can range from 1 to 12 m/hr (3 to 40 ft/hr) depending on the soil conditions.[17] This does not include construction of the entry and exit shafts. If the excavation embankments can be sloped, and are less than 3 m (10 ft), shaft construction can take a single day. However, if the sides cannot be sloped, or are too deep, a steel sheet piling support system may be required, which could take several weeks. The size of the required work space is typically determined by the bore hole diameter and length of casing segments. A common shaft size is 9.1 – 10.7 m (30 – 35 ft) in length by 2.5 – 3.6 m (8 – 12 ft) in width.[17]

Slurry boring is not used as often as it has been in the past, due to the popularity and improved technology of horizontal directional drilling. It is used by many contractors, however, and can be used successfully over a wide range of utility applications and ground conditions. Slurry boring is best suited for firm, stable, cohesive soil conditions, but can be used in wet, non-cohesive soils if extra precautions are taken. The National Utility Contractor's Association publication *Trenchless Construction Methods and Soil Compatibility Manual* contains information about safety precautions for construction under various soil conditions.[23]

Specifications and Guidelines

Since auger boring has been in use for so many years, all state highway agencies allow its use, although many do not have specifications governing its application.[17] In cases where state specifications exist for auger boring, they are often general in nature, require the use of steel casings, only describe the type of pipe material that can be used, and limit the damage allowed to surrounding pavements, structures, or other features.[17] A sample of a boring specification is included in Appendix C.

Slurry boring is less popular among the state highway agencies. Many do not allow this type of boring, since it is similar to water jetting, in that overexcavation can occur and subsidence can result. Slurry boring is used extensively in Texas, Louisiana, Mississippi and Oklahoma.[17]

4.1.3 Pipe Jacking and Microtunneling

Pipe jacking (PJ) and microtunneling (MT) are very similar. In fact, in North America, microtunneling has become the preferred terminology for all remote-controlled pipe jacking operations. Traditionally, the term microtunneling has been limited to those operations with diameters up to 914 mm (36 in), although in the US the term has been applied to all diameters of this method. Operations greater than 914 mm (36 in) in diameter, where a worker can enter the pipe, has been traditionally called pipe jacking.[24] Generally, pipe jacking operations require a person to be in the pipe, while microtunneling does not. Microtunneling was developed in 1975 in Japan, and was introduced into the United States in 1984, on a project in Miami, Florida.

Initially, this method of trenchless technology was thought to be ill-suited for use in the US, due to highly variable geology and expense. In 1987, however, the City of Houston began using the technology extensively to expand their sewer system. In four years, over 21 km (13 mi) of microtunnels and 18 km (11 mi) of jacked pipe were installed in Houston. By the end of the sewer construction process, the City of Houston had developed a good specification for microtunneling, which was modeled after the US Military Unified Facilities Guide Specifications. This can be found in the sample specifications section in Appendix C, as can a sample from the City of Wichita, Kansas.

Methods

Both PJ and MT methods require launch pits and reception pits. For long, man-entry operations, intermediate jacking stations can be used to extend the drive length, which is based on the jacking capacity of the machinery. In non-man-entry operations, the jacking length is limited to the jacking capacity at the entry pit, and only one drive can be completed for each pit. table 13 provides information regarding typical applications, pipe materials, and pipe length and diameters available for use in PJ or MT operations.

In the larger diameter, pipe jacking operations, the tunneling is either done by hand, or by mechanical means such as backacter, cutter boom, or rotating cutter head (see figure 9). As the material is removed through the tunnel, by means of a bucket on rails, conveyor belt, or vacuum system, the pipe is jacked into place, which advances the tunneling operation forward.

Table 13. Comparison of Pipe Jacking and Microtunneling Features.[25]

System Description	Product Pipe Diameter	Bore Length	Pipe Material	Typical Applications
Pipe Jacking	> 900 mm (36 in)	≤ 1000 m (3,280 ft)	Concrete, steel, fiberglass, clay	Crossings, sewers, force mains
Microtunneling	450-1500 mm (18-60 in)	≤ 460 m (1500 ft)	Concrete, steel, fiberglass, clay	Crossings, sewers, force mains

In order to minimize friction between the pipe string and the ground through which the pipe is traveling, lubrication is often used. In the early days, the problem of friction was overcome by brute force – using larger jacking frames to force the pipe through the ground. This often led to pipe failures, when the jacking frame exceeded the axial capacity of the pipe.[18] Lubrication systems using bentonite slurry were introduced which not only lubricates the pipe as it moves through the soil, but fills voids left by the tunneling process. Jacking forces have been reported to decrease by 20 – 50 percent, with the most common reduction being about 20 – 30 percent.[17] It is often important to keep the pipe string moving through the ground to reduce the effect of the soil "gripping" a pipe string which remains stationary too long.[18]

The basic procedure for pipe jacking, as reported in reference 17, is as follows:

1. Place jacking equipment in the drive shaft.
2. Place PJ track in shaft and adjust to the proposed design line and grade.
3. Install laser guidance system.
4. Place shield or tunnel boring machine (TBM) on the jacking tracks.
5. Mate jacking push plate to shield or TBM.
6. Advance shield or TBM through the prepared opening in the forward shaft support structure. Begin the excavation and spoil removal process.
7. Continue excavation, spoil removal, and forward advancement until shield or TBM is installed.
8. Retract jacks and push plate.
9. Place first pipe segment on the jacking tracks.
10. Mate push plate to pipe and pipe to the shield or TBM.

11. Initiate forward advancement, excavation, and spoil removal.
12. Repeat pipe jacking cycles until complete line is installed.
13. Remove shield or TBM from reception shaft.
14. Remove jacking equipment and tracks from drive shaft.
15. Restore site as required.

Regarding the pipe size and length shown in table 13, reference 17 reports that the minimum recommended pipe diameter for pipe jacking operations is 1075 mm (42 in.) and that there is no theoretical upper limit, but that the largest diameter is usually approximately 3.7 m (12 ft). It further reports that the most common sizes fall within 1220 mm (48 in.) to 1830 mm (72 in.) in diameter.

In microtunneling, the remote-controlled tunneling device excavates the bore into which the product pipe is installed. This method is generally too small in diameter to allow a man to enter the pipe. The cutting head may be fitted with blades for soft soils, picks for hard soils / soft rock, and disc cutters for hard rock. The spoils can be removed from the bore using a mechanical auger, vacuum, or slurry. A flight of augers running through the newly installed pipe is preferred for short drives, due to the faster removal rate compared to other systems.

Using the slurry removal system, water or bentonite may be used to convert the soil into a slurry at the cutting face. The slurry, which is water based, is then pumped to the surface along pipes within the product pipeline. The spoil is then collected in a processing plant, where it is removed and the slurry recycled back to the cutting face. The slurry system can be used to control external groundwater by balancing the slurry pressure so that it offsets the groundwater pressure. The slurry system is usually more suitable for long drive lengths, especially in granular soil and where there is groundwater.

Ground conditions have a large impact on the choice of microtunneling system for a particular situation as they will determine the type of machine to be used, the cutting head, the spoil removal system and the jacking force required.

Microtunneling machines can be steered to ensure the correct line and level of the product pipe. The accuracy of the bore is normally determined using laser guidance control systems. The machines are operated from a control cabin at the surface.

Equipment

Various types of equipment are used in pipe jacking and microtunneling operations. Figure 9 shows the various types of pipe jacking shields that can be used, depending on the tunneling method. The jacking shield protects any workers at the end of the pipe string in the event of a tunnel collapse. As the shield advances underground, additional pipes are added to the pipe string at the drive shaft.

For long lengths of pipe, intermediate jacking stations may be necessary to allow sequential thrusting of sections of the pipeline. Drives of several hundred meters are attainable using this technique. These pipes are specially designed to ensure that all joints are flush within the pipe wall, and that they are strong enough to withstand the jacking forced applied to them.

Figure 10 shows the equipment and setup for a typical pipe jacking operation. Notice the operator at the entry to the pipe in the pit. Figure 11 shows the same type of setup for a typical microtunneling operation. In this operation, the operator is above the ground, in a control station. The pipe diameter is too small for the operator to enter, and the entire process must be done by remote control.

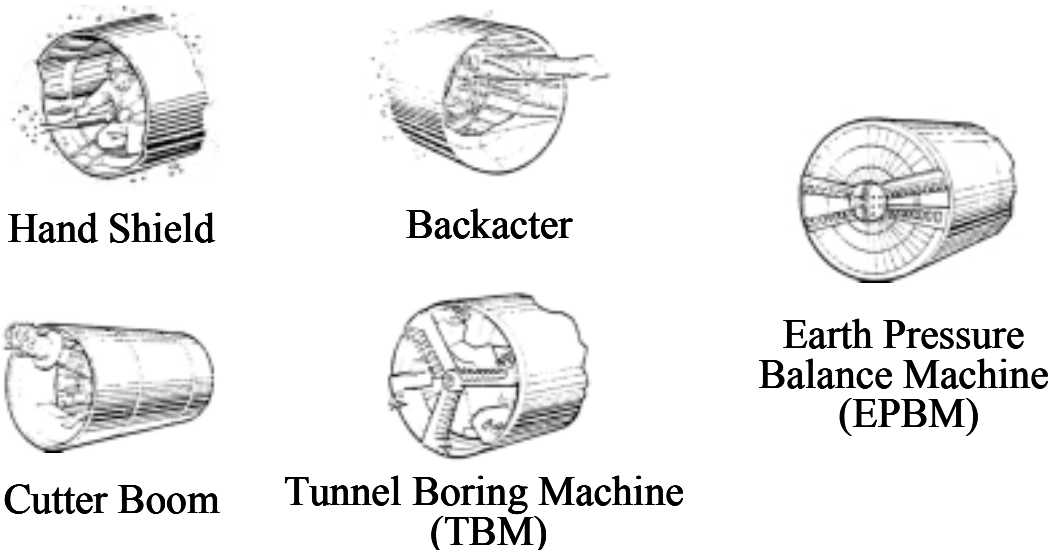

Figure 9. Various Pipe Jacking Excavation Techniques.[17]

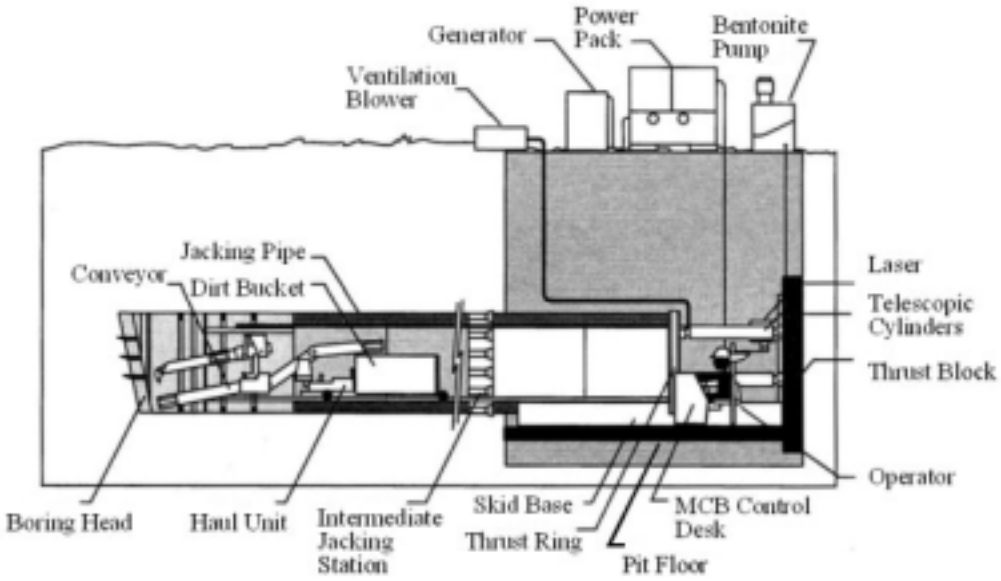

Figure 10. Pipe Jacking Setup.[17]

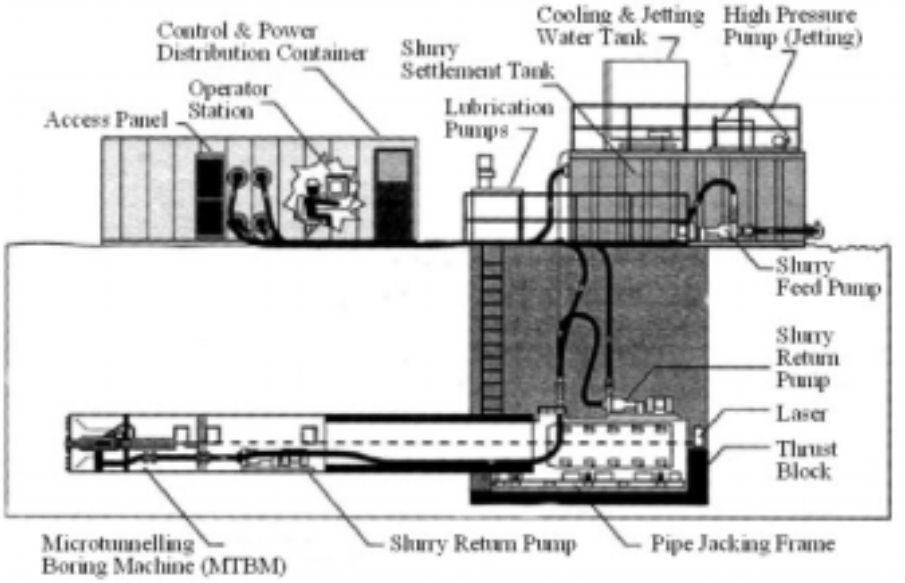

Figure 11. Typical Microtunneling Setup.[17]

Practical Applications

Favorable soil conditions for pipe jacking is a sandy clay, although many other types of soil conditions can be accommodated if appropriate precautions are taken.[17] Microtunneling favors wet sand for the slurry system, and sandy clay conditions for the auger system.[17] It can be used in many types of rock as well, with the proper equipment. Microtunneling is also well-suited for marine and other water crossings.

Types of casings are generally limited to steel, reinforced concrete, and other materials that can transmit the jacking and other forces involved in the pipe installation. The microtunneling method generally produces lower jacking forces, and thus other materials have been used, such as vitrified clay, ductile iron, and polyvinyl chloride (PVC).[17]

Under good working and soil conditions, a microtunneling crew can average 9 m to 18 m (30 to 60 ft) in a standard shift.[17] This production rate varies depending on the soil conditions, jacking forces required, and skill of the crew, among others.

Specifications and Guidelines

Pipe jacking and microtunneling is allowed and specified by many state highway agencies and cities throughout the United States as well as the US Department of Defense. Some examples of agencies with defined specifications are the State of California, the Cities of Los Angeles, California, Wichita, Kansas, Houston, Texas, and the Dallas-Fort Worth International Airport. Sample specifications are provided in Appendix C, including an excellent sample from the Florida DOT.

4.1.4 Impact Moling and Ramming

Impact moling and pipe ramming may be the most widely used trenchless installation methods. Tens of thousands of impact moles are in service with utilities and contractors worldwide. They first appeared in Russia and Poland in the 1960s. These methods offer solutions to a wide range of installation problems, particularly over short distances.[20] The impact mole and pipe ramming methods use the same type of equipment, but they employ different techniques.

Impact moles are commonly used to install gas and water lines and cabling. The impact mole produces a bore by displacing soil using a hammering, or percussion, action. It is a type of soil compaction technique, where the soil is displaced radially from the center of the bore and not removed. This *earth piercing* tool, as it is known in North America, is a self-propelled down-hole hammering device that is used for the placement of small diameter pipes, ducts and cables.[20]

Pipe ramming is a non-steerable technique for pipeline installation. Typically, an open-ended steel casing or new pipe is driven through the ground by a percussive hammer from a drive pit. This technique is typically used under railways, road embankments and waterways. Pipe ramming installation distances are relatively short, about 50 m (164 ft) on average.[20] Since this technique usually involves pushing a open-ended pipe, after is has been rammed to the other end of the drive, the pipe or casing remains filled with soil. This must be removed by various methods that will be discussed within this section.

Methods

Although these two types use similar methods to drive a pipe or pull a conduit through the ground, some aspects of their operations can be quite different. For this reason, the methods section will be divided into two segments.

Impact Moling

Figure 12 and figure 13 show the common method of the impact moling operation. The mole device is propelled through the soil and can pull a new pipe behind it, depending on the application. The bore hole is formed by the displacement of soil using a compacting device called a mole that is generally shaped like a torpedo.

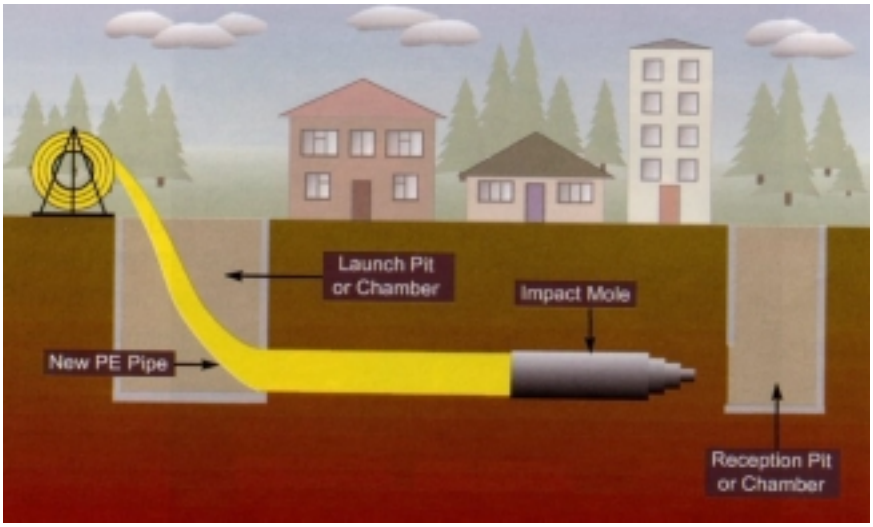

Figure 12. Typical Impact Moling Operation.[20]

The mole is composed of a long hollow cylindrical housing with a conical-shaped displacement head at the front and a percussive piston inside. It is forced through the soil by applying a static thrust force or a dynamic impact energy, most commonly powered by compressed air.[18] The surrounding soil grips the mole and prevents its backwards movement. The performance of the mole depends on the soil type and ground conditions in which it is operating. The percussive action of the impact mole compacts and displaces the soil in the immediate area surrounding the formed bore. No spoil removal is needed. The impact mole also has a self-propelled feature, and reverse capacity, so it can be withdrawn if it has deviated from the desired path.[17] The bore

may always take the path of least resistance in nonhomogeneous soils, and this must be considered in the project planning phase. Piercing tools can penetrate even the most adverse soil types, but solid rock is unsuitable for this technique.

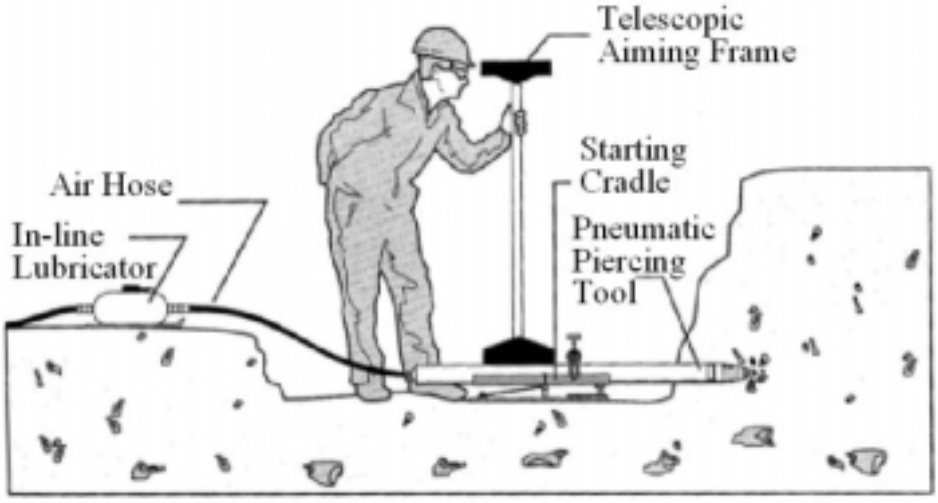

Figure 13. Impact Moling Process.[17]

In impact moling, two pits are excavated, one to launch the mole and the other to receive it. A launching cradle is set up and adjusted to set the line and level of the mole before the operation commences. This ensures that the mole will reach the reception pit and will emerge at the correct depth. The launching pit is typically 1.5 m (5 ft) long and 1m (3.3 ft) wide by 1m (3.3 ft) deep. The reception pit should be at least the length of the mole to allow its removal. After the hammering tool has constructed the bore hole, the product pipe can be installed by pulling or jacking. As mentioned, it can also be installed while the bore hole is being molded.[20] This is advantageous for loose soils where an unsupported hole is susceptible to collapsing. The bore hole diameter is limited to the size of the piercing tool's cylindrical housing.

This method is typically not steerable, but steerable systems have recently become available. The steerable impact moles allow for curved trajectories and bores with multiple direction changes and alignment corrections during the moling process.[26] To ensure successful installation with the non-steerable impact moles, it is important that the direction, depth and level are accurately established before the mole is launched. Monitoring equipment can be used to track the progress of the mole through the ground. If the mole meets an obstruction or is seen to deviate from its course, it can be withdrawn and work restarted. It is also essential that no pipes, ducts, or cables lie along the intended route of the new pipeline. They can potentially damage the mole, or be damaged by it. However, it is possible for impact moles to deal with some obstructions without being deflected off course by attaching a different head type that allows for different ground conditions.

Pipe Ramming

The pipe ramming operation requires the establishment of a solid base on the launch side of the installation pit, shown in figure 14. Normally, a concrete mat is used against the side of a slope or in a start pit.[20] Guide rails are installed on the mat, and the first length of steel casing is placed on them. The cutting edge of the pipe is formed by welding a steel band to its exterior surface and the ramming hammer is attached to the rear of the pipe. Depending on the diameter of the casing and the impact hammer, inserts can be used to ensure solid contact between the hammer and the pipe.[17]

Figure 14. Pipe Ramming Entry Pit.[20]

Pipe ramming can be thought of as an extension of impact moling. The ramming hammer forces the pipe into the ground along the line of the guide rails. It is in essence a large impact mole that fits into the end of the steel casing. Steel is used since the pipe must be strong enough to withstand the impact forces created by the hammer. The wall thickness is also important in the design. Once one pipe segment has been driven, the hammer is stopped and moved. The next length of casing is welded in place. It may be necessary to lubricate the outer surface of the casing. This cycle is repeated until the leading edge of the first pipe arrives at the reception shaft.[20] Since pipe ramming is an unguided process, it is important that the initial set-up be accurate in line and grade. Gravity draws the pipe down, so initially the ramming should begin on the upstream side of the crossing.[17]

Compressed air or water is used to remove the soil from the casing. For large casings, an auger can be used. If the soil conditions are appropriate, a closed casing can be used. Continuous casing support is provided to the bore hole at all time, thereby preventing over excavation. Also, no water is needed in the excavation. After installation, the casing can be used as a pipe, or as a duct for most types of pipe or cable.[20]

To install a pipe, the following procedure is used on a typical ramming operation:[17]

1. Construct an adequate launch shaft.
2. Install a cone or band on the leading edge of the casing.
3. Place the casing in the drive shaft and adjust for the desired line and grade.
4. Attach the hammer device and connect it to a pneumatic or hydraulic power source.
5. Initiate the drive and continue until installation is complete. For multiple pipe segments, remove the hammer, weld another pipe to the end of the casing, and repeat the cycle until installation is complete.

6. Remove the cone or band (if used) and clean out the casing.
7. Remove the equipment.
8. Restore the area as required.

Equipment

The non steerable moles are designed with either fixed or moving heads. The fixed-type hammer, operated by compressed air, impacts on a solid head that is welded or screwed onto the body of the tool. The moving-head hammer impacts on an intermediate anvil and the head that penetrates the ground is mounted on a spring. In theory, the moving-head hammer allows all the initial impact energy to concentrate on pushing the head into the ground, whereas the fixed-type head must overcome friction on the housing and move the body forward at the same time.[26]

There are two basic head shapes: a cone (or stepped) and chisel head. The cone pierces the ground and pushes the soil aside. The stepped head also acts like a cone when the steps fill with soil, but when the head strikes an obstacle, the stepped edges concentrate the impact energy against the obstruction. This may apply sufficient force to move or shatter the obstruction. A smooth cone would tend to be deflected by the obstacle.[20] An example of a stepped cone head is shown in figure 15.

Figure 15. Stepped Cone Impact Moling Head Emerging at the Reception Pit.[20]

The non-steerable bores are intended to advance in a straight line. The operator can maintain alignment only through the tool's air supply. Accuracy of the mole is influenced by its speed. The average rate of advance is 0.3 to 1.5 m/min (1 to 5 ft/min) for a non-steerable mole, depending on the displacement head configuration and soil conditions.[26] When selecting the head configuration, it is necessary to balance the desired advancing speed and boring stability. Soft soils cause the head to lose traction and its speed has to be reduced. The forward motion is increased with the application of additional static pressure. Impact moles can be used accurately in most compactable soils for distances up to 10 m (32 ft). For greater distances, where accuracy is reduced, the practice of stitching can be employed. Small pits are excavated along the mole's route so that line and level can be verified. Moles are generally used to install small diameter service pipes of between 30-80 mm (1-3 in) in a single operation. Multiple passes of the mole can achieve diameters between 200 and 500 mm (8-10 in). Product pipe is commonly PVC, high density polyethylene (HDPE) or steel.[26]

For pipe ramming, either an open-ended or closed-ended pipe can be rammed. For closed-ended pipes, the face must be cone-shaped, similar to the impact moling head. The ram compresses the soil as the casing is rammed forward. The open-ended pipe is the preferable method of pipe ramming construction. This method requires less ramming force since only the cutting edge of the pipe is compacting soil. Thus, harder soil can be penetrated, since the soil is not compacted to as high a degree as the closed-ended pipe or the impact moling method. There is less likelihood of the pipe deflecting if it encounters and obstacle.[20] Figure 16 shows the typical pipe ramming setup.

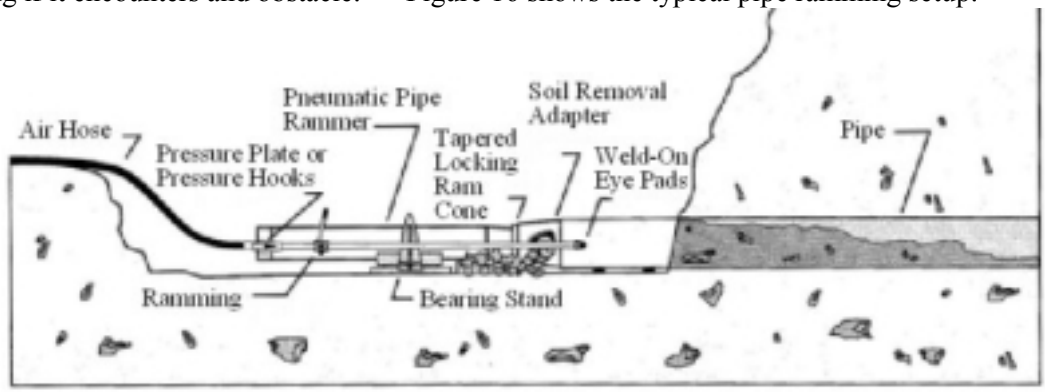

Figure 16. Typical Pipe Ramming Setup and Process.[17]

When using the open-faced leading edge, the surrounding soil must be self-supporting. If it is not, a loss of support around the cutting edge may occur if the soil moves through the pipe and flows into the starting pit. This could cause surface subsidence or loss of support to adjacent pipelines. Closed-face pipe ramming would be more effective in such soil conditions. However, the closed-ended ramming method creates a greater risk of surface heave.[20]

There is usually no means of monitoring the direction of the pipe during a bore. Therefore, establishing a clear bore path prior to commencing work is essential. Accuracy of the pipe ramming placement depends on the initial setup, length of the drive shaft, the pipe diameter, obstructions and soil conditions.[17] For high precision projects, oversize casings are commonly installed and the pipe is adjusted in the casing. Accuracy ranges from 1 to 3 percent of the length of the pipe. The diameter range of open-faced pipes is between 102 and 1524 mm (4 and 60 in); for the closed-faced installation, the diameter range is from 102 to 203 mm (4 to 8 in). The typical length of bore is 15 to 61 m (50 to 200 ft). Bores of up to 2000 mm (78.7 in) in diameter have been installed in suitable ground conditions using impact hammers that generate about 18,000 kN (2000 tons) of ramming force. For successful installation, an adequate amount of space for site access is necessary. Typically, a site 6 to 12 m (20 to 40 ft) wide by 10 to 20 m (33 to 66 ft) long is needed.[17]

Practical Applications

Since impact moling uses the principles of compaction to create the bore hole, it is most appropriate for use in compressible soils. Difficulty can occur in compacting densely packed soils and in loose sands and gravels, including collapse of the bore head. A high water table can affect a soil's compressibility. Compressible soils with a high void ratio are most favorable for soil displacement methods (unconsolidated soft silt, clay, mixed grain, or a well-graded soil). For unconsolidated loose soils, the dynamic impact energy created when compacting the soil may cause surface subsidence. Poorly graded or dense soils are difficult to pierce. It is essential to know the ground conditions and to identify the depth and location of all existing utilities and underground objects prior to beginning an impact moling job.[26] This soil compaction method does not require spoil removal, so it can be used in contaminated soil zones.

To avoid surface damage, impact moling should be performed at a depth at least 10 times the diameter of the product pipe, or a depth of 0.9 to 1.2 m (3 to 4 ft), whichever is greater, to avoid surface damage and to prevent heave.[26] This method is most commonly used for short distance bores, between 12 and 24 m (40 and 80 ft) and for diameters up to 0.3 m (12 in).[17] One of its most popular uses is to install telecommunications and residential service connections because of its operating simplicity and low operational costs. A minimal amount of skill required to operate it. Usually a two-person crew is required. However, the operation may be noisy, and this should be considered.

Impact moling has a wide range of applications. Besides gas and water service lines, these tools are used for cabling, cable ducts, garden irrigation, water treatment systems, outdoor water supplies, landscape lighting, drain replacements, and lead pipe replacement. They can also be used in other applications, such as pipeline rehabilitation for pulling a liner into a pipe or in non-utility applications such as the installation of environmental wells.

Typical applications of the pipe ramming method include pipe installation, placing conduits inside the pipe after the ramming operation is complete, or mounting a smaller pipe that requires precise line and grade inside the rammed pipe.

A thorough ground investigation is required prior to starting a pipe ramming project. Large obstacles can deflect the casing off course or damage the cutting edge. When the cutting edge is damaged, this can cause a steering bias. The soil should also be evaluated for the potential for ground heaving and subsidence. For closed face ramming, the depth of cover should be greater than 10 times the diameter of the pipe being installed. Heaving is not a major problem for open faced installation, where there is minimal disturbance. Subsidence can occur from either technique because of the potential for consolidation caused by the vibratory action of the hammer. However, pipe ramming is suitable for a wide range of soil conditions, stable or unstable, with and without a high groundwater table. A two to three person crew is needed for small applications and the rate of penetration is between 51 and 254 mm/min (2 to 10 in/min).[17]

Pipe ramming is not particularly suited for long drives. Its range of application is between 30.5 and 61 m (100 and 200 ft).[27] As the drive length increases, the accumulation of soil on an open faced pipe can become a problem. The spoil adds weight to the pipe and affects the rate of advancement. It may be necessary to clean out the pipe to limit the extra burden on the ramming hammer. Cleaning spoil out of the pipe during an intermediate stage of construction can be done manually or by the use of a scraper winch system.[20]

Specifications and Guidelines

There is limited information in state highway agencies specifications about soil compaction methods. Yet most are concerned about the effect of dynamic action on the surrounding utilities, pavements, and structures. Research is on-going to predict movement due to impact moling under various soil conditions. This should help gain wider acceptance of this soil compaction method in roadway crossings. Particular concerns by state are listed below:

Colorado DOT	The drives should not deviate from line and grade.
Florida DOT	Impact moling is not allowed for pipe diameters greater than 127 mm (5 in).
Michigan DOT	All dynamic methods of trenchless technology require special approval.
New York State DOT	The installation of pipes more than 102 mm (4 in) in diameter without spoil removal is not permitted.

North Carolina DOT	Driving a pipe by steady thrust, hammering, or vibration that is larger than 152 mm (6 in) in diameter is not permitted.
Oregon DOT	With driving or moling, disturbance to the surrounding material has to be kept to a minimum.

Typically, there is no bidding on individual impact moling jobs because municipal agencies have their own crews with equipment or they hire contractors. Instead, guidelines are needed on how to purchase the impact mole and not how to proceed with individual impact moling projects.[26] The process of impact moling is not currently covered by any widely accepted standards.

4.1.5 Pipe Bursting

Pipe bursting is a method of on-line replacement consisting of a bursting tool that moves through the existing pipeline, applying radial forces to break open or to split the pipe. A spreader device on the bursting tool pushes the fragments of the pipe into the surrounding soil. A thin-walled sleeve is generally pulled into the newly formed bore directly behind the spreader. This sleeve, made of either push-fit PVC pipe or butt-fused polyethylene, protects the product pipe from contamination by small quantities of lubricating oil present in the exhaust gases from the burster head. The sleeve also prevents the product pipe from being damaged by fragments of the old pipe in the surrounding ground.

On-line replacement involves the replacement of existing pipes size-for-size or up-sizing with new pipes in the same location economically and with minimal or no excavation. An ideal candidate for on-line replacement is a pipeline with inadequate capacity or whose structural condition is too poor for relining. Additional developments continue to extend the capabilities of on-line replacement systems, and add to their economic benefits. Typically, existing pressure or gravity pipes are replaced or up-sized in this fashion.[18]

There are a wide range of on-line techniques available. Most of them differ in the way that the old pipe is fractured and the new pipe is replaced. Most are designed to replace brittle pipes, but some are designed for ductile materials like steel. Pipe bursting is the most common trenchless method for on-line replacement.[29] The pipe is fractured, the fragments are displaced outward, and the new pipe is drawn in to replace the old one, as shown in figure 17. Figure 18 shows a standard pipe bursting head. Other techniques that will be discussed briefly in this section include:

- Pneumatic pipe bursting.
- Hydraulic pipe bursting.
- Pipe implosion.
- Rodding.
- Pipe eating.
- Pipe reaming.
- Pipe splitting.
- Pipe ejection.

Figure 17. Pipe Bursting Mechanism.[20]

Figure 18. Standard Pipe Bursting Head.[18]

The pipe bursting technique was originated in the United Kingdom and in the United States in the early 1980s. In some countries, it is referred to as *pipe cracking*. It was originally designed to replace old cast-iron gas mains. With its widespread use as a technique to replace small diameter cast-iron potable water systems, pipe bursting has an increasing worldwide market.[20]

Methods

Pipe bursting involves the insertion of a cone shaped tool, or head, into an old pipe in the insertion pit, as shown in figure 19. It fractures the old pipe and forces the fragments into the surrounding soil. The new pipe is pushed in or pulled in behind the bursting head. The rear of the bursting head is connected to the new pipe and the front end is connected to a cable or pulling rod in the reception pit. To cause the fracturing of the old pipe, the base of the bursting head is larger than the diameter of the old pipe. Its outer diameter is slightly larger than the diameter of the new pipe. This provides space for maneuvering the bursting head in the pipe and also reduces friction on the new pipe.[20]

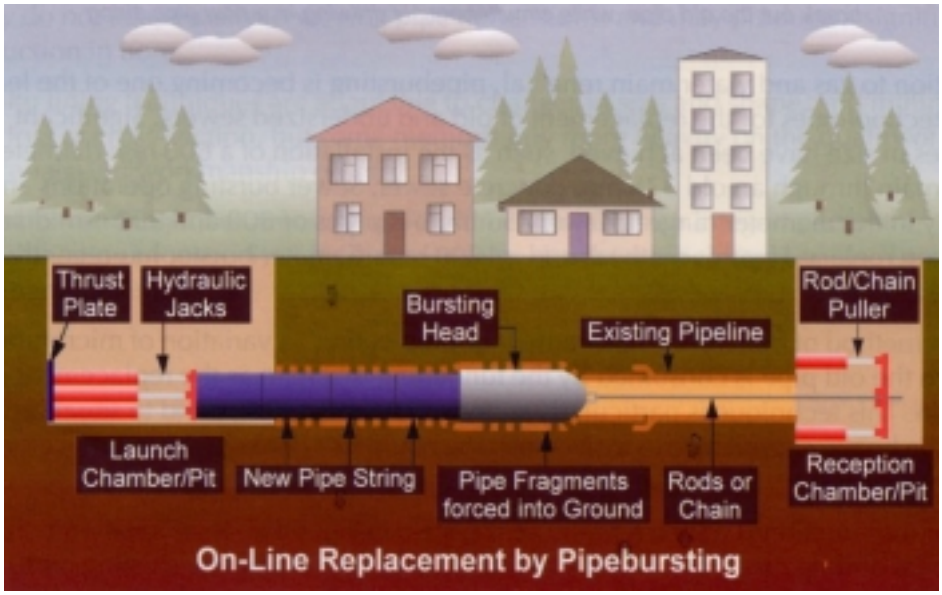

Figure 19. On-Line Replacement by Pipe Bursting.[20]

The variations in pipe bursting are discussed below.

Pneumatic (or percussive) Pipe Bursting

For this technique, air driven impact moles, also called *ground piercing* or *earth piercing tools* as described in the section on impact moling and ramming, are driven forward by a hammer that repeatedly strikes an anvil at the nose of the tool. The mole, with fins, travels up the existing pipe, breaks it out and forces the fragments into the surrounding soil. The percussive fracture mechanism breaks up the existing pipe with its high impact force. This technology is used for brittle materials like cast iron, spun iron, clayware and unreinforced pipe. This is the most popular technique for size-for-size replacement and up-sizing of pressure pipes.[20]

An improvement to this system came in the form of a hydraulically powered rod system to pull the burster through the pipeline. This new method offers increased power control and greater safety to operators and the facility for increased pulling power and larger diameter pipes. The new pipe that is installed is usually polyethylene, pre-welded to the required length. It may be necessary to have intermediate jacking, rather than to have to rely on the pull from the bursting head at the front, or on the jacking force from the rear.[20]

Pipe bursting allows the pipe capacity to be maintained or increased. Therefore the progress rates are much greater when compared to open cut, with less surface disruption.

Hydraulic Pipe Bursting

Since the percussion of pneumatic pipe bursting can be felt on adjacent pipes, services, building foundations and paved surfaces, an alternative, hydraulic pipe bursting, may be used in sensitive areas. This bursting head has *petals* that open and close under hydraulic pressure. When the hydraulic pipe bursting head is used, it first expands to crack the old pipe, and is then retracted. The new pipe is jacked into place and the burster is pulled ahead. This process is repeated, and more pipes are added to the end as work progresses.

The hydraulic burster is designed to operate with short lengths of product pipes and is primarily for sewerage and gravity pipeline applications, rather than for pressure pipes. Pipelines 1 m (3.3 ft) in diameter have been installed with this method. There is also a portable system that can replace pipes up to 150 mm (5.9 in) in diameter, using equipment that is compact enough for gardens, under buildings and other locations with limited access.

Another variation is to use a powerful hydraulic pushing and pulling machine that acts on high tensile steel rods connected to the bursting head that is pulled through the existing pipeline. The new pipeline is then drawn or jacked behind the head. The typical pulling capacity is 177 to 2046 kN (20 to 230 tons). This method relies more on the power of the pulling machine than on the hydraulic expansion of the head.

New pipes used with the hydraulic pipe bursting method are commonly polyethylene that have joints that snap together. Replacement clayware pipes have also been introduced that allow sewers to be replaced or upsized. Clayware pipes have stainless steel collars to enhance the shear strength at the joints. They can withstand higher jacking forces than most polymeric materials, but they are heavier and may require powered systems for lifting and handling on site.[20]

Pipe Implosion

When using pipe implosion, the pipe fractures inwards prior to the outward displacement of pipe fragments. The procedure is similar to that of pipe bursting.

Rodding

The hydraulic rodding system consists of a static bursting head, fitted with fins, that is pulled through the pipeline by a series of rods. These rods are first pushed through the pipeline by a

hydraulically powered rig that is located in the lead trench. The steel rods, approximately 1 m (3.3 ft) long, are pushed into the pipeline individually. After each rod has been inserted, a new rod is threaded onto the previous rod and the process is repeated. At the far end of the pipeline, the bursting head is attached to the rods. As the rods are pulled back, the old pipe is broken open.

Pipe Eating

Pipe eating is a variation of microtunneling. The old pipe is consumed by the tunneling machine as the new pipe is jacked into place. It crushes the existing pipe with an eccentric-cone crusher. This allows realignment and upsizing of the sewer. These systems can also allow on-line pipe replacement without flow diversion. This pipe eating process can be used for the replacement of clayware, concrete, asbestos cement, and reinforced concrete pipes. This system has teeth in the crusher cone that can cut the reinforcement in a concrete pipe, allowing excavation of all conventional pipe materials in addition to the concrete. This technique is suited for large diameter pipes and in situations where the heave caused by expansive upsizing could damage the surface or adjacent services.[20]

Pipe Reaming

Pipe reaming with a horizontal directional drilling machine is a newly introduced technique. A specialized reaming tool grinds up the old pipe as the new one is drawn in behind. The fragments are suspended in drilling fluid and pass through the existing pipe to a manhole or recovery pit.[20]

Pipe Splitting

This system was developed specifically for the replacement of steel pipes. This technique works in a similar manner to rodding techniques, but a splitting head is used to break open the pipe. This head consists of a series of discs that score the inside of the pipe. Blades follow that cut open the pipe. The spreader behind the blade pushes the sections of the pipe open, to allow the replacement pipe to be installed.

If the pipes that are to be replaced are non-brittle, the burster may cease to make forward progress. An alternative approach was developed that uses a cutting and an expanding head that can cut through the wall of a ductile pipe or fitting. This head is pulled through the old pipe by a hydraulic rod system and slices open the old pipe as the new pipe is drawn in behind. It can be used on pipes made of steel, ductile iron, repaired cast iron, asbestos-cement, PVC and polyethylene. Diameters of up to 305 mm (12 in) have been installed under suitable conditions. Rates of progress of 2 m/min (6.5 ft/min) have been recorded.[20,29]

Pipe Ejection

In pipe ejection, the old pipe is jacked towards the receiving pit where it is broken and removed, while the new pipe is simultaneously inserted. This is commonly used with old lead pipes. Lead pipes are a significant health risk when the lead is absorbed into the drinking water. The existing lead pipe is pulled out of the ground and replaced with a new polyethylene pipe. For this technique, a steel cable is inserted into the lead pipe, which expands and grips the walls of the lead pipe. The old pipe is extracted and wound onto a drum. The new replacement polyethylene pipe is pulled in at the same time by the cable. This technique is fairly successful for straight service pipes, but excavation may be required if the pipe has a sharp bend, is surrounded in concrete or has been fitted with flange couplings.[29]

Equipment

For pipe bursting applications to be successful, the pipes should be made of brittle materials like vitrified clay, cast iron, plain concrete, asbestos and some plastics. Reinforced concrete pipe can also

be replaced if it is not heavily reinforced or if it has not deteriorated substantially. For ductile pipes (steel or ductile iron) they can be replaced only by pipe splitting.

Specially designed heads can reduce the effects of existing sags or misalignment of the new pipe. The size of the pipe that is typically replaced can range from 51 to 914 mm (2 to 36 in) in diameter. The size of the bursting head is increasing over time, and pipes with diameters up to 1219 mm (48 in) have been replaced. See the previous section for more detailed information on pipe bursting equipment.[29]

Practical Applications

The primary applications of pipe bursting are in gas and water main renewal. It is also becoming more prevalent among trenchless technologies for the replacement of old and undersized sewers. Significant increases in pipe size can be accomplished, as noted in a replacement of an old concrete sewer, about 375 mm (15 in) in diameter, which was upgraded to a 600 mm (24 in) plastic main. Typically, pipes that are burst have diameters between 150 to 375 mm, (6 to 15 in) and have been replaced with pipes 800 to 900 mm (32 to 36 in) in diameter.[20]

The success of the operation depends on having accurate information about the original construction materials and the condition of the existing pipeline. For example, if there have been localized repairs or if the pipeline is encased with concrete, problems could arise during construction that may not have been identified during the planning stages.

Typical lengths for pipe bursting drives are 91 to 122 m (300 to 400 ft) lengths, which is also the typical length between sewer manholes. However, longer drives have been replaced.[29]

Specifications and Guidelines

Pipe bursting is currently being used in California and Texas for water and sewer pipe replacement. See reference 28 and Appendix C. These specifications cover materials, preparation, construction methods, pipe joining, payment and warranties. General guidelines and sample technical specifications for the reconstruction of sanitary sewers by the pipe bursting process are also available.[29] The guidelines in reference 29 provide details on the main classes of pipe bursting, design considerations, and construction considerations. Notable design considerations are the ground and groundwater conditions, surrounding subsurface utilities, and the effect of pipe bursting on nearby structures. However, the pipe bursting process is currently not covered by ASTM specifications, although the plastic replacement pipes are covered.

4.2 Summary of Methods

The previous section provided a basic overview of several different trenchless technology applications. Throughout the section, information regarding the appropriate use of each technique was given. This section provides a summary of information on all the methods described in the previous section. This section includes the following discussions:

- Selecting the appropriate methods based on type of construction and type of utility.
- Advantages and limitations of each method.
- Cost analysis to determine if trenchless is a feasible alternative.
- Safety.
- Project planning.

These sections are intended to provide addition information to help agencies and private industry determine the most appropriate method of trenchless technology, or if trenching is indeed the most appropriate method of utility construction. This is not a complete catalog of methods and applica-

tions, and the reader should consult references in the bibliography and a trenchless technology contractor for a detailed analysis of a particular situation.

4.2.1 Finding the Appropriate Method

This section provides information on the various trenchless methods and their applicability to the individual types of utilities and types of construction. The tables contained in this section include not only the methods of trenchless technology described in section 4.1, but other methods that are similar to those, but that were not described in this manual. The four major types of construction include:

- New installation.
- Online replacement.
- Renovation.
- Repair and maintenance.

As mentioned, the technique selected also depends on the type of utility, including:

- Water.
- Wastewater.
- Gas.
- Electricity.
- Telecommunications (including cable television).

The trenchless technology methods most suited for the combination of construction and utility type are shown in the following four tables, which are organized by construction type: new installation (table 14), online replacement (table 15), renovation (table 16), and repair and maintenance (table 17). This information is summarized from reference 18.

Table 14. Appropriate Techniques for New Installation.[18]

TECHNIQUE	Water	Waste Water	Gas	Electricity	Telecommunications
Auger Boring	√	√	√	√	√
Directional Drilling	√	√	√	√	√
Guided Boring	√	√	√	√	√
Impact Moling	√		√	√	√
Microtunneling		√			
Mole Ploughing	√	√	√	√	√
Narrow Trenching	√	√	√	√	√
Pipe Jacking		√			
Pipe Ramming	√	√	√	√	√
Thrust Boring	√	√	√	√	√

Table 15. Appropriate Techniques for Online Replacement.[18]

TECHNIQUE		Water	Waste Water	Gas
Pipe Eating			√	
Pipe Bursting	Pneumatic	√	√	√
	Hydraulic		√	
	Rod pull-ing	√		√
	Splitting	√		√
Pipe Pulling		√		√

Table 16. Appropriate Techniques for Renovation.[18]

TECHNIQUE		Water	Waste Water	Gas
Close Fit Lin-ing	Die drawing	√	√	√
	Rolldown	√	√	√
	Deformed pipe	√	√	√
	Service pipe liner	√		
Continuous Sliplining		√	√	√
Cured in place pipe		√	√	√
Discrete Sliplining			√	
Ferrocement			√	
Live Insertion				√
Segmental Lining			√	
Spiral Lining			√	
Spray Lining	Cement Mortar	√	√	
	Epoxy resin	√		
	Polymeric		√	
Reinforced Cementitious			√	

Table 17. Appropriate Techniques for Repair and Maintenance.[18]

TECHNIQUE		Water	Waste Water	Gas
Air Scouring		√		
Chemical Stabilization			√	
Flushing		√		
Jetting		√	√	
Localized Repair	Joint Sealing		√	
	Patch		√	
	Pointing		√	
	Rerounding		√	
	Robotic		√	
Pigging		√		√
Pressure Scraping		√		

The selection of a trenchless method depends not only on the type of construction and type of utility, but on local attitudes, policies, and regulations. For example, the City of Dallas, Texas, banned di-

rectional boring in the downtown area after a contractor hit a water main on Labor Day, 2000. The damage done by the water was over $4.5 million.[30]

Other restrictions on the choice of construction method could also include, among others, ground conditions, availability of trenchless technology contractors and equipment, cost, safety, and the technical feasibility of the various method desired. The appropriate techniques in the preceding tables are only recommendations, and should not be taken as absolute. There will certainly be exceptions to the recommendations in these tables, as various highway agencies, cities, and industry users become more familiar with the technology and its capabilities.

Standard pipe sizes, bore lengths, and depths are also a consideration in determining the appropriate method. table 18 provides an indication of the range of depth, length and diameter of the various methods.

Table 18. Range of Application for New Construction.[17]

	Range of Application		
Method	**Depth**	**Length**	**Diameter**
Maxi and Midi HDD	< 50 m (160 ft)	120-1800 m (400-600 ft)	75-1370 mm(3-54 in)
Mini HDD	< 15 m (15 ft)	12-180 m (40-600 ft)	50-350 mm (2-14 in)
Auger and Slurry Boring	Varies	12-150 m (40-500 ft)	200-1500 mm (8-60 in)
Pipe Jacking	Varies	No theoretical limit – 490 m (1600 ft)	1060-3050 mm (42-120 in)
Microtunneling	Varies	25-225 m (80-750 ft)	250-3000 mm (10-120 in)
Impact Moling (Non-Steerable)	Minimum 12 mm/mm (1 ft/in) diameter	12-30 m (40-100 ft)	50-150 mm (2-6 in)
Impact Moling (Steerable)	Minimum 12 mm/mm (1 ft/in) diameter	12-60 m (40-200 ft)	50-200 mm (2-8 in
Ramming	Minimum 12 mm/mm (1 ft/in) diameter	12-60 m (40-200 ft)	100-1070 mm (4-42 in)

As described above, the range of application guidelines in the previous table should be used as a general guide in determining an appropriate method for trenchless construction. As technology improves within the various methods, each may expand its range of depth, length, and diameter application.

4.2.2 Advantages and Limitations

This section summarizes the advantages and limitations of the various trenchless technology applications. In general, all trenchless technology applications have the common advantage of reducing the impact to the surface, and to pavement structures. Although some city ordinances consider directional drilling or microtunneling to be a disruption to the pavement structure, the surface of the pavement is generally not impacted.[31]

Other benefits include reduced impacts to traffic, and the other costs or impacts associated with traffic congestion. Although this section includes some reference to cost and safety, they are only made

as they relate to the advantages and limitations of the particular method. These will be discussed in more detail in later sections.

Horizontal Directional Drilling

In general, the advantages of HDD are similar to those of the entire trenchless technology industry. HDD allows for rapid installation, and relatively large pipelines can be installed over long distances. The guided bore can be made accurately, and safety is greatly improved when used in conjunction with subsurface utility engineering. Line and level available is controllable, which can also be confirmed by a print out. Mini-HDD equipment is portable, self-contained, and is designed to work in small, congested areas.[17]

Limitations on HDD include the amount of space required to develop the underground access points. A relatively large area may be required for the drilling rig and associated equipment at the drill entry point. Another large area is generally required at the drill exit point, although surface-entry operations can reduce the need for access shafts. Other limitations include the possibility that the bore may collapse in some granular soils and gravels. Ground movement must be considered, especially in midi- and maxi-HDD applications. The pressure and high flow rates of the drilling fluid can cause some excess soil to erode, which leaves a void outside the installed pipe, which may eventually collapse. Additionally, pressure may cause the drilling fluid to flow into a soil stratum as the drilling head advances, potentially causing heaving of that soil layer. Drilling fluid can also seep to the surface in shallow cover. Other limitations include excessive torque and thrust applied to the drill stem, especially in curving boreholes, which can cause drill stem failure in mini-HDD application.[32]

Auger and Slurry Boring

Both auger and slurry boring have decreased risk of disrupting the surface either by subsidence or heaving, but an experienced operator is necessary to minimize the risk. Auger boring can be used in a wide range of soil conditions. Table 5 on page 19 of reference 17 provides extensive information on the influence of ground conditions on auger boring operations. Both auger and slurry boring can be used to install any type of pipe or cable.

Both auger and slurry boring are generally un-steerable, however some basic steering systems are available. Both also require entry and reception shafts. As with any trenchless technology application, a thorough site investigation is recommended, primarily to identify obstacles such as large boulders and soft ground. Auger boring can accommodate larger rocks, up to one-third the diameter of the casing.[17] Slurry boring is generally limited to firm, stable, cohesive soils to limit the risk of bore hole collapse. In auger boring, the casing should be made of steel, to accommodate the steel augers turning inside the casing. Subsidence is possible with overexcavation in slurry boring, but is less of a risk in auger boring. There is a greater risk of heaving, however, in auger boring if excessive force is applied at the excavation face.

Pipe Jacking and Microtunneling

If used properly, both pipe jacking and microtunneling can have a low risk of surface disruption. Subsidence can be kept to about 25 mm (1 in). Pipe jacking has been in use for over 100 years, thus providing a long history of success and much experience in the industry.[17] Curved, steered bores are possible, although the radius of curvature depends on the equipment and the product materials.

As with most trenchless applications, pipe jacking and microtunneling require a skilled operator who can make adjustments based on almost imperceptible changes in the operation of the machines. Again, a thorough site investigation is essential to the success of the project. Access shafts are required at both ends of the drive. Soil characteristics can have a significant effect on the choice and application of pipe jacking systems, including the bore face excavation, which must be properly supported to prevent sudden collapse. Since the definition of pipe jacking compared to microtunneling

is that workers are present in the jacked pipe, the safety of the operators is important. Pipe jacking systems require pipes that can transmit the jacking forces expected in the operation.

Impact Moling and Ramming

Impact moling and pipe ramming operations are generally much more simple to operate than other trenchless applications. Due in part to the simplicity of the methods, these types are generally less expensive than other operations as well. Pipe ramming allows larger casings to be installed in a wide range of soil conditions.[17] In open-faced pipe ramming, the casing is fully supported throughout the driving operation, does not present the risk of overexcavation, and does not require water for the excavation.

Most state highway agencies to not consider pipe ramming in their specifications explicitly, but experience has found that many do not oppose the method. Operations in hard soils can be difficult, including the risk of deflecting the impact mole or lead pipe off course due to large rocks, changing soil characteristics, or other obstructions. Impact moles and rammed pipes have little to no steering control, and are used primarily for straight-line bores. Both types present the risk of damaging existing utilities, as do other methods of trenchless technology. Closed-face pipe ramming operations should be at a depth at least 10 times the diameter of the installed pipe.

Pipe Bursting

Advantages of pipe bursting for in-line pipe replacement include the fact that the alignment of the pipe is already established. This type of operation also provides the flexibility of maintaining or increasing the pipe capacity. Compared to open trench operations, the progress of pipe bursting can be much greater. Also, compared to other trenchless operations, there is less vibration, so damage or other impact to nearby services and structures is minimized.[29]

A limitation of this type of operation is that with the bursting of the pipe, and its expansion radially outward, existing utilities can be damaged, if they are not well-defined and located prior to commencing construction. Surface displacement can be extensive, especially in shallow applications, or in less compactable soils. Also, where unexpected conditions are encountered, such as unrecorded repair collars or adverse soil conditions, the operation may need to be stopped and excavation may be required to get past the obstruction. Another condition that generally requires additional excavation is negotiating sharp bends in the existing pipe. Additionally, excavations must be made to connect the new pipe to the existing service.[29]

4.2.3 Potential Impacts

Although trenchless technology methods of utility installation and maintenance generally impact the public and surrounding infrastructure to a lesser magnitude than utility cuts, there are some potential impacts that should be understood. Many of the trenchless methods described in this manual have similar potential impacts, while others have unique impacts that may affect the public or property. The following is a list of some of the potential impacts that should be considered when deciding on trenchless technology for a project:

- Bore hole collapse / subsidence.
- Access / reception pit excavation.
- Ground displacement / upheaval.
- Ground vibrations.
- Worker safety.

Loose, cohesionless, and granular soils are more susceptible to bore hole collapse if a casing is not placed immediately after excavation. Pipe jacking, and auger and slurry boring are most affected by this type of soil with respect to collapse or subsidence.

Pipe bursting can cause outward ground displacement along the pipe alignment. The displacement is typically localized, and their effects dissipate rapidly away from the bursting operation. Some causes for displacement or upheaval include:

- The pipe to be burst is shallow.
- The ground displacement is directed upwards.
- The new pipe diameter is significantly larger than that of the old pipe.

These displacements can also cause damage to nearby utilities if they are within two to three times the diameter of the new pipe.

Ground vibrations can affect the surrounding soil and adjacent structures. This can be caused by pneumatic pipe bursting, as well as impact moling and pipe ramming. Other sources of information regarding the potential impacts and costs of trenchless technology can be found in reference 33.

4.2.4 Cost and Cost Analysis

This section discusses both the components of cost associated with the trenchless methods and the overall conditions to consider when determining the economic feasibility of the methods. It also gives a range of cost for each method of trenchless construction. Such an economic analysis is an important step in determining the appropriate method for construction.

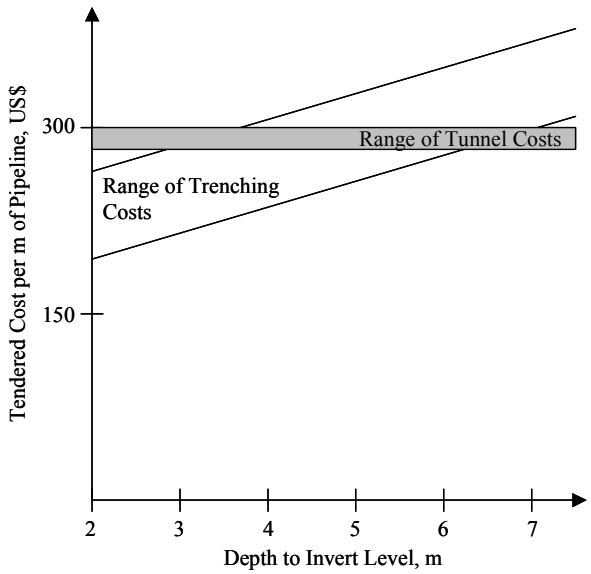

Figure 20. Break-Even Depth for Trenchless Methods in Sewer Construction.[33]

An example of one type of economic analysis is shown in figure 20.[33] In this figure, the range of tunneling costs is approximately constant, regardless of the depth to which the sewer line is placed. The range of trenching costs, however, rises rapidly based on the depth. The information shown in this figure is reasonable, since deeper excavation for trenching methods requires much greater expenditures for labor, safety measures, and equipment. Conversely, trenchless applications do not incur much additional cost based on depth, once the equipment has entered the ground. Some additional costs could be realized in the required depth of entry and exit pits, or time and pipe required to

get down to the appropriate depth. This example assumes consistent soil, ground water, and other conditions at the construction site. As conditions change, the break-even depth may change.

If the depth is consistent, a different type of economic analysis may be necessary. For a particular project, the specific costs associated with the available methods should be considered, and compared to traditional trenching methods. In addition to the costs related to construction, the indirect costs and other impacts should be considered. These were discussed in chapter 2. Although it is difficult to quantify many of the indirect costs, such impacts should be included in some manner in the economic feasibility analysis.

Costs Associated with Trenchless Technology

Many of the trenchless methods described in this manual share cost components. Some of the methods have more particular costs associated with the construction, such as boring, pipe ramming, and pipe bursting. The general costs associated with the use of trenchless technology include:[18]

- ***Capital Cost of Equipment.***
  This includes drilling rig, boring unit, impact mole, cutting head, jacking unit, control cabin, spoil removal system, power unit, directional control and detection device, and other equipment specialized for a particular method.
- ***Operating Cost.***
  Equipment setup, operation, and labor costs.
- ***Site Investigation.***
  A complete site survey should be conducted to determine soil conditions, ground water conditions, water table location, and location of existing utilities and other obstacles. Subsurface utility engineering studies are becoming more popular, and with good location equipment, can save much more than it costs.
- ***Excavation Cost.***
  Cost incurred while excavating and replacing any required entry and reception pits, or other access points from the surface to the machine as work progresses.
- ***Traffic Management.***
  In cases where workers or equipment must be in the traveled lanes of highways or streets, traffic control devices must be utilized with a traffic management plan. Such a plan must conform to the Manual on Uniform Traffic Control Devices and any local traffic control regulations.[34]
- ***Product Pipe.***
  The cost of the pipe to be installed.

Besides the general costs that are associated with most of the trenchless methods described in this manual, other costs that are specific to various methods should also be considered. These include, but are not limited to, the following:

- Steel casing for auger boring, slurry boring, and pipe ramming.
- Sleeving, re-connecting, and overpumping for pipe bursting.
- Electrical strike protection for many of the trenchless methods.

Each of the costs involved in a potential choice for construction should be considered in a cost analysis that compares to traditional trenching. The next section discusses the specific range of costs for many of the trenchless methods described in this manual.

Relative Cost of Trenchless Methods

The cost information in this section is not necessarily current, although the relative values should be fairly consistent over time. Conditions that could change the relative nature of these costs include technological innovation within specific methods that do not cross over into other methods, and governmental regulations that impact specific methods and not others. Other conditions that could effect a change in the relative nature of these costs are also possible. The cost information contained in this section is largely taken from Table 10, page 58 in reference 17.

- ***Horizontal Directional Drilling***
  When line and grade are not critical, the following are estimates of the costs associated with HDD. For small diameter installation, the cost is a function of bore length more than diameter. For larger installations, the cost is a function of diameter and bore length.

  Mini-HDD: $16 – 164 / m ($5 – 50 / linear ft)
  Midi-HDD: $164 – $656 / m ($50 – 200 / linear ft)
  Maxi-HDD: $656 – 1640 / m ($200 – 500 / linear ft)

- ***Costs for Auger Boring***
  $0.39 – 0.52 / mm pipe diameter / m ($3 – 4 / in / linear ft) of pipe if line and grade are not critical
  $0.52 – 0.78 / mm pipe diameter / m ($4 – 6 / in / linear ft) of pipe if line and grade are critical

- ***Costs for Slurry Boring***
  Slurry boring is typically a low cost operation. The equipment is inexpensive and only two to three men are needed. Costs can vary depending on diameter and length of the bore hole; soil conditions; casing installation; and requirements for grouting the casing and the carrier pipe. A nominal value for the unit cost of slurry boring is about $0.13 – 0.39 / mm diameter / m ($1-3 / in diameter / linear ft), when line and grade are not critical.

- ***Costs of Impact Moling***
  Impact moling is one of the best-suited trenchless technologies for the segments of the gas and water industries that install pipes up to 254 mm (10 in) in diameter with a boring distance of 3.05 to 305 m (10 to 100 ft). Impact moles can be less costly than even the smallest mini-directional drills. Compared to other trenchless technologies on small jobs, impact moling can provide a substantial cost and time savings.[26]

- ***Cost of Pipe Ramming***
  Pipe ramming is a relatively simple technique and it can be a highly cost-effective solution to short length installation projects. A typical price is $0.39 – 0.78 / mm diameter / m ($3 – 6 / in diameter / linear ft). This price does not include the cost of the pipe or construction of the drive shafts or reception shafts. Drive shafts can cost from $3,000 to $10,000, or more if extensive excavation support is required. The reception shaft is only for soil removal, or retrieval of the drive cone.

- ***Cost of Pipe Bursting***
  Lateral connections and deteriorated pipe can add significant cost to pipe bursting operations. The number of times lateral connections must be made can be a determining factor when assessing the economics of using pipe bursting as a trenchless replacement method. The limit on the size of the pipe to burst depends on the cost effectiveness compared to conventional replacement, on local ground conditions (potential for ground movement and vibration) and the ability to provide sufficient energy to break the existing pipe and to pull behind the new pipe.

4.2.5 Safety

It is important to maintain jobsite safety throughout any project. Special consideration must be given to trenchless projects, however, due to the level of uncertainty involved in the operation. This section only provides an overview of the steps that should be taken to ensure safety at the jobsite. The following components are essential to have in any safety program. This information is largely from reference 19.

- ***Safety Plan***
  The safety plan covers all other aspects of the safety program. It includes emergency procedures for utility strikes and high-risk activities, an emergency evacuation plan, training, method for recording accidents, incidents, and training.
- ***Contingency Plan***
  In the event of an unforeseen or other unplanned event, a contingency plan must be in place. This plan describes the responsibilities of all those involved in the construction and a course of action for any number of potential events and emergencies.
- ***Responsible Personnel***
  A safety manager is an important component of a trenchless team. Operators should be well-trained and understand the importance of maintaining a professional attitude throughout the operation. The safety manager and all others involved in the operation should understand the hazards and potential problems that can occur. They should remember that hazards are present in the underground, surface, and overhead areas.
- ***Traffic Control Plan***
  The safe management of traffic is also important to a successful trenchless operation. This plan should be designed to minimize traffic disruption without compromising the safety of the workers or the public.
- ***Safe Practices and Equipment***
  All personnel involved should be aware of safe practices and procedures that are in place to protect them, the public, existing utilities, and the public infrastructure.

These components, as part of a formal, written safety program, can help promote responsibility and accountability, and the overall safety and success of the project.

4.2.6 Project Planning

The most important aspect of a trenchless project is likely to be the planning stage. It is at this point in the project development that potential risks and problems can be identified and mitigated. Contingency plans can then be made or adjusted. Alternative plans and design adjustments can be made during the planning process while impacting the project as little as possible. Poor planning can create larger problems during the project, including requiring design changes after construction begins, unexpected utility relocations, etc.

The project planning discussion contained in this section is largely a summary of reference 19. Although this reference is directed at horizontal directional drilling, many of the planning aspects are similar among most methods of trenchless technology. The following seven categories are identified in reference 19:

1. ***Review of Plans, Specifications, and Geotechnical Report***
   The scope of work is described in the contract documents, as well as the period of performance, design / performance criteria, physical locations and dimensions, products to be furnished and installed, and procedures for quality control, measurement, acceptance, and

payment. All parties involved in or interested in becoming involved in the project should understand the contract documents, and have the following questions answered to their satisfaction:

- Is the information sufficient for evaluating constructability and estimating the cost of the project?
- Are the project requirements and site conditions adequately described?
- Are site access and period of performance addressed?
- Is the project buildable? If not, what changes are needed?
- Is the period of performance reasonable for completing the project? If not, how much time is required?
- Are the methods, materials, and equipment allowed by the contract documents appropriate? Can the bidder propose or select alternative methods, materials, or equipment?
- What are the permitting and regulatory issues and who are the parties involved?
- Who has responsibility for permits, easements, etc?
- Does the bidder have the resources needed, i.e. expertise, personnel, equipment, and time to construct the project? If not, what are the additional resources needed? Can the be acquired?

2. Project Requirements

Project requirements often dictate the equipment, product pipe material, methods, or other aspects of construction. The following list includes items that should be considered when making decisions on both letting and bidding a project:

- Intended function
- Diameter
- Depth
- Length
- Cable / pipe material to be used
- Bend radius and bending stress calculations
- Site geometry, topography, and constraints
- Schedule constraints
- Machine size selection
- Drilling fluid system support
- Drilling fluid materials needs

3. Surface Investigation and Utility Survey

A surface investigation should be conducted during the planning stages of the project, and again just prior to construction. This includes survey data such as benchmarks, surface elevations, property lines, right of way lines, etc. Regardless of the size of the project or the state of the design plans, the bidder is responsible for the accuracy and completeness of his bid. It is the responsibility of the owner to make the contract and design documents as complete as possible.

A utility survey should be conducted to locate all existing utilities in the area accurately. This can be done by several methods. It is recommended that a subsurface utility engineering study be conducted with as high a quality level as is technically and economically feasible. Possible methods include one-call services, existing as-built plans, ground penetrating radar, and vacuum excavating / potholing.

4. ***Geotechnical Site Investigation***
   Geotechnical evaluation of site conditions for trenchless projects is critical. The types of soils, and their condition is closely tied to the performance of the selected machinery as it bores through the ground. The cost of performing a thorough geotechnical investigation must be weighed against the project cost and potential profit for the contractor. For small projects, most owners will not approve of the expense of a geotechnical investigation, even though such information may be very important to the success of the project. Reference 19 has a detailed discussion about alternative methods of obtaining information for lower cost.

5. ***Bore Plan***
   Bore planning helps to reduce the risk of encountering obstacles and other difficulties by defining a route prior to beginning the bore. Potential obstacles include foundations, structures, existing utilities, elevation differences between the entry and exit locations, and extreme turns. Bore planning tools include devices that both map and help plan the bore. The devices and associated software can help provide alternative plans that minimize potential problems and increase the probability of a successful bore.

6. ***Regulations, Permits, and Easements***
   There are a great number of Federal, State, County, and Municipal regulations and agencies that govern the public ROW, including access to, and construction activities within the ROW. Depending on the project and the regulatory agencies involved, permitting and easements can be easily negotiated, or they can be difficult. It is essential that these issues be considered during the planning stages and scheduled to ensure that the project is not delayed while the correct permits are obtained and regulations are met.

7. ***Other Considerations***
   Other matters that should be considered during the planning stages of a trenchless project include noise, traffic, fish and wildlife habitat, water resources, drilling fluids clean-up, and historical and cultural resources. As with the section on regulations, permits, and easements, many governmental agencies have regulatory control over some, if not all, of these areas. It is important to know which of these may be impacted by the project and which require special attention during the early stages of the project.

4.3 Subsurface Utility Engineering

To this point, chapter 4 has discussed the various trenchless technology methods, their application, advantages, limitations, and other aspects of the technology. This section is a summary of subsurface utility engineering, its advantages and limitations, and case studies additional technologies that have, and continue to improve the safety, reliability, and technical and economical feasibility of trenchless technology applications.

Some reasons SUE may not have become as widespread in the recent past could be related to the following:

- It has not been used as a professional standard practice in some areas.
- There has been no concerted local or regional effort to educate project owners or engineers on benefits, other than the FHWA effort to educate all state highway agencies.
- There may be a lack of interest by state highway agencies.
- Currently there are few providers nationally.
- Combined construction values are lower in some areas than in others.

- The lack of well-defined standards in the past has created little incentive for changing the status-quo.[35]

Development of SUE methodologies has primarily been on the east coast. However, national standards have been under development, and should be completed in the near future. The American Society of Civil Engineers (ASCE) has developed a standard pertaining to SUE for publication. The official title is ASCE C-I 38-02, *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data*. It will be available from ASCE in September 2002.

Overall, the SUE methodologies have been successful. Of 71 projects studied by Purdue University for economic benefits, only three had a negative return on investment.[36] Subsurface utility engineering has been endorsed and encouraged by AASHTO, FHWA, Association of General Contractors, The National Transportation Safety Board, the Network Reliability Council, and many state highway agencies. The types of people involved in conducting and studying SUE include both office and field personnel, such as highway designers, utility experts, field technicians and specialists, survey crews, records researchers, CAD technicians, geologists, etc.[35]

4.3.1 What is SUE?

Subsurface utility engineering is an engineering process for accurately identifying the quality of subsurface utility information needed for project plans, and for acquiring and managing that level of information during the development of a project. By identifying the quality of the information, engineers and contractors can move ahead with design and construction work with a certain level of confidence in the existing utility data. The design and construction activities can be planned, taking into account the existing utilities, and appropriate clearance can be planned which considers the margin of error in the utility location. This information is based on four quality levels. Each level can be thought of as representing a different degree of risk. Depending on the importance of the project and the potential cost involved in an accident, engineers may justify the expense of a higher quality level and require the utility location information to conform to that quality level. These levels range from A through D, with Quality Level A representing the highest degree of accuracy. The following discussion of the four quality levels is a summary of a discussion in reference 35.

Quality Level D (QL-D) This information is obtained through utility construction records and location activities in the past. This information is very unreliable, and very little, if any, confidence should be given to the data. The contractor is generally liable for the safe negotiation of the underground space, or to locate the utilities on his own. Data of this quality level is generally considered as an "unknown or differing site condition", thus allocating the risk to the contractor.

Quality Level C (QL-C) Information of QL-C enhances that of QL-D surveying and visually locating surface utility features. Risk is assumed by the engineer or surveyor. QL-D information is correlated to that found by the visual inspection.

Quality Level B (QL-B) Utility location data at this level of quality is obtained through geophysical techniques to identify the existence and horizontal location of existing utilities within a standard margin of error. This type of information must be reproducible by similar methods, and must be recorded for later use. As the horizontal location of existing utilities is identified with a more narrow confidence margin, the liability assumed by the engineer also increases.

Quality Level A (QL-A) Information reported as QL-A is of the highest accuracy, which is generally set at 15 mm (0.59 in) vertical, and to applicable horizontal standards. This information is obtained by visual verification of the utility in-place using non-destructive digging equipment. This requires actual exposure of the facility so that location and size can be deter-

mined. The liability assumed by the engineer is yet again increased, since construction documents and activities will depend greatly on the accuracy of the utility location data.

4.3.2 Benefits of SUE

Subsurface Utility Engineering has provided many benefits to a large array of agencies and entities, including highway agencies, airports, utility companies, and nuclear power plants. A list of some of the benefits cited in the literature was reported in reference 37:

- Positive visual identification of buried facilities.
- Reduced utility conflicts.
- Significant cost savings.
- Minimum traffic disruption.
- Reduced delays.
- Reduced risks.
- Improved public relations.
- Reduced contingency fees and claims.
- Safer excavation.
- Less disruption of the environment.
- Less damage to utilities.
- Minimum disruption of utility service.
- Fewer field conflicts.
- Fewer project redesigns.
- Improved design schedules.
- More cost-effective designs.

These benefits, and others, have been realized by actual users of SUE. Some of these benefits and cost savings are illustrated in the case studies in the next section.

4.3.3 Case Studies

This section includes short summaries of projects that demonstrate the effectiveness of subsurface utility engineering studies. Many of these summaries are taken from references 35 and 37.

Maryland State Highway Administration

On a highway project in Maryland involving realignment of a state road and widening from 2 to 6 lanes, the use of SUE enabled the Maryland State Highway Administration to redesign the hydraulic system to minimize conflicts with utilities. Instead of relocating 5,000 feet each of gas, water, and sanitary sewer lines, conflicts were reduced and only about 400 feet of each utility needed to be relocated. The cost of SUE was $56,000. Combined cost savings to the state and the utilities amounted to $1,340,000.

Hopkins Road, Richmond, Virginia

A SUE study called for 156 test holes where highway / utility conflicts were seen as possible on a highway project. The data obtained showed that conflicts would have occurred at almost half of the locations. Design changes were made (prior to beginning of construction) and about 80 percent of the conflicts were resolved. The changes early in the project avoided over $731,000 in unnecessary adjustments and change orders later in the project, at a cost of only $93,553.

NC 168, Currituck County, North Carolina

A highway widening project along 18 miles of NC 168 in North Carolina used SUE to identify conflicts with a critical PVC water line. Forty holes were vacuum-excavated (QL-A information), at a

cost of only $10,000. Rather than move the entire water line, it was determined that four miles of the water line could remain in place, saving NCDOT about $500,000.

Comanche Peaks Nuclear Power Facility, Texas Utilities

This project utilized three different SUE quality levels for different areas of importance. QL-B information was obtained in more critical areas to develop a plan view of the utility system around the nuclear power facility. QL-C and QL-D information was collected at less critical areas. The owner then obtained a comprehensive map of all utilities in the area, with varying degrees of reliability depending on the relative importance of each area.

Ohio Bell, Lost Nation Road, Willoughby, Ohio

In a politically sensitive area, 29 test holes were excavated to verify data previously supplied to the utility company. Of the 29 holes, six were found to be areas where the existing utility information was in error. Such errors could have cost the utility company in time, money, and embarrassment if they had not been detected.

Reagan National Airport, Washington, DC

On a parking deck project, QL-D information was provided by one contractor. Some time later, another contractor provided QL-B information. An error rate of about 30 percent was found between the two sets of location data, illustrating the benefit of obtaining more accurate data. As seen in other case studies, vacuum excavation can be relatively inexpensive.

4.4 Survey Results and Informal Interviews

As part of the investigation, a survey was conducted among state highway agencies and some cities. The results discussed in this section relate only to those questions in the survey referring to the use of trenchless technology. A summary of the results is discussed in section 4.4.1. Another part of the investigation involved informal interviews conducted primarily by telephone to assess the attitudes of those involved in utilities in and around pavements. Interviews were conducted with representatives from state highway agencies, telecommunications companies, water and wastewater agencies, and others. These informal interviews are summarized in section 4.4.2.

4.4.1 Survey Results

The survey conducted by the research team included many questions regarding right-of-way management and policies, and one section regarding the use and experience with trenchless technologies. Representatives from 30 states and cities responded to the survey. The following subsections contain discussions of responses to the individual questions within the trenchless technology section of the survey.

Has your jurisdiction used or required trenchless technology (TT) in the past?

Of the 30 responses, 29 have used / required trenchless technology in the past.

If so, what has been your experience?

Most responses to this question indicated that the experience has been "generally good". Some of the positive comments indicate the following:

- The price of trenchless is improving.
- Quality is a function of expertise.
- Less traffic impact.
- It is the preferred method.
- Good – but needs more research.

Some of the negative comments about states' experiences include:

- Some conditions prevent use.
- Experienced some poor quality construction.
- A lot of problems with damages.
- Can hit rocks.

What are the major technical obstacles to the successful use of TT in your area?

The following comments were made regarding the major technical obstacles to trenchless technology:

- Accurate utility location.
- Limited ROW for setup.
- Local contractors using outdated machinery.
- Operational quality control.
- Variable soil conditions.
- Operator training.
- Lack of guidelines or specifications.
- Minor pavement damage to riding surfaces.

What are the major attitudes inhibiting the use of TT?

Some of the major attitudes among the state highway agencies which can have the effect of inhibiting the use of trenchless technologies include the following. These are the opinions of the various respondents.

- Trenchless technology is more expensive.
- Need assurance that it will be cost-effective to use.
- Concern for damages to existing facilities.
- Operators are too rushed.
- Users do not thoroughly investigate site.
- "This is how we've always done it!"
- There is a general lack of knowledge about the technology.

In addition to these comments regarding attitudes inhibiting the use of trenchless technologies, six respondents suggested that there are none in their experience.

In your opinion, can pavement utility cuts be reduced through policies, incentives and disincentives, increased availability of information, etc?

Most of the respondents suggested that through policies, incentives, disincentives, availability of information, etc., the frequency of pavement utility cuts can be reduced. Some indicated that this was a possibility, and some had no comment. None of the respondents suggested that this could not be done.

If so, which of these factors would be of the greatest benefit?

Of those indicating that pavement utility cuts can be reduced through those actions mentioned in the previous question, the following were suggested as being the most promising methods, in order of frequency.

- Incentives / disincentives.
- Availability of technical information.
- Moratoria on cutting new streets.

- Requiring bonds and 10-year warranties.
- Encouragement of joint (shared) trenching.
- Advance planning.
- Enforcement of policies.

Summary

Overall, the responses to the trenchless technology section seemed to indicate that many states have had some good experiences in using or specifying trenchless technologies. It is also evident that more information regarding potential policies, specifications, etc., could prove helpful in further encouraging agencies to use trenchless technologies more often.

4.4.2 Informal Interviews

During the course of the project development, several informal interviews were conducted to assess agency and industry attitudes and opinions regarding the use of trenchless technology and other methods to reduce the frequency of pavement utility cuts. This section summarizes the attitudes, usage, and innovative techniques that are used by those interviewed while conducting these telephone interviews.

Attitudes

This section summarizes the attitudes about trenchless technology and utility cuts in general.

- **Using Trenchless Since 1995.** One state highway agency began using trenchless technology about 1995. It developed a manual regarding its use, but says the technology wasn't good enough at that time to make it work well. Lately, however, the technology is better and they use it wherever possible, which is in the hundreds of projects per year. They have been very happy with the results.
- **Cut Permits Include Trenchless.** In a new ordinance, one city requires utility cut permits for all construction within the city right-of-way. Although it was intended for utility cuts, it has been interpreted to mean trenchless as well, since trenchless operations also disturb material beneath the streets. Essentially, the permit cost is the same for trenching and trenchless.
- **Too Expensive.** Many potential users think (right or wrong) that trenchless is too expensive, and therefore do not consider it as a viable alternative. Perhaps the dissemination of good information, the use of pilot projects, advances in technology, and time will change some of these attitudes.

Usage and Innovations

The following are methods of use and innovations, on both the industry and the agency sides, which have proven successful.

- **Vacuum Excavation for Visual Location.** In urban settings, use a vacuum excavation firm to excavate a hole in the vicinity of existing utilities that may be compromised. If the drilling head enters this hole, it will be seen (visually) and the head is backed up and advanced on the correct path.
- **Shared Trenches.** When new housing developments are built, require the utilities to share trenches. Some utility companies have taken this a step further and shared construction, as well. For example, the cable company may give their cable to the gas company to install at the same time as the gas lines.
- **Safety Meeting.** Hold a weekly safety meeting where all utilities in the region are represented and present. Discuss the work schedule for the upcoming week.
- **SUE Studies.** Require a subsurface utility engineering study for any project where existing utilities or other obstructions may be present.

- **Cost Analysis.** Utility companies should determine their cost for trenching, traffic control, street cut repair, safety precautions, repair warranties, and other costs. Compare these costs to those associated with trenchless technology.
- **Create Database to Track Information.** One industry utilities construction manager has developed a database to interface with the city's electronic online cut permit system. Managing over 200 utility cuts and some trenchless projects on any given day, many benefits are realized with such a system. Utility cut ordinance violations can be quickly identified and resolved, coordination between his own crews and the city inspectors are streamlined, and it provides a single point of contact between the city and the utility company.

4.5 Other Technologies and Methods

New technologies are constantly being developed. Many of these complement the trenchless technology industry, and others use different methods of installing or helping install facilities. This section is for informational purposes, and only presents a few typical new technologies. This section does not intend to promote or endorse any particular company or product, nor does it purport to present information on all new technologies that may be available or under development. Some of the promising new technologies include the following:

- ***North-Seeking Gyroscopic Tool.***
  Developed in Holland in the 1980s, this technology has been improved to allow use inside the drill pipe during drilling operations. It sends altitude and location information to a computer up to 15 times per second, allowing the device to be used to steer a bore to a specific target or to provide location information after the bore has been completed.(38)

- ***Wireless Applications.***
  Several wireless devices have been developed to eliminate, or reduce dependence on, hard-wired downhole cables transmitting data back to the computer control station. Such devices may be subject to interference from other magnetic fields and radio waves.

- ***Global Positioning System.***
  The global positioning system technology has been established and greatly advanced in the past decade. Depending on the accuracy of the receiver and the needs of the user, drilling systems can often be used with this system. Programmed with entry and exit coordinates, the boring system can then steer its way from one end of the hole to the other. Limitations on this technology include the necessity of line-of-sight to the global positioning satellites, and the remaining problem of steering and locating the system between the two points.

- ***Improved Tracking and Mapping Systems.***
  These systems are being developed to provide operators with more, reliable, and accurate data in real-time. Systems such as this, combined with accurate subsurface utility information, can produce excellent results during boring operations.

- ***City Sewer Installation of Broadband Internet Connection.***
  At least one company has begun supplying high-speed internet access to the "last mile" in the Nation's major cities. Broadband continues to grow, but the so-called "last mile" from the high-speed internet connection to desktop computers in major urban areas remains a bottleneck. "One of the biggest obstacles to the rollout of high-speed Internet and data services is that companies must tear up city streets to lay fiber-optic cables. That increases costs, sparks lengthy battles over rights-of-way and disrupts traffic."(39) One solution has been to attach fiber-optic cable to the inside of city sewer pipes using small robots. The city of Albuquerque, New Mexico was the

first city to install this type of system. Since that time, many cities throughout the world have begun similar installations.

- ***Construction of Large Conduit for Multiple Uses.***
  The City of Houston has considered a strategy for constructing 1219-mm (48-in) conduits within which all utilities would be contained. This conduit would be made available for public as well as private utilities. With such a large conduit, construction and future installations can be done inside the pipe, rather than additional excavation through the pavement structure.

As technological advances continue, the advantages to the trenchless and other technology industries will also improve. The reliability of trenchless technology will increase, as will the positional accuracy of the boring heads. The probability of striking existing facilities and other objects will also decrease, as location and steering capability improve. Technologies relating to subsurface utility engineering studies will also improve the ability to locate existing facilities and map them accurately for the trenchless equipment operator.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

As demand for access to the public ROW increases, many effects have been and continue to be observed. As this demand continues and is largely satisfied with traditional trenching methods, not only have existing facilities beneath the public rights-of-way become congested, but pavement structures have become deteriorated more quickly than under normal operation, and other effects related to trenching methods have become critical.

Implementation of the Telecommunications Act of 1996 has created many challenges for local, county and state jurisdictions as they attempt to manage developed ROW usage policies and compensation methodologies effectively. Lack of such management could result in excessive excavation activity that potentially might impact public safety, value of ROW, local businesses, cost assessed taxpayers, and deterioration of infrastructure. The execution of franchise, license, ROW, shared resource and other agreements have yielded positive results for jurisdictions that are enforcing provisions governing permit issuance, construction, inspection, repair, and maintenance activities by utility and other companies that have been permitted to utilize the public rights-of-way.

This manual has presented some alternative construction methods to trenching and some policies that can be promoted and implemented by cities, counties, and states throughout the United States. Two major recommendations can be made as a result of the development of this manual. First is that the policies presented herein be evaluated and their implementation attempted. Not all policies presented in this manual will be appropriate for every agency, however. Many of these policies can be modified and tailored to the specific needs of many agencies throughout the Nation.

Three types of policies were identified that are designed to encourage alternative behavior with respect to utility cuts. These are incentive-based, fee-based and requirement-based policies. Each type of policy can affect the frequency of pavement utility cuts by placing explicit requirements on those cutting the pavement (requirement-based), by making pavement utility cuts more expensive by imposing appropriate fees in order to recover the true cost of the cuts (fee-based) or by providing an incentive to use new technologies where appropriate (incentive-based). Overall, these policy recommendations can help public agencies reduce the frequency of pavement utility cuts, and thereby reduce the rate at which the local and national infrastructure deteriorates due to such cuts.

The recommended policies include:

- ***Incentive-Based.***
  Incentives to Encourage Use of Trenchless Technology.
  Incentives to Encourage Less Damaging Types of Cuts.
  Encourage Coordination – Shared Trenching.
  Encourage Coordination – Shared Resources.

- ***Fee-Based.***
  Assess Appropriate Rights-of-Way Fees.
  Assess Appropriate Pavement Degradation Fees.
  Assess Appropriate Permit Fees.
  Assess Lane-Rental Fees.
  Require Deposits to Protect Against Poor Repairs.
  Assess Penalties for Non-Compliance or Failed Repairs.

- ***Requirements-Based.***
  Require Agency-Owned Utilities to Meet Repair Quality Standards.

Require Justification for Not Using Trenchless Technology.
Establish Moratorium Periods for New Pavement.
Require Repaving Area Larger than Cut to Mitigate Pavement Damage.
Enhance Inspection and Enforcement of Specification Requirements .

The second recommendation is that the methods of trenchless technologies be encouraged where possible and practical. Again, not all methods are suited for all situations, and some situations may not be suited for any type of trenchless technology. However, most agencies and geographic locations can successfully encourage the use of some of these methods to improve their control over, and to try to reduce the frequency of, pavement utility cuts in the public ROW. Trenchless technologies have become more popular in recent years as the cost and probability of encountering existing facilities have decreased and the probability of success has increased. Many city and state agencies are using or specifying the technology, and have had great success. Some have had bad experiences, but the industry is constantly trying to improve the chances for success, and it is hoped that the bad experiences will diminish over time as the industry improves. The trenchless technology and other methods that were discussed in this report include the following:

- ***Trenchless Technology Methods.***
  Horizontal Directional Drilling (or Guided Boring)
  Auger and Slurry Boring
  Pipe Jacking and Microtunneling
  Impact Moling and Ramming (or Thrust Boring)
  Pipe Bursting

- ***Other Components.***
  Selecting the Appropriate Methods
  Advantages and Limitations of Each Method
  Cost Analysis
  Safety
  Project Planning
  Subsurface Utility Engineering
  Other Technologies and Methods

Users of this manual are encouraged to evaluate the policies and technologies presented, and to use the samples in the appendices to begin to develop policies, ordinances, regulations, and specifications of their own. The samples in the appendices are actual documents that have been used successfully by various city and state agencies. Beginning with these examples, any city, county, or state right-of-way, public works, or highway agency can develop a program for both controlling pavement utility cuts within their jurisdiction and reducing their frequency.

APPENDIX A. SAMPLE DEGRADATATION FEE CALCULATION

This appendix contains a sample method of computing the pavement degradation fee for the effect of utility cuts on the pavement structure. This calculation is comprised of four steps, calculating an appropriate degradation fee per unit area:

- Calculate the future cost of rehabilitation.
- Calculate the equivalent uniform annual cost (EUAC) of future rehabilitation for new design life.
- Calculate the value of the EUAC for remainder of original design period.
- Calculate the present value of the future EUAC.

Step 1: Calculate the future cost of rehabilitation

$$F_{repair} = P_{repair}(1 + i)^{N_{RL}} \quad (1)$$

where:
F_{repair} = future cost of P_{repair}
P_{repair} = present day pavement repair cost
i = discount rate
N_{RL} = number of years to end of service life, after cut is made

Step 2: Calculate the equivalent uniform annual cost (EUAC) of future rehabilitation for new design life.

$$A = F_{repair}\left(\frac{i(1+i)^{Nd}}{(1+i)^{Nd}-1}\right) \quad (2)$$

where:
A = Annual cost of rehabilitation (over its design life) performed at end of current (adjusted) service life
N_d = Design life of new rehabilitation

Part 3: Calculate the value of the EUAC for remainder of original design period.

$$P_{rehab} = A\left(\frac{(1+i)^{LL}-1}{i(1+i)^{LL}}\right) \quad (3)$$

where:
P_{rehab} = cost of portion of rehabilitation that will carry the pavement section to the end of the original design life
L_L = lost life due to utility cut

Part 4: Calculate the present value of the future EUAC.

$$PLRC = P_{rehab}\left(\frac{1}{(1+i)^{NRL}}\right) \quad (3)$$

where:
P_{rehab} = Cost of rehabilitation earlier than expected
PLRC = Present value of future rehabilitation (P_{rehab}) to carry pavement to end of original design life.

APPENDIX B. MODEL ORDINANACES

This appendix contains several ordinances developed and passed by cities in the United States to regulate the use of public right-of-way. Each of these ordinances have been used for several years, and have been modified to satisfy current regulatory and technological climates. The full text of these and other such ordinances can be found on city websites throughout the country.

San Francisco Public Works Code – ARTICLE 2.4 EXCAVATION IN THE PUBLIC RIGHT-OF-WAY

[Excavation in the Public Right-of-Way]
AMENDING PART II, CHAPTER 10 OF THE SAN FRANCISCO MUNICIPAL CODE (PUBLIC WORKS CODE) BY REPEALING ARTICLE 8 (EXCAVATIONS IN STREETS), REPEALING SECTIONS 672 AND 673 OF ARTICLE 14 (UNDERGROUND PIPES, WIRES AND CONDUITS), AND ADDING ARTICLE 2.4 (EXCAVATION IN THE PUBLIC RIGHT-OF-WAY), INCLUDING SECTION 2.4.44 TO IMPOSE A NEW STREET DAMAGE RESTORATION FEE; AUTHORIZING ESTABLISHMENT OF THE STREET CONSTRUCTION COORDINATION CENTER AND REQUESTING OTHER OFFICIAL ACTIONS IN CONNECTION THEREWITH; MAKING FINDINGS FOR THESE AMENDMENTS; AND AMENDING ARTICLE XIII OF CHAPTER 10 OF THE SAN FRANCISCO ADMINISTRATIVE CODE BY ADDING SECTION 10.117-119 TO CREATE A FUND FOR COLLECTION OF STREET DAMAGE RESTORATION FEES AND ADDING SECTION 10.117-120 TO REESTABLISH THE EXCAVATION FUND FOR THE COLLECTION OF OTHER DEPOSITS, FEES, AND PENALTIES IMPOSED BY ARTICLE 2.4.

Be it ordained by the People of the City and County of San Francisco:

Section 1. **FINDINGS**. The Board of Supervisors finds that:

(a) Excavation in City streets can significantly disrupt and interfere with public use of me streets. Among other things excavation can disrupt traffic flow, impeding public transportation such as buses and street cars that travel on fixed, scheduled routes and creating barriers for pedestrians and bicyclists to navigate. additionally, obstruction of streets during excavation can result in a loss of parking to nearby businesses and residents. Noise and debris from excavation can further inconvenience nearby businesses and residents and limit access to their premises. These impacts can be magnified when a street is subject to multiple excavations within a relatively short period of time.

(b) It is desirable to revise the Public Works Code to modify the existing street excavation permitting process to improve and encourage coordination of street work in order to minimize disruption to traffic flow limit inconvenience to San Francisco businesses, residents and visitors and provide for the public health safety and well-being. Coordination of excavations can be improved and encouraged through a number of means.

(c) Major excavation projects should be undertaken jointly and, with limited exceptions, there should be a moratorium on excavation in City streets that have been repaved in the past five (5) years.

(d) Excavators should also be required to submit five-year plans of anticipated major excavations that will allow the Department of Public Works to identify conflicts and opportunities for coordinating street excavation with repaving while protecting confidential information submitted by excavators.

(e) The street excavation permitting process should enhance the public's access to information about construction in streets by requiring excavators to provide notice of major excavation projects to the surrounding communities and to place explanatory signs at the excavation site.

(f) The street excavation permitting process should minimize the impact of construction on

neighborhood residents and businesses by enforcing cleanliness and safety standards for construction sites imposing strict lifelines for construction and requiring excavators to install finished pavement with a uniform visual appearance.

(g) The Department of Public Works should have the authority to enforce violations of the street excavation permitting process through the imposition of civil criminal or administrative penalties,

(h) The impacts of excavation do not end when construction is complete. The Department of Public Works has sponsored two studies prepared by a panel of engineering, statistical and economic experts which demonstrate that excavation increases taxpayer costs to maintain City streets because it accelerates the deterioration and reduces the service life of streets. The Engineering Report commissioned by the Department of Public Works concludes that street damage occurs no matter how well the excavation is restored, and the more excavations that occur in a street, the more the street is damaged. Both the Engineering Report and the Economic Report completed in September and October of 1998, respectively, are available in the Board of Supervisors' file. Studies performed in a number of cities, including the California cities of Los Angeles and Sacramento confirm the findings of the City's reports.

(i) The City's streets are a valuable public asset which the city holds in trust for its citizens. The city spends millions of tax dollars every year to maintain this public asset. The Economic Report commissioned by the Department of Public works concludes that excavation costs city taxpayers an additional $3.3 to $5.1 million annually in increased street maintenance because of the damage it causes. Consequently it is reasonable and in the public interest to impose a Street Damage Restoration Fee to be paid by excavators in order to recover the increased repaving and reconstruction costs caused by excavation which are currently born by taxpayers. It is also reasonable and in the public interest to structure the fee and any exclusions from the fee in a manner which discourages excavation in newly paved streets and encourages excavators to minimize excavation and to coordinate necessary excavation with the Department of Public Works' repaving schedule. Consequently, among other things, it is appropriate for the Street Damage Restoration Fee to be higher for newer streets and lower for older streets and those scheduled for imminent repaving.

(j) The Economic Report estimates that the square foot cost to the city of excavation is between $5.37 and $8.38. Consequently, if the Street Damage Restoration Fee is $3 50 or less per square foot of excavation, the City's proceeds from the fee will not exceed the repaving and reconstruction costs incurred by the city that are reasonably attributable to the impact of excavation in city streets and no individual excavator will be charged a fee that exceeds the reasonable costs of the impact of that party's excavation on the need for repaving and reconstruction of City streets. Proceeds collected from the Street Damage Restoration shall be used solely for repaving and reconstruction of City streets.

(k) To ensure that proceeds from the Street Damage Restoration Fee do not exceed the repaving and reconstruction costs incurred by the City that are reasonably attributable to excavation, a separate fund should be created to deposit proceeds from the fee. Additionally, the Department of Public Works shall report to the Board of Supervisors regarding the proceeds collected and costs incurred and a refund shall be granted to excavators in the event that proceeds from the fee exceed costs incurred that are reasonably attributable to excavation.

(l) In a further effort to minimize disruption caused by excavation and other construction in City streets, the City shall create a Street Construction Coordination Center which will be responsible for planning and coordinating excavation in streets. In addition, the Director shall undertake efforts to inform the public, private and public excavators, and this Board about the progress of this legislation.

[Sections 3 and 4 deleted Article 8 (Sections 335 et seq.) and Sections 672 and 673 from Part II, Chapter 10 of the San Francisco Municipal Code (Public Works Code]

Section 4. Part II, Chapter 10 of the San Francisco Municipal Code (Public Works Code) is hereby amended by adding Article 2.4 (Excavation in the Public Right-of-Way) to read as follows:

ARTICLE 2.4
EXCAVATION IN THE PUBLIC RIGHT-OF-WAY
SUBARTICLE I – GENERAL PROVISIONS

SUBARTICLE II – APPLICATIONS FOR PERMITS TO PERFORM AN EXCAVATION

SUBARTICLE III – PERMITS TO EXCAVATE

SUBARTICLE IV – DEPOSITS AND FEES

SUBARTICLE V – EXCAVATIONS

SUBARTICLE VI – POST-EXCAVATION REPAIR, MAINTENANCE, AND PAVEMENT FAILURE

SUBARTICLE VII – VIOLATION OF ARTICLE

SUBARTICLE I – GENERAL PROVISIONS

SEC. 2.4.1. EXCAVATION IN THE PUBLIC RIGHT-OF-WAY. This Article 2.4 shall govern excavation in the public right-of-way within the City that is under the jurisdiction and control of the Department of Public Works. The Director of Public Works shall be responsible for managing the public right-of-way.

SEC. 2.4.2. PERMITS REQUIRED TO EXCAVATE. (a) It is unlawful for any person to make or to cause or permit to be made any excavation in any public right-of-way that is under the jurisdiction of the Department of Public Works without first obtaining from the Department a permit authorizing such excavation.

(b) The Department shall issue a permit to excavate only if the owner has the legal authority to occupy and use the public right-of-way for the purposes identified in the application for the permit and the owner and its agent, if any, are in compliance with this Article.

(c) No permit to excavate shall be required when an excavation is to be completed within a period of 24 hours or less to install a parking meter, street light, street tree, traffic sign, traffic signal, or utility pole or to repair a utility box in a sidewalk; or when an excavation is in connection with the construction or maintenance of a subsidewalk basement; or when an excavation is performed for the sole purpose of repairing a sidewalk.

(d) Permit requirements pertaining to emergency excavation are addressed in Section 2.4.22.

SEC. 2.4.3. DEPARTMENT ORDERS AND REGULATIONS. In addition to the requirements set forth in this Article, the Department may adopt such orders or regulations as it deems necessary in order to preserve and maintain the public health, safety, welfare, and convenience. Each excavation in the public right-of- way pursuant to this Article shall be performed in accordance with the standard plans and specifications of the Department and any Department orders or regulations, except where the Director, in his or her discretion, grants prior written approval to deviate from such standard plans and specifications, orders, or regulations. The Director shall develop guidelines to implement the granting of waivers authorized pursuant to this Article. Furthermore, excavation in the public right-of-way shall conform to the orders, regulations, and rules of the Department of Parking and Traffic, including, but not limited to, the regulations adopted in accordance with Article 11 of the San Francisco Traffic Code (the "Blue Book").

SEC. 2.4.4. DEFINITIONS. For purposes of this Article, the following terms shall have the following meanings:

(a) "Agent" shall mean a person or persons authorized to assist an owner in the permitting process or in the performance of an excavation.

(b) "Applicant" shall mean an owner or duly authorized agent of such owner, who has submitted an application for a permit to excavate.

(c) "Article" shall mean this Article 2.4 of the Public Works Code.

(d) "Block" shall mean that part of the public right-of-way that includes the street area from the property line to the parallel property line in width and extending from the property line of an intersecting street to the nearest property line of the next intersecting street in length. For purposes of this definition, an intersection also shall be considered a "block."

(e) "City" shall mean the City and County of San Francisco.

(f) "Department" shall mean the Department of Public Works.

(g) "Deposit" shall mean any bond, cash deposit, or other security provided by the applicant in accordance with Section 2.4.40 of this Article.

(h) "Director" shall mean the Director of the Department of Public Works or his or her designee.

(i) "Excavation" shall mean any work in the surface or subsurface of the public right-of-way, including, but not limited to opening the public right-of-way; installing, servicing, repairing or modifying any facility(ies) in or under the surface or subsurface of the public right-of-way, and restoring the surface and subsurface of the public right-of-way.

(j) "Facility" or "facilities" shall include, but not be limited to, any and all cables, cabinets, ducts, conduits, converters, equipment, drains, handholds, manholes, pipes, pipelines, splice boxes, surface location markers, tracks, tunnels, utilities, vaults, and other appurtenances or tangible things owned, leased, operated, or licensed by an owner or person, that are located or are proposed to be located in the public right-of-way.

(k) "Large excavation project" shall mean any excavation of more than 1000 square feet.

(l) "Major work" shall mean any reasonably foreseeable excavation that will affect the public right- of-way for more than 15 consecutive calendar days.

(m) "Medium excavation project" shall mean any excavation of more than 100 but no greater than 1000 square feet.

(n) "Moratorium street" shall mean any block that has been reconstructed, repaved, or resurfaced by the Department or any other owner or person in the preceding five-year period.

(o) "Municipal excavator" shall mean any agency, board, commission, department, or subdivision of the City that owns, installs, or maintains a facility or facilities in the public right-of-way.

(p) "Owner" shall mean any person, including the City, who owns any facility or facilities that are or are proposed to be installed or maintained in the public right-of-way.

(q) "Permit" or "permit to excavate" shall mean a permit to perform an excavation as it has been approved, amended, or renewed by the Department.

(r) "Permittee" shall mean the applicant to whom a permit to excavate has been granted by the Department in accordance with this Article.

(s) “Person" shall mean any natural person, corporation, partnership, any municipal excavator, or any governmental agency, including the State of California or United States of America.

(t) "Public right-of-way" shall mean the area across, along, beneath, in, on, over, under, upon, and within the dedicated public alleys, boulevards, courts, lanes, roads, sidewalks, spaces, streets, and ways within the City, as they now exist or hereafter will exist and which are or will be under the permitting jurisdiction of the Department of Public Works.

(u) "Responsible party" shall mean the owner for each excavation involving the owner's facility or facilities. In addition, it shall mean any person who performs an excavation or has a duty or right to manage or participate in the management of an excavation and whom the Director designates as responsible, in whole or in part, for such excavation.

(v) "Sidewalk" shall mean the area between the fronting property line and the back of the nearest curb.

(w) "Small excavation project" shall mean any excavation of 100 square feet or less.

(x) "Utility excavator" shall mean any owner whose facility or facilities in the public right-of-way are used to provide electricity, gas, information services, sewer service, steam, telecommunica-

tions, traffic controls, transit service, video, water, or other services to customers regardless of whether such owner is deemed a public utility by the California Public Utilities Commission.

SUBARTICLE II – APPLICATIONS FOR PERMITS TO PERFORM AN EXCAVATION

SEC. 2.4.10. APPLICATIONS. (a) Applications shall be submitted in a format and manner specified by the Department and shall contain:

(i) The name, address, telephone, and facsimile number of the applicant. Where an applicant is not the owner of the facility to be installed, maintained, or repaired in the public right-of-way, the application also shall include the name, address, telephone, and facsimile number of the owner;

(ii) A description of the location, purpose, method of excavation, and surface and subsurface area of the proposed excavation;

(iii) A plan showing the proposed location and dimensions of the excavation and the facilities to be installed, maintained, or repaired in connection with the excavation, and such other details as the Department may require;

(iv) A copy or other documentation of the franchise, easement, encroachment permit, license, or other legal instrument that authorizes the applicant or owner to use or occupy the public right-of-way for the purpose described in the application. Where the applicant is not the owner of the facility or facilities to be installed, maintained, or repaired, the applicant must demonstrate in a form and manner specified by the Department that the applicant is authorized to act on behalf of the owner;

(v) The proposed start date of excavation;

(vi) The proposed duration of the excavation, which shall include the duration of the restoration of the public right-of-way physically disturbed by the excavation;

(vii) Written acknowledgment that all material to be used in the excavation, installation, maintenance, or repair of facilities, and restoration of the public right-of-way will be on hand and ready for use so as not to delay the excavation and the prompt restoration of the public right-of-way;

(viii) Written acknowledgment that the owner and its agent, if any, are in compliance with all terms and conditions of this Article, the orders, regulations, and standard plans and specifications of the Department, and that the owner and its agent are not subject to any outstanding assessments, fees, penalties that have been finally determined by the City or a court of competent jurisdiction;

(ix) A current Business Tax Registration Certificate issued by the San Francisco Tax Collector pursuant to Section 1003 of Part III of the San Francisco Municipal Code for the owner and its agent, if any;

(x) Evidence of insurance as required by Section 2.4.23 of this Article;

(xi) A deposit as required by Section 2.4.40 of this Article;

(xii) Any other information that may reasonably be required by the Department.

(b) The Department may allow an applicant to maintain documents complying with Subsections (iv), (ix), (x), and (xi) on file with the Department rather than requiring submission of such documents with each separate application.

SEC. 2.4.11. COORDINATION OF EXCAVATION. (a) **Five-Year Plans.** (i) On the first day of April and October, or the first regular business day immediately thereafter, each utility and municipal excavator shall prepare and submit to the Department a plan, in a format specified by the Department, that shows all major work anticipated to be done in the public right-of-way in the next five years. Any utility or municipal excavator that does not propose major work in the next five years shall submit a plan with a statement that no such major work is anticipated and shall immediately report any major work to the Department as soon as it becomes reasonably foreseeable.

(ii) The Department may disclose information contained in a five-year plan to any utility excavator or municipal excavator only on a need-to-know basis in order to facilitate coordination among excavators and to avoid unnecessary excavation in City streets. To the maximum extent per-

missible under federal, State, and local laws applicable to public records, the City shall not otherwise disclose to the public any information contained in a five-year plan submitted by a utility excavator that is proprietary, trade secret or is otherwise protected from disclosure; provided, however that the City shall have no duty to decline to disclose any information that the utility excavator has not identified on its face as proprietary, trade secret or otherwise protected from disclosure. The Department shall notify a utility excavator of any request for inspection of public records that calls for disclosure of any five-year plan on which any information has been identified as proprietary, trade secret or otherwise protected from disclosure. The Department shall consult with the City Attorney regarding any such request and shall inform the affected utility excavator either that the Department will refuse to disclose the protected information or, if there is no proper basis for such refusal, that the Department intends to disclose the requested information unless ordered otherwise by a court.

(b) **Department Repaving Plans.** (i) The Department shall prepare a five-year repaving plan showing all proposed repaving and reconstruction of the public right-of-way. The Department's repaving plan shall be revised and updated on a semiannual basis after receipt of the five-year plans from utility and municipal excavators. In order to facilitate coordination and minimize the cost of excavation, the Department shall make its repaving plan available for public inspection.

(ii) At least one hundred twenty calendar days prior to undertaking the repaving and reconstruction of any block, the Department shall send a notice of the proposed repaving and reconstruction to each utility and municipal excavator.

(c) **Coordination.** (i) The Department shall review the five-year plans and identify conflicts and opportunities for coordination of excavations. The Department shall notify affected owners and permittees of such conflicts and opportunities to the extent necessary to maximize coordination of excavation. Each applicant shall coordinate, to the extent practicable, with each potentially affected owner and permittee to minimize disruption in the public right-of-way.

(ii) When two or more applicants coordinate major work in the same block so that, in the opinion of the Department, such major work minimizes disruption to the affected neighborhood, and is likely to qualify the block for repaving, the Department shall make its best effort to schedule the affected block for repaving. Such scheduling shall occur, to the extent funds are available in the Street Damage Restoration Fund, so that the applicants may qualify for a waiver of the street damage restoration fee under Section 2.4.44(b)(ii). Notwithstanding the foregoing, nothing in this subsection shall interfere with the Department's authority to allocate available repaving resources in a manner that it determines best serves the public interest.

SEC. 2.4.12. JOINT EXCAVATION. (a) **Municipal Excavators.** Whenever two or more municipal excavators propose major work in the same block within a five-year period, such work shall be performed by one municipal excavator. The participants to the excavation shall pay their pro rata share of the work. For purposes of this subsection, the municipal excavators shall be treated as a single applicant and shall submit one application.

(b) **Utility Excavators.** Whenever two or more utility excavators propose major work in the same block within a five-year period, such work shall be performed by one utility excavator. For purposes of this subsection, the utility excavators shall be treated as a single applicant and shall submit one application.

(c) **Municipal Excavator and Utility Excavator.** Whenever a municipal excavator(s) and a utility excavator(s) propose major work in the same block within a five-year period, the Department shall condition permits for such work in a manner that maximizes coordination and minimizes the total period of construction.

(d) **Waiver of Joint Excavation Requirements.** Applicants may seek a waiver of the joint excavation requirements with respect to a particular excavation. Within 30 calendar days of receipt of a written request for a waiver, the Director, in his or her discretion, may grant a waiver to the joint excavation requirements for good cause. In making his or her decision on the request for waiver, the Director shall consider the impact of the proposed excavation on the neighborhood, the applicant's

need to provide services to a property or area, facilitating the deployment of new technology as directed pursuant to official City policy, and the public health, safety, welfare, and convenience. The Director shall indicate in written, electronic, or facsimile communication the basis for granting any waiver pursuant to this subsection. The Director may place additional conditions on any permit(s) subject to a waiver, including, but not limited to, the charging of additional fees pursuant to Section 2.4.43. The Director's decision regarding waivers of the joint excavation requirements shall be final.

SUBARTICLE III PERMITS TO EXCAVATE

SEC. 2.4.20. ACTION ON APPLICATIONS FOR PERMITS TO EXCAVATE. (a) After receipt of an application for a permit to excavate, the Department, within a reasonable time period, shall determine whether an application is complete.

(b) If the application is deemed to be incomplete, the Department promptly shall advise the applicant in a written, electronic, or facsimile communication of the reasons for rejecting the application as incomplete.

(c) If the application is deemed to be complete, the Department, in its discretion, may deny, approve, or conditionally approve the application.

(i) If the application is approved or conditionally approved, the Department shall issue a permit to the applicant. The Department may condition a permit with specified requirements that preserve and maintain the public health, safety, welfare, and convenience. The Department shall inform the permittee of the basis for such requirements.

(ii) If the application is denied, the Department shall advise the applicant in a written, electronic, or facsimile communication of the basis for denial.

SEC. 2.4.20.1. TERMS AND LIMITATIONS. The permit shall specify the location, extent, and method of the excavation, the start date and duration of the excavation, the permittee to whom the permit is issued, and any conditions placed on the permit. The terms and conditions of the permit shall include the application, all information submitted therewith, and all Department orders and regulations applicable to the permit. The Department must approve any and all modifications to the permit.

SEC. 2.4.20.2. DURATION AND VALIDITY. Permits shall be void if the excavation has not begun within 30 calendar days of the start date specified in the permit, if the excavation is not prosecuted diligently to its conclusion, or if the excavation, including restoration, has not been completed within the specified duration; provided, however, that the Director, at his or her discretion, may issue extensions to the start date, the duration of excavation, or both upon written request from the permittee. Such written requests must explain why the wok could not be commenced on the start date, completed in the approved number of calendar days, or both; shall specify the additional number of calendar days required to complete the work; and shall be accompanied by applicable fees specified in Subarticle IV. All requests to modify the start date of an excavation shall be made at least five (5) calendar days prior to the excavation start date. All requests to modify the duration of the excavation shall be made at least five (5) calendar days prior to the permit expiration date. Any extension that the Director grants may be subject to additional special conditions, including, but not limited to, conditions that ensure timely completion and coordination of the project. The Director shall not grant requests for extensions to the start date after the permitted start date nor shall the Director grant requests for extensions to the duration of the excavation after the permit expiration date.

SEC. 2.4.20.3. PERMIT AMENDMENTS. The Director, at his or her sole discretion, may allow amendments to the permit, such as to change the method of construction, to advance the start date of the excavation, or modify permit conditions, upon written request from the permittee. Such requests shall explain the basis for the permit amendment and shall be accompanied by applicable fees specified in Subarticle IV. Any amendments that the Director grants may be subject to additional special

conditions, including, but not limited to, conditions that ensure timely completion and coordination of the project. The Director shall not grant requests for amendments to the excavation after the permit expiration date.

SEC. 2.4.20.4. NONTRANSFERABILITY OF PERMITS. Permits are not transferable.

SEC. 2.4.21. MORATORIUM STREETS. The Department shall not issue any permit to excavate in any moratorium street; provided, however, that the Director, in his or her discretion, may grant a waiver for good cause. The Director is specifically authorized to grant a waiver for an excavation that facilitates the deployment of new technology as directed pursuant to official City policy. The Director shall issue his decision on a waiver within a reasonable period after receipt of a written request for a waiver. The Director may place additional conditions on a permit subject to a waiver, including, but not limited to, the charging of additional fees pursuant to Section 2.4.43. The Director's decision regarding a waiver shall be final.

SEC. 2.4.22. EMERGENCY EXCAVATION. Nothing contained in this Article shall be construed to prevent any person from taking any action necessary for the preservation of life or property or for the restoration of interrupted service provided by a municipal or utility excavator when such necessity arises during days or times when the Department is closed. In the event that any person takes any action to excavate or cause to be excavated the public right-of-way pursuant to this Section, such person shall apply for an emergency permit within four hours after the Department's offices are first opened. The applicant for an emergency permit shall submit a written statement of the basis of the emergency action and describe the excavation performed and any work remaining to be performed.

SEC. 2.4.23. LIABILITY AND INDEMNIFICATION. Each permit, except one obtained by a municipal excavator, shall incorporate by reference and require the owner and its agent, if any, to comply with the liability, indemnity, insurance, and taxable possessory interest provisions set forth below in this Section; provided, however, that the Director, with the concurrence of the City Controller and City Risk Manager, may modify the indemnity and insurance provisions as they pertain to a particular permit.

(a) **Liability upon Owner and Agent.** Each owner and its agent is wholly responsible for the quality of the excavation performed in the public right-of-way and both the owner and agent are jointly and severally liable for all consequences of any condition of such excavation and any facilities installed in the public right-of-way. The issuance of any permit, inspection, repair, or suggestion, approval, or acquiescence of any person affiliated with the Department shall not excuse any owner or agent from such responsibility or liability.

(b) **Indemnification, Defense, and Hold Harmless.** (i) Each owner and agent shall agree on its behalf and that of any successor or assign to indemnify, defend, protect, and hold harmless the City, including, without limitation, each of its commissions, departments, officers, agents, and employees (hereinafter in this subsection collectively referred to as "San Francisco") from and against any and all actions, claims, costs, damages, demands, expenses, fines, injuries, judgments, liabilities, losses, penalties, or suits including, without limitation, attorneys' fees and costs (collectively, "claims") of any kind allegedly arising directly or indirectly from:

(1) Any act by, omission by, or negligence of, owner or its agent, contractors, subcontractors, or the officers, agents, or employees such entities, while engaged in the performance of the excavation authorized by the permit, or while in or about the property subject to the permit for any reason connected in any way whatsoever with the performance of the excavation authorized by the permit, or allegedly resulting directly or indirectly from the maintenance or installation of any equipment, facility(ies), or structures authorized under the permit;

(2) Any accident, damage, death, or injury to any contractor or subcontractor, or any

officer, agent or employee of either of them, while engaged in the performance of the excavation authorized by the permit, or while in or about the property for any reason connected with the performance of the excavation authorized by the permit, or arising from liens or claims for services rendered or labor or materials furnished in or for the performance of the excavation authorized by the permit;

(3) Any accident, damage, death, or injury to any person(s) or accident, damage, or injury to any real or personal property in, upon, or in any way allegedly connected with the excavation authorized by the permit from any cause or claims arising at any time; and,

(4) Any release or discharge, or threatened release or discharge, of any hazardous material caused or allowed by permittee about, in, on, or under the excavation site subject to the permit or the environment. As used herein, "hazardous material" means any gas, material, substance, or waste which, because of its quantity, concentration, or physical or chemical characteristics, is deemed by any federal, state, or local governmental authority to pose a present or potential hazard to human health or safety or to the environment. "Release" when used with respect to hazardous materials shall include any actual or imminent disposing, dumping, emitting, emptying, escaping, injecting, leaching, leaking, pumping, pouring, or spilling.

(ii) Upon the request of San Francisco, the owner or its agent, at no cost or expense to San Francisco, must indemnify, defend, and hold harmless San Francisco against any claims, regardless of the alleged negligence of San Francisco or any other party, except only for claims resulting directly from the sole negligence or willful misconduct of San Francisco. Each owner and its agent specifically acknowledges and agrees that it has an immediate and independent obligation to defend San Francisco from any claims which actually or potentially fall within the indemnity provision, even if the allegations are or may be groundless, false, or fraudulent, which obligation arises at the time such claim is tendered to owner or its agent by San Francisco and continues at all times thereafter. In addition, San Francisco shall have a cause of action for indemnity against each owner and its agent for any costs San Francisco may be required to pay as a result of defending or satisfying any claims that arise from or in connection with the permit, except only for claims resulting directly from the sole negligence or willful misconduct of San Francisco. Owner and its agent agree that the indemnification obligations assumed under the permit shall survive expiration of the permit or completion of excavation.

(c) **Insurance.** (I) Each owner or its agent shall maintain in full force and effect, throughout the term of the permit, an insurance policy or policies issued by an insurance company or companies satisfactory to the City's Controller and Risk Manager. Policy or policies shall afford insurance covering all operations, vehicles, and employees, as follows:

(1) Workers' Compensation with employers' liability limits not less than $1,000,000 each accident;

(2) Commercial general liability insurance with limits not less than $1,000,000 each occurrence combined single limit for bodily injury and property damage, including contractual liability; personal injury; explosion, collapse, and underground (xcu); products; and completed operations;

(3) Business automobile liability insurance with limits not less than $1,000,000 each occurrence combined single limit for bodily injury and property damage, including owned, nonowned, and hired auto coverage, as applicable;

(4) Contractors' pollution liability insurance, on an occurrence form, with limits not less than $1,000,000 each occurrence combined single limit for bodily injury and property damage and any deductible not to exceed $25,000 each occurrence.

(ii) Said policy or policies shall include the City and its officers and employees jointly and severally as additional insureds, shall apply as primary insurance, shall stipulate that no other insurance effected by the City will be called on to contribute to a loss covered thereunder, and shall provide for severability of interests. Said policy or policies shall provide that an act or omission of one insured, which would void or otherwise reduce coverage, shall not reduce or void the coverage as to any other insured. Said policy or policies shall afford full coverage for any claims based on acts,

omissions, injury, or damage which occurred or arose, or the onset of which occurred or arose, in whole or in part, during the policy period. Said policy or policies shall be endorsed to provide 30 calendar days advance written notice of cancellation or any material change to the Department.

(iii) Should any of the required insurance be provided under a claims-made form, the insured owner or its agent shall maintain such coverage continuously throughout the term of the permit, and, without lapse, for a period of three years beyond the expiration or termination of the permit, to the effect that, should occurrences during the term of the permit give rise to claims made after expiration or termination of the permit, such claims shall be covered by such claims-made policies.

(iv) Should any of the required insurance be provided under a form of coverage that includes a general annual aggregate limit or provides that claims investigation or legal defense costs be included in such general annual aggregate limit, such general aggregate limit shall be double the occurrence or claims limits specified above in Subsection (c)(i).

(v) Such insurance shall in no way relieve or decrease owner's and its agent's obligation to indemnify the City under Subsection (b) or any other provision of this Article.

(vi) Certificates of insurance, in the form satisfactory to the Department, evidencing all coverages above, shall be furnished to or maintained on file with the Department before issuance of a permit, with complete copies of policies furnished promptly upon the Department's request.

(vii) Where an owner is self-insured, and such insurance is no less broad and affords no less protection to the City than the requirements specified above in Subsection (c) the Department, in consultation with the City's Controller and Risk Manager, may accept such insurance as satisfying the requirements of Subsection (c). Evidence of such insurance shall be provided in the manner specified in Subsection (c)(vi).

(d) **Taxable Possessory Interest.** Each owner shall acknowledge on its behalf and that of any successor or assign that its permit incorporates the following statements: The owner of the facility(ies) for which the permit to excavate was obtained recognizes and understands that the permit may create a possessory interest subject to property taxation and that owner may be subject to the payment of property taxes levied on such interest under applicable law. Owner agrees to pay taxes of any kind, including possessory interest taxes, if any, that may be lawfully assessed on owner's interest under the permit to excavate or for use of the public right-of-way and to pay other excises, licenses, taxes, or permit charges or assessments based on owner's usage of the public right-of-way that may be imposed on owner by applicable law. Owner shall pay all of such charges when they become due and before delinquency.

SEC. 2.4.24. PERMIT TO BE AVAILABLE AT EXCAVATION SITE. The permit or a photo duplicate shall be available for review at the site of the excavation for the duration of the excavation and shall be shown, upon request, to any police officer or any employee of a City agency, board, commission, or department with jurisdictional responsibility over activities in the public right-of-way.

SUBARTICLE IV DEPOSITS AND FEES

SEC. 2.4.40. DEPOSIT. Each applicant shall submit and maintain with the Department a bond, cash deposit, or other security acceptable to the Department securing the faithful performance of the obligations of the owner and its agent under any permit(s) to excavate and the compliance with all terms and conditions of this Article (the "deposit"). The deposit shall be in the sum of $25,000 in favor of the "Department of Public Works, City and County of San Francisco." Utility and municipal excavators and other frequent applicants may submit a single deposit for multiple excavations so long as a constant balance of $25,000 is maintained on file with the Department. If the Director has deducted from such a deposit pursuant to Section 2.4.46(c), the utility or municipal excavator or other frequent applicant must restore the full amount of the deposit prior to the Department's issuance of a subsequent permit.

SEC. 2.4.41. ADMINISTRATIVE FEE. Each applicant shall pay to the Department a fee of $66 for each permit issued for a small excavation project, a fee of $83 for each block contained in a medium excavation project, or a fee of $110 for each block contained in a large excavation project. Said fees shall compensate the Department for the cost incurred to administer the provisions of this Article. If the Director grants a permit extension or amendment pursuant to Sections 2.4.20.2 or 2.4.20.3, the permittee shall pay a fee of $66 for any block for which the permit has been extended or amended to cover the cost of additional permit review and administration.

SEC. 2.4.42. INSPECTION FEE. Each applicant shall pay to the Department a fee of $16 for each permit issued for a small excavation project, a fee of $55 for each calendar day of a medium excavation project, or a fee of $81 for each calendar day of a large excavation project. Said fee shall compensate the Department for the cost of the inspection and regulatory services provided to such applicant when he or she becomes a permittee pursuant to this Article. No inspection fees shall be collected from a municipal excavator when: (a) the municipal excavator pays the Department to manage and inspect the construction or (b) the excavation is to construct, replace, or repair Municipal Railway tracks. If the Director grants a permit extension pursuant to Section 2.4.20.2, the permittee shall pay $16 for a small excavation project or the appropriate fees for a medium or large excavation project for each additional calendar day for which the permit is extended to cover the cost of additional permit inspection. If the Director grants a permit amendment pursuant to Section 2.4.20.3 that results in additional permit inspection, the permittee shall pay the fees specified above for permit extensions.

SEC. 2.4.43. ADDITIONAL FEES FOR EXCAVATION. In instances where administration of this Article or inspection of an excavation is or will be unusually costly to the Department, the Director, in his or her discretion, may require an applicant or permittee to pay any sum in excess of the amounts charged pursuant to Sections 2.4.41 and 2.4.42. This additional sum shall be sufficient to recover actual costs incurred by the Department and shall be charged on a time and materials basis. The Director also may charge for any time and materials costs incurred by other agencies, boards, commissions, or departments of the City in connection with the administration or inspection of the excavation. Whenever additional fees are charged, the Director, upon request of the applicant or permittee, shall provide in writing the basis for the additional fees and an estimate of the additional fees.

SEC. 2.4.44. STREET DAMAGE RESTORATION FEE. (a) **Calculation of Fee.** Each applicant shall pay to the Department a street damage restoration fee to recover the increased repaving and reconstruction costs incurred by the City that are reasonably attributable to the impact of excavation in City streets. The fee shall not generate proceeds in excess of the City's costs of street repaving and reconstruction reasonably attributable to the excavation for which the fee is charged. The amount of the fee shall be calculated as follows:

Age of Block (Years Since Last Resurfacing)	Fee Amount
0-5 years	$3.50 per square foot of excavation
6-10 years	$3.00 per square foot of excavation
11-15 years	$2.00 per square foot of excavation
15-20 years	$1.00 per square foot of excavation

Where an applicant proposes an excavation in a block whose age is unknown to the Department and the block's pavement condition score recorded in the Department's pavement management and mapping database is greater than 53, the applicant shall be charged the street damage restoration fee at the rate specified for streets 15 to 20 years old.

(b) **Exceptions from the Street Damage Restoration Fee to Encourage Coordination.** To encourage coordination of excavation with the Department's repaving schedule and to encourage excavation in older blocks and those with lower pavement condition scores:

(i) No fee will be assessed for excavation in blocks with a recorded pavement condition score of 53 or less, or a recorded age of greater than 20 years.

(ii) No fee will be assessed for excavation in a block scheduled to be completed by an applicant less than two years prior to the Department's scheduled repaving of that block.

(c) **Fee Waived for Excavation that Includes Repaving.** The street damage restoration fee shall be waived for an excavation where an applicant proposes to reconstruct and repave the entire block affected by the excavation or any and all traffic lanes affected by the excavation, where such reconstruction and repaving is performed consistent with all of the standards set forth in orders, rules, plans and specifications of the Department.

(d) **Fee Waiver for In-Kind Payment of Fee-Installation of Conduit.** With the approval of the Director of the Department of Public Works and the Director of the Department of Telecommunications and Information Services, where it would minimize neighborhood disruption, and where savings in street resurfacing costs through avoidance of future excavation are anticipated to exceed amounts that would otherwise be due from the street damage restoration fee, some portion or all of the otherwise applicable street damage restoration fee may be waived for an excavation in which the applicant installs: (i) conduit for City use or control or (ii) conduit made available via approval and coordination with the Department and Department of Telecommunications and Information Services to other subsequent applicants or excavators such that future excavation is permanently avoided. The City shall make any available space in such conduit available to subsequent applicants to avoid future excavation in the block. The Departments of Public Works and Telecommunications and Information Services shall adopt orders or regulations prescribing circumstances under which in-kind payment of all or some portion of the fee shall be permitted, prescribing specifications for the conduit to be installed, and prescribing terms under which the conduit shall be made available to interested parties on a competitively neutral and nondiscriminatory basis.

(e) **Exception for Excavation in Sidewalks, Concrete Blocks, or Unaccepted Blocks.** No street damage restoration fee shall be assessed with respect to excavation in a sidewalk, block constructed solely of portland cement concrete, or a block that the City has not accepted for maintenance purposes.

(f) **Exception for Excavation to Accommodate the City's Use.** No street damage restoration fee shall be assessed for excavation performed to relocate the facilities of a utility excavator to accommodate the City's use of the block.

SEC. 2.4.45. REPORT TO BOARD OF SUPERVISORS. Within one year after adoption or amendment of the street damage restoration fee or other fees set forth in this Subarticle, and every three years thereafter, the Director shall review the proceeds of the street damage restoration fee and such other fees, the costs of repaving and reconstruction reasonably attributed to excavation in City streets, the City's costs to administer this Article and inspect excavations, and any other new information that shall become available, and prepare a report to the Board of Supervisors. Based upon the result of the review, the Director shall recommend to the Board of Supervisors any necessary adjustments to the fee, along with written justification for the recommended adjustment and any necessary legislation. In the event that fee proceeds have exceeded, or are anticipated to exceed, the costs for street repaving and reconstruction reasonably attributable to excavation or the City's costs to administer this Article or inspect excavations, the Director shall recommend legislation to the Board of Supervisors that modifies the applicable fee to ensure that fee proceeds do not exceed the costs for street repaving and reconstruction reasonably attributable to excavation or the City's costs to administer this Article or inspect excavations. In the event that fee proceeds have undercollected, or are anticipated to undercollect, for the costs for street repaving and reconstruction reasonably attributable to excavation or the City's costs to administer this Article or inspect excavations, the Director

may recommend legislation to the Board of Supervisors that modifies the applicable fee to more accurately recover the costs for street repaving and reconstruction reasonably attributable to excavation or the City's costs to administer this Article or inspect excavations.

SEC. 2.4.46. COLLECTION, RETURN, AND REFUND OF DEPOSIT AND FEES. (a) **Collection of Deposit and Fees.** The Director shall establish procedures for billing, collection, and refund of a deposit(s), fees, and other charges provided for in this Article. The Director shall deposit all funds in accordance with Sections 10.117-119 and 10.117-120 of the San Francisco Administrative Code.

(b) **Refunds.** (i) When an application is either withdrawn by the applicant or denied by the Department before the start of construction, the applicant's administrative fee assessed under Section 2.4.41 shall be retained and those fees assessed under Sections 2.4.42, 2.4.43, and 2.4.44 shall be returned to the applicant.

(ii)In the event that the Director determines, after preparing a report pursuant to Section 2.4.45, that there has been an overcollection of any of the fees identified in this Subarticle, the Director shall establish procedures to refund excess fee proceeds in a manner which fairly and reasonably reimburses those excavators who paid the fee during the relevant period consistent with their level of excavation.

(iii) In the event that a project is completed prior to the permit expiration date, a permittee may make a written request for a refund of the inspection fee that is proportionate to the number of calendar days the project was completed early. Prior to the issuance of any refund, the Department shall verify the date of completion, that the project has been satisfactorily completed, that all punch list work has been completed, and that there are no outstanding fines or penalties pending against the permittee or its agent. The Department shall not release the requested refund until any and all outstanding fines or penalties pending against the permittee and its agent have been paid. The permittee seeking a refund shall pay the Department a fee of $110 for the cost of the calculation and processing of the refund.

(c) **Deductions for Deposits.** The Director may make deductions from the balance of a permittee's deposit(s) to ensure the faithful performance of the obligations under a permit to excavate, to pay fees, to offset the costs for any excavation done or repairs made by the Department, or to pay any assessed penalties or costs associated with violations of this Article.

(d) **Retention of Deposit for Three Years.** Each deposit made pursuant to Section 2.4.40 shall be retained by the City for a period of three years after the satisfactory completion of the excavation to secure the obligations in the permit and this Article.

(e) **Return of Deposit.** Upon expiration of three years from the satisfactory completion of the excavation, a permittee's deposit(s), less the deductions made pursuant to Subsection (c), shall be returned to the permittee or to its assigns.

SUBARTICLE V EXCAVATIONS

SEC. 2.4.50. NOTICES. Any permittee who excavates or causes to be made an excavation in the public right-of-way shall provide notice as follows:

(a) **Two to Fourteen-Day Excavations.** For excavations that will be completed and restored in a period exceeding 24 hours but within 14 calendar days of commencement, the permittee shall post and maintain notice at the site of the excavation. The notice shall include the name, telephone number, and address of the owner and its agent, a description of the excavation to be performed, and the duration of the excavation. The notice shall be posted at least every 100 feet along any block where the excavation is to take place at least 72 hours prior to commencement of the excavation.

(b) **Notice for Major Work.** (i) At least 30 calendar days prior to commencement of the excavation, the permittee shall provide written notice delivered by United States mail to each property owner on the block(s) affected by the excavation and each affected neighborhood and merchant or-

ganization that is listed in the City Planning Department's Directory of Neighborhood Organizations and Service Agencies. The latest City-wide assessor's roll for names and addresses of owners shall be used for the mailed notice. This notice shall include the same information that is required for the posted notice pursuant to Subsection (a) and the name, address, and 24-hour telephone number of a person who will be available to provide information to and receive complaints from any member of the public concerning the excavation.

(ii) The permittee shall post and maintain notice at the site of the excavation at least 10 calendar days prior to commencement of the excavation in the same manner and with the same information as required for posted notice pursuant to Subsection (a). At least 10 calendar days prior to commencement of the excavation, the permittee also shall deliver a written notice to each dwelling unit on the block(s) affected by the excavation. This written notice shall include the same information that is required for the written notice pursuant to this Subsection (i).

(iii) Before commencement of construction, a permittee for major work shall post and maintain excavation project signs at the site of the excavation that describe the excavation being done and bear the name, address, and 24-hour telephone number of a contact person for the owner and its agent. Said excavation project signs shall be in format, quantity, and size specified by the Department.

(c) **Notice of Emergency Excavation.** For emergency excavation, the permittee, or the applicant if a permit has not been issued, shall post and maintain notice at the site of the excavation during the construction period. The notice shall include the name, telephone number, and address of the owner, permittee, applicant, and its agent, a description of the excavation to be performed, and the duration of the excavation. The notice shall be posted at least every 100 feet along any block where the excavation is to take place.

SEC. 2.4.51. NOTICE FOR MARKING OF SUBSURFACE FACILITIES. In accordance with State law, any person excavating in the public right-of-way shall comply with the requirements of the Underground Service Alert ("USA") regarding notification of excavation and marking of subsurface facilities. Such person shall provide USA with the assigned number for the permit to excavate or other information as may be necessary to properly identify the proposed excavation.

SEC. 2.4.52. LIMITS UPON EXCAVATION IN THE PUBLIC RIGHT-OF-WAY. (a) **Scope.** It is unlawful for any permittee to make, to cause, or permit to be made any excavation in the public right-of-way outside the boundaries, times, and description
set forth in the permit.

(b) **Rock Wheel and Trenchless Technology.** Use of a rock wheel or trenchless technology to excavate in the public right-of-way is unlawful without prior written approval of the Director.

(c) **Single Excavation Maximum of 1,200 Feet.** No single excavation site shall be longer than 1,200 feet in length at any time except with the prior written approval of the Director.

SEC. 2.4.53. REGULATIONS CONCERNING EXCAVATION SITES. Each owner and its agent shall be subject to requirements for excavation sites that are set forth in Department orders or regulations. Such orders or regulations shall include, but not be limited to, the following measures:

(a) **Protection of the Excavation.** Each owner and its agent shall cover open excavation with steel plates ramped to the elevation of the contiguous street, pavement, or other public right-of-way, or otherwise protected in accordance with guidelines prescribed by the Department.

(b) **Housekeeping and Removal of Excavated Material.** Each owner and its agent shall keep the area surrounding the excavation clean and free of loose dirt or other debris in a manner deemed satisfactory to the Department. Excavation sites shall be cleaned at the completion of each work day. In addition, the owner and its agent shall remove all excavated material from the site of the excavation no later than the end of each work day.

(c) **Storage of Materials and Equipment.** Materials and equipment that are to be used for the

excavation within seven calendar days may be stored at the site of the excavation, except that fill material, sand, aggregate, and asphalt-coated material may be stored at the site only if it is stored in covered, locked containers.

(d) **Hazardous Material.** Each owner and its agent shall be subject to hazardous material guidelines for date collection; disposal, handling, release, and treatment of hazardous material; site remediation; and worker safety and training. The Department, in consultation with the Department of Public Health, shall develop, prescribe, and update such hazardous material guidelines. The guidelines shall require the owner and its agent to comply with all federal, state, and local laws regarding hazardous material. For purposes of this subsection, "hazardous materials" shall mean any gas, material, substance, or waste which, because of its quantity, concentration, or physical or chemical characteristics, is deemed by any federal, state, or local governmental authority to pose a present or potential hazard to human health or safety or to the environment.

SEC. 2.4.54. STOP WORK ORDER, PERMIT MODIFICATION, AND PERMIT REVOCATION. When the Director has determined that a person has violated this Article or that an excavation poses a hazardous situation or constitutes a public nuisance, public emergency, or other threat to the public health, safety, or welfare, or when the Director determines that there is a paramount public purpose, the Director is authorized to issue a stop work order, to impose new conditions upon a permit, or to suspend or revoke a permit by notifying the permittee of such action in a written, electronic, or facsimile communication.

SEC. 2.4.55. RESTORATION OF THE PUBLIC RIGHT-OF-WAY. (a) **Restoration.** In any case in which the sidewalk, street, or other public right-of-way is or is caused to be excavated, the owner and its agent shall restore or cause to be restored such excavation in the manner prescribed by the orders, regulations, and standard plans and specifications of the Department. At a minimum, trench restoration shall include resurfacing to a constant width equal to the widest part of the excavation in accordance with the following diagram; provided, however, that the width of resurfacing need not exceed 13 feet;

(b) **Backfill, Replacement of Pavement Base, and Finished Pavement.** Activities concerning backfilling, replacement of pavement base, and finished pavement shall be performed in a manner specified by the orders, regulations, and standard plans and specifications of the Department. In addition, these activities shall be subject to the following requirements:

(i) Backfill. Each excavation shall be backfilled and compacted within 72 hours from the time the construction related to the excavation is completed.

(ii) Replacement of pavement base. Replacement of the pavement base shall be completed within 72 hours from the time the excavation is backfilled.

(iii) Finished pavement. Finished pavement restoration shall be completed within 72 hours of replacement of the pavement base.

(c) **Modification to Requirements.** Upon written request from the permittee, the Director may grant written approval for modifications to the requirements of Subsection (b).

(d) **Incomplete Excavation; Completion by the Department.** In any case where an excavation is not completed or restored in the time and manner specified in the permit, this Article, or the orders, regulations, and standard plans and specifications of the Department, the Director shall order the owner or its agent to complete the excavation as directed within 24 hours. If the owner or its agent should fail, neglect, or refuse to comply with the order, the Director may complete or cause to be completed such excavation in such manner as the Director deems expedient and appropriate. The owner or its agent shall compensate the Department for any costs associated with the administration, construction, consultants, equipment, inspection, notification, remediation, repair, restoration, or any other actual costs incurred by the Department or other agencies, board, commissions, or departments of the City that were made necessary by said excavation. The cost of such work also may be deducted from the permittee's deposit pursuant to Section 2.4.46(c). The Director's determination as to

the cost of any work done or repairs made shall be final. In addition, the owner, its agent, or other responsible party may be subject to those enforcement actions set forth in Subarticle VII.

(e) Subject to the limitation set forth in Section 2.4.70, completion of an excavation or restoration by the Department in accordance with Subsection (d) shall not relieve the owner or its agent from liability for future pavement failures at the excavation site.

SUBARTICLE VI POST-EXCAVATION REPAIR, MAINTENANCE, AND PAVEMENT FAILURE

SEC. 2.4.70. REPAIR AND MAINTENANCE OBLIGATION OF OWNER AND AGENT. Each owner and its agent that excavates or causes to be made an excavation in the public right-of-way shall be responsible to maintain, repair, or reconstruct the site of the excavation so as to maintain a condition acceptable to the Director until such time as the public right-of-way is reconstructed, repaved, or resurfaced by the Department.

SEC. 2.4.71. SUBSURFACE OR PAVEMENT FAILURES. In the event that subsurface material or pavement over or immediately adjacent to any excavation should become depressed, broken, or fail in any way at any time after the excavation has been completed, the Director shall exercise his or her best judgment to determine the person(s) responsible, if any, for the failure in the subsurface or surface of the public right-of-way and shall designate such person as the responsible party. The Director shall notify said person(s) of the condition, its location, and the required remedy, and such person(s) shall repair or restore, or cause to be repaired or restored, such condition to the satisfaction of the Director within 72 hours of the notification. The Director may extend the time for the responsible party to repair or restore the affected public right-of-way.

SEC. 2.4.72. REPAIR BY THE DEPARTMENT. (a) In the event that any person(s) fails, neglects, or refuses to repair or restore any condition pursuant to the Director's notice as set forth in Section 2.4.71, the Director may repair or restore, or cause to be repaired or restored, such condition in such manner as the Director deems expedient and appropriate. The person(s) identified by the Director as the responsible party shall compensate the Department for any costs associated with the administration, construction, consultants, equipment, inspection, notification, remediation, repair, restoration, or any other actual costs incurred by the City that were made necessary by reason of the repair or restoration undertaken by the Department. The cost of such work also may be deducted from the permittee's deposit pursuant to Section 2.4.46(c). The Director's determination as to the cost of the repair or restoration performed shall be final. In addition, the responsible party may be subject to those enforcement actions set forth in Subarticle VII.

(b) Subject to the limitation set forth in 2.4.70. repair or restoration by the Department in accordance with this Section shall not relieve the person(s) from liability for future pavement failures at the site of the repair or restoration.

SEC. 2.4.73. EMERGENCY REMEDIATION BY THE DEPARTMENT. (a) If, in the judgment of the Director, the site of an excavation is considered hazardous or if it constitutes a public nuisance, public emergency, or other imminent threat to the public health, safety, or welfare that requires immediate action, the Director may order the condition remedied by a written, electronic, or facsimile communication to the person(s) responsible, if any, for remedying the condition and shall designate such person as the responsible party.

(b) If the responsible party is inaccessible or fails, neglects, or refuses to take immediate action to remedy the condition as specified in said communication, the Director may remedy the condition or cause the condition to be remedied in such manner as the Director deems expedient and appropriate. The person(s) identified by the Director as the responsible party shall compensate the Department for any reasonable costs associated with the administration, construction, consultants,

equipment, inspection, notification, remediation, repair, restoration, or any other actual costs incurred by the Department or other agencies, boards, commissions, or departments of the City that were made necessary by reason of the emergency remediation undertaken by the Department. The cost of such work also may be deducted from the permittee's deposit pursuant to Section 2.4.46(c). The Director's determination as to the cost of any remediation performed shall be final. In addition, the responsible party may be subject to those enforcement actions set forth in Subarticle VII.

(c) Subject to the limitation set forth in Section 2.4.70, remediation by the Department in accordance with this Section shall not relieve the person(s) from liability for future pavement failures at the site of the remediation.

SUBARTICLE VII VIOLATION OF ARTICLE

SEC. 2.4.80. VIOLATION OF ARTICLE. (a) The Director shall have authority to enforce this Article against violations thereof. Upon the Director's determination that a person has violated any provision of this Article, the standard plans and specifications, notices, orders, or regulations of the Department; any term, condition, or limitation of any permit; or is subject to any outstanding fees, deposits, or other charges, the Director shall serve notice on said person to abate the violation. Any person whom the Director determines to be a responsible party may be subject to any or all of the enforcement mechanisms specified in Section 2.4.81, 2.4.82, and 2.4.83.

(b) Municipal excavators are not subject to the penalties and fines specified in Sections 2.4.82 and .83; however, municipal excavators that violate Article 2.4 may be subject to administrative penalties and costs as specified in Section 2.4.81. The Director is empowered to charge municipal excavators with such penalties and costs, abate violations by municipal excavators, or both. The Director may assess such penalties, costs, and abatement charges against the deposit or budget of the municipal excavator, take other appropriate action against such excavator within the Director's authority, or both.

SEC. 2.4.81. ADMINISTRATIVE PENALTIES AND COSTS. (a) **Notice of Violation.** Except as specified in Subsections (1) through (3) below, the Director shall notify the responsible party for a violation that he or she has seventy-two (72) hours to correct or otherwise remedy the violation or be subject to the imposition of administrative penalties. The Director's notice of violation shall be a written, electronic, or facsimile communication and shall specify the manner in which the violation shall be remedied.

(1) For those violations subject to the incomplete excavation provisions of Section 2.4.55(d), the responsible party shall have twenty-four (24) hours to remedy the violation or be subject to the imposition of administrative penalties.

(2) For violations that create an imminent danger to public health, safety, or welfare or are otherwise subject to Section 2.4.73, the Director shall notify the responsible party to immediately remedy the violation or be subject to the imposition of administrative penalties.

(3) For violations that cannot be cured within seventy-two (72) hours, including, but not limited to, excavating without a permit, the Director shall notify the responsible party of the Director's imposition of administrative penalties pursuant to Subsection (e).

(b) **Amount of Administrative Penalties.** Administrative penalties assessed pursuant to Subsection (a) shall not exceed one thousand dollars ($1,000) per day, per violation commencing with the first day of the violation. Notwithstanding the penalty limitation set forth above, a person who excavates without a valid permit may be assessed a penalty not to exceed ten thousand dollars ($10,000.00) per day, per violation commencing with the first day of the violation. In assessing the amount of the administrative penalty, the Director may consider any one or more of the following: the nature and seriousness of the misconduct, the number of violations, the persistence of the misconduct, the length of time over which the misconduct occurred, the willfulness of the violator's misconduct, and the violator's assets, liabilities, and net worth.

(c) **Enforcement Costs.** In addition to the administrative penalty assessed pursuant to Subsection (a), the Director may assess enforcement costs to cover the reasonable costs incurred in enforcing the administrative penalty, including reasonable attorneys' fees. Any enforcement costs imposed and recovered shall be distributed according to the purpose for which the Director imposed them.

(d) **Accrual of Penalties and Costs.** Penalties and costs assessed under this Section shall continue to accrue against a responsible party until the violation of this Article is corrected or otherwise remedied in the judgment of the Director or the responsible party pays the assessed penalties and costs. If such penalties and costs are the subject of a request for administrative review or an appeal, then the accrual of such penalties and costs shall be stayed until the determination concerning the administrative penalties is final.

(e) **Notice Imposing Administrative Penalties.** If the responsible party fails to remedy the violation within the time specified in the notice of violation or if the violation is incurable pursuant to Section 2.4.81(a)(3), the Director shall notify in writing the responsible party of the Director's imposition of administrative penalties. This notice shall include the amount of the penalties and costs and declare that such penalties and costs are due and payable to the City Treasurer within thirty (30) calendar days. The notice also shall state that the person designated as the responsible party has the right, pursuant to Subsection(g), to request administrative review of the Director's determination as to the designation of the responsible party and the assessment of penalties.

(f) **Finality of the Director's Determination and Collection of Assessed Penalties.** If no request for administrative review is filed pursuant to Subsection (g), the Director's determination is final. Thereafter, if the penalties and costs are not paid within the time specified in Subsection (e), the Director is empowered to pursue any method of collection of such penalties and costs authorized by local law including, but not limited to deductions of the permittee's deposit pursuant to Section 2.4.46(c).

(g) **Administrative Review.** Any Person that is designated as the responsible party for a violation or is subject to an administrative penalty may seek administrative review of the designation or the assessment of the penalty or cost within ten (10) calendar days of the date of the notice imposing administrative penalties. Administrative review shall be initiated by filing with the Director a request for review that specifies in detail the basis for contesting the designation of the responsible party or the assessment of the penalty or cost.

(h) **Notice for and Scheduling of Administrative Hearing.** Whenever an administrative review hearing is requested pursuant to Subsection (g), the Director, within ten (10) calendar days of the date of receipt of the request, shall notify the affected parties of the date, time, and place of the hearing by certified mail. Such hearing shall be held no later than thirty (30) calendar days after the Director received the request for administrative review, unless extended by mutual agreement of the affected parties. The Director shall appoint a hearing officer for such hearing.

(i) **Submittals for the Administrative Review Hearing.** The parties to the hearing shall submit written information to the hearing officer including, but not limited to, the following: the statement of issues to be determined by the hearing officer and a statement of the evidence to be offered at the hearing.

(j) **Conduct of the Administrative Review Hearing.** The administrative review hearing is a public hearing and shall be tape recorded. Any party to the hearing may at his or her own expense, cause the hearing to be recorded by a certified court reporter. During the hearing, evidence and testimony may be presented to the hearing officer. Written decisions and findings shall be rendered by the hearing officer within ten (10) calendar days of the hearing. Copies of the findings and decision shall be served upon the parties to the hearing by certified mail. A notice that a copy of the findings and decisions is available for inspection between the hours of 9:00 a.m. and 5:00 p.m., Monday through Friday shall be posted at the offices of the Department of Public Works.

(k) **Director's Decision on the Hearing Officer's Recommendation.** The decision of the hearing officer shall be a recommendation to the Director, and the Director, within five (5) calendar days of receipt of such recommendation, shall adopt, modify, or deny such recommendation. The Direc-

tor's decision on the hearing officer's recommendation is final. Such decision shall be served upon the parties to the hearing and posted in the same manner as the hearing officer's decision as set forth in Subsection (j). If any imposed administrative penalties and costs have not been deposited at this time, the Director may proceed to collect the penalties and costs pursuant to Subsection (f).

(l) **Additional procedures.** The Director, by Departmental order, may adopt additional procedures to implement this Section.

SEC. 2.4.82. CIVIL PENALTIES AND FEES. (a) The Director may call upon the City Attorney to maintain an action for injunction to restrain or summary abatement to cause the correction or abatement of the violation of this Article, and for assessment and recovery of a civil penalty and reasonable attorney's fees for such violation.

(b) Any person who violates this Article may be liable for a civil penalty, not to exceed $500 for each day such violation is committed or permitted to continue, which penalty shall be assessed and recovered in a civil action brought in the name of the people of the City by the City Attorney in any court of competent jurisdiction. In assessing the amount of the civil penalty, the court may consider any one or more of the relevant circumstances presented by any of the parties to the case, including, but not limited to, the following: the nature and seriousness of the misconduct, the number of violations, the persistence of the misconduct, the length of time over which the misconduct occurred, the willfulness of the defendant's misconduct, and the defendant's assets, liabilities, and net worth. The City Attorney also may seek recovery of the attorneys fees and costs incurred in bringing a civil action pursuant to this Section.

SEC. 2.4.83. CRIMINAL FINES. (a) The Director is authorized to enforce the criminal provisions of this Article, to call upon the Chief of Police and authorized agents to assist in the enforcement of this Article, or both.

(b) Any person who violates this Article shall be deemed guilty of an infraction. Every violation determined to be an infraction is punishable by (1) a fine not exceeding $100 for the first violation within one year; (2) a fine not exceeding $200 for a second violation within one year from the date of the first violation; (3) a fine not exceeding $500 for the third and each additional violation within one year from the date of the first violation.

(c) When a government official authorized to enforce this Article pursuant to Subsection (a) has reasonable cause to believe that any person has committed an infraction in the official's presence that is a violation of this Article, the official may issue a citation to that person pursuant to California Penal Code, Part II, Title 3, Chapters 5, 5C, and 5D.

(d) Among other violations, citations may be issued for the following specific violations:

(i) Excavation without a valid permit;

(ii) Excavation without proof of the permit issuance on site;

(iii) Excavation without proper notice to the Underground Service Alert;

(iv) Excavation without proper public notice;

(v) Excavation that violates the San Francisco Traffic Code;

(vi) Excavation that violates the regulations concerning excavation sites (Section 2.4.53), which include, but are not limited to, protection of the excavation, housekeeping and removal of excavated material, and hazardous material;

(vii) Excavation that does not meet the requirements for restoration concerning backfill, replacement of pavement base, and finished pavement (Section 2.4.55(b)); or

(viii) Excavation that exceeds the scope of the permit, including, but not limited to, obstructing the path of automobile or pedestrian travel in excess of the permitted area.

SEC. 2.4.84. DEPOSIT OF PENALTIES INTO EXCAVATION FUND. Any penalty assessed and recovered in an action brought pursuant to Sections 2.4.81 or 2.4.82 shall be deposited in the Excavation Fund, as provided in Section 10.117-120 of the San Francisco Administrative Code.

SEC. 2.4.85. SUSPENSION OF ACTION ON APPLICATIONS. A person who is in willful noncompliance with this Article shall not apply for nor be issued a permit to excavate in the public right-of-way unless the Director, by written authorization, grants a waiver to this prohibition. Willful noncompliance shall include, without limitation, deliberate acts that result in failure to: (a) satisfy any terms and conditions of this Article, the orders, regulations, or standard plans and specifications of the Department or (b) pay any outstanding assessments, fees, penalties that have been finally determined by the City or a court of competent jurisdiction.

SUBARTICLE VIII MISCELLANEOUS PROVISIONS

SEC. 2.4.90. ABANDONMENT OF UNDERGROUND FACILITIES, REPORTS, AND MAPS. (a) Whenever any facility(ies) is abandoned in the public right-of-way, the person owning, using, controlling or having an interest therein, shall, within 30 calendar days after such abandonment, file in the office of the Director a statement in writing, giving in detail the location of the facility(ies) so abandoned. Each map, set of maps, or plans filed pursuant to the provisions of this Article, including those maps or plans required by Section 2.4.11 shall show in detail the location of each such facility(ies) abandoned subsequent to the filing of the last preceding map, set of maps, or plans.

(b) It shall be unlawful for any person to fail, refuse, or neglect to file any map or set of maps at the time, and in all respects as required by this Section.

SEC. 2.4.91. IDENTIFICATION OF VISIBLE FACILITIES. Each visible facility installed in the public right-of-way shall be clearly identified with the name of the owner of the facility. The Department shall adopt orders or regulations to specify other appropriate methods for identification.

SEC. 2.4.92. CITY'S OBLIGATION. In undertaking enforcement of this Article, the City is assuming an undertaking only to promote the general welfare. It is not assuming, nor is it imposing on its officers and employees, an obligation for breach of which it is liable in money damages to any person who claims that such breach proximity caused injury.

SEC. 2.4.93. TIME LIMITATION ON COMMENCEMENT OF ACTIONS. Any action or proceeding to attack, review, set aside, void or annul this Article or any provision thereof shall be commenced within 120 calendar days from the effective date of the ordinance approving this Article; otherwise, the provisions of this Article shall be held to be valid and in every respect legal and incontestable.

SEC. 2.4.94. SEVERABILITY. If any part of this Article, or the application thereof to any person or circumstance, is held invalid, the remainder of this Article, including the application of such part or provision to other persons or circumstances, shall not be affected thereby and shall continue in full force and effect. To this end, provisions of this Article are severable.

City of Mesquite, Texas, Rights-of-Way Rules and Regulations

AN ORDINANCE OF THE CITY OF MESQUITE, TEXAS, AMENDING CHAPTER 15 OF THE CODE OF THE CITY OF MEWQUITE BY ADDING ARTICLE III ENTITLED RIGHTS-OF-WAY RULES AND REGULATIONS THEREBY ESTABLISHING RULES AND REGULATIONS GOVERNING THE USE AND OCCUPANCY OF THE CITY'S RIGHTS-OF-WAY BY PROVIDERS OF UTILITY, TELECOMMUNICATIONS AND CABLE SERVICES; PROVIDING FOR INSURANCE; REQUIRING ALTERATION TO CONFORM WITH PUBLIC IMJPROVEMENTS; PROVIDING A SEVERABILITY CLAUSE; PROVIDING A REPEALER CLAUSE; PROVIDING FOR A PENALTY NOT TO EXCEED FIVE HUNDRED ($500.00) DOLLARS FOR EACH OFFENSE; AND DECLARING AN EMERGENCY.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF MESQUITE, TEXAS:

SECTION 1. That Chapter 15 of the Code of the City of Mesquite is hereby amended by adding Article III to read as follows, in all other respects said Code and Chapter to remain in full force and effect.

STREETS AND SIDEWALKS
ARTICLE III. RIGHTS-OF-WAY RULES AND REGULATIONS

Sec. 15-191. Definitions.

Whenever used in this article, the following terms shall have the following definitions and meanings, unless the context of the sentence in which they are used clearly indicates otherwise. When not inconsistent with the context, words used in the present tense include the future tense, words in the plural number include the singular number and words in the single number include the plural number. The word "shall" is always mandatory and not merely directory.

Applicant means the owner of facilities to be constructed in the rights-of-way who makes application for a construction permit hereunder.

City means the City of Mesquite, Texas.

Department means the Public Services Department of the City of Mesquite.

Director means the Director of the Public Services Department of the City of Mesquite, or his/her designee.

Emergency means a reasonably unforeseen situation presenting an imminent hazard to personal or public health, safety or property, and the work necessary to address a service interruption. Upgrading of facilities, new service installation and neighborhood improvement projects are not emergencies under this article.

Facilities means personal property, owned by a provider of utility, telecommunications or cable television services including but not limited to pipe, conduit, ducts, cables, wires, lines, towers, wave guides, optic fiber, microwave, any associated converters and all equipment located in the rights-of-way.

Permitee means a person to whom a construction permit has been granted hereunder.

Person means natural persons (individuals), corporations, companies, associations, partnerships, firms, limited liability companies, joint ventures, joint stock companies or associations, and other such entities, and includes their lessors, trustees and receivers.

Public nuisance means a condition dangerous to the health, safety or welfare of the general public.

Registered user means a person who has complied with the registration provisions of this article.

Rights-Of-Way means all present and future public streets, avenues, highways, alleys, sidewalks, boulevards, drives, tunnels, easements, bridges and other such similar passageways, thoroughfares and public ways under the jurisdiction and control of the city.

Use and Occupancy means the acquisition, installation, construction, reconstruction, maintenance or repair of any facilities within the rights-of-way for any purpose whatsoever.

Sec. 15-192. General provisions.

(a) No person shall use or occupy rights-of-way within the city for the purpose of providing utility, telecommunications or cable television services except in compliance with the provisions of this article. All construction activities in, on and under the rights-of-way shall be undertaken in compliance with the provisions of this article.

(b) The provisions of this article shall apply to the use and/or occupancy of the rights-of-way by a person under the authority granted by a franchise agreement or ordinance as if fully set forth in the franchise agreement or ordinance. The express terms of this article will prevail over conflicting or inconsistent provisions in a franchise agreement or ordinance unless such franchise agreement or ordinance expresses an explicit intent to waive a requirement of this article.

(c) The provisions of this article shall be liberally construed in favor of the city in order to effectuate the purposes and objectives of this article and to promote the public interest.

Sec. 15-193. Registration of users and occupants of rights-of-way.

(a) Registration required. All users and occupants of the rights-of-way shall register with the city pursuant to this section. For existing users and occupants, such registration shall be accomplished within thirty (30) days following the date of final adoption of this article. For persons using and occupying the rights-of-way under a franchise, permit or license that is valid on the effective date of this article, such existing valid franchise, permit or license shall be considered such person's initial registration hereunder. Persons seeking to use or occupy the rights-of-way after adoption of this article shall register with the city
prior to initiating any such use or occupancy. All registrations must be renewed annually on or before January 31 of each calendar year using forms developed by and available from the city. For persons with a current franchise from the city, the franchise will be evidence of renewal. If a registration is not renewed, the facilities will be deemed to have been abandoned ninety (90) days after the date of written notice was sent to the facility owner by the city. Persons that are not certificated telecom-

munications providers providing access lines, as defined in Chapter 283, Texas Local Government Code, are also required to obtain a franchise or license from the city in accordance with City Charter or ordinance in addition to registering under the provisions of this article prior to entering into the rights-of-way.

(b) Purpose of registration. The purpose of registration under this section is to:

(1) Provide the city with accurate and current information concerning the users and occupants of the rights-of-way;

(2) Assist the city in enforcement of this article; and

(3) Assist the city in monitoring compliance with applicable laws.

(c) Contents of registration. The registration shall include:

(1) The name of the user and occupant of the rights-of-way;

(2) The name, address and telephone number of people who will be contact person(s) for the user and occupant;

(3) Proof of insurance as required in section 15-198 hereof; and

(4) description of the type of facilities in the rights-of-way, for example, electric conduit, fiber-optic cables, wire cables, coaxial cables and the like. This description shall include a statement of whether the user and occupant is a certificated telecommunications provider as defined in V.T.C.A. Local Government Code, § 283.002(2), and if so, whether the user and occupant is providing access lines as defined in V.T.C.A. Local Government Code, § 283.002(1).

Sec. 15-194. Use and occupancy--Regulation by city.

(a) Temporary rearrangement or removal of aerial facilities. Upon written request a registered user shall remove, raise or lower its aerial wires, fiber or cables temporarily to permit the moving of houses or other bulky structures. The expense of such temporary rearrangements shall be paid by the person requesting them, and the registered user may require payment in advance. The registered user shall make such temporary arrangement or removal as soon as practicable, but in all events such rearrangement or removal shall be accomplished within forty-five (45) calendar days after notification by moving permit holder.

(b) Right to trim trees. The registered user, its contractors and agents have the right, permission and license to trim trees upon and overhanging the rights-of-way to prevent trees from coming in contact with the registered user's facilities. All trimming shall be done in consideration of the health of the trees and shall be limited to the minimum amount necessary to eliminate the interference with the facilities. When directed by the city, tree trimming shall be done under the supervision and direction of the parks department of the city or under the supervision of the city's delegated representative. Under normal circumstances registered users shall notify adjacent residents and occupants at least forty-eight (48) hours in advance of any trimming. Any tree trimmings generated by the registered user, its contractors or agents shall be removed within twenty-four (24) hours. Should the registered user, its contractors or agents fail to timely remove such trimmings, the city may remove same or have them removed and shall bill registered user for all costs incurred, which costs shall be promptly paid by the registered user. Nothing herein shall be construed to grant a registered user the right of access to private property.

(c) City work. The city shall have the right at all times to lay, and to permit to be laid, sewer, gas, water and other pipelines or cable and conduits, as well as drainage pipes and channels and streets and to do and permit to be done any underground and overhead installation or improvement that may be deemed necessary or proper by the governing body of the city in, across, along, over or under any rights-of-way occupied by a registered user, and to change any curb or sidewalk or the grade of any street and to maintain all of the city's facilities.

(d) Removal of facilities. Whenever it shall be necessary to require a registered user to relocate its facilities to permit the widening or straightening of a street or construction of any water, sewer or

stormwater facilities by the city associated with widening or straightening of a street, the city shall give the registered user ninety (90) calendar days notice of such requirement. Such relocation shall be made by the registered user promptly with consideration given to the magnitude of such alterations or changes without claim for reimbursement or damages against the city. If any such requirements impose a financial hardship upon the registered user, the registered user shall have the right to promptly present alternative proposals to the city, and the city shall give due consideration to any such alternative proposals. If the city determines that the preservation and protection of the public health and safety require removal of facilities from the rights-of-way that are being abandoned, the city shall require registered user to remove its facilities entirely from the abandoned rights-of-way at no cost to the city.

(e) Public safety. The city retains the right to move any facilities within the rights-of-way to cure or otherwise address a public health or safety emergency. The city shall cooperate to the extent possible with the registered user in such instances to assure continuity of service and to afford to the registered user the opportunity to make such relocation itself.

(f) Abandonment of facilities. Whenever a registered user intends to abandon any of its facilities within the rights-of-way, it shall submit to the director written notification of such intent, describing the facility to be abandoned and the date of the proposed abandonment. Such notification shall include a statement of waiver of claims against the city for subsequent damages to abandoned facilities. City may require the registered user, at the registered user's expense:

(1) To remove the facility from the rights-of-way; or
(2) To modify the facility in order to protect the public health and safety or otherwise serve the public interest.

A registered user shall remove all abandoned above-ground facilities and equipment upon receipt of written notice from the city and shall restore any affected rights-of-way to their former state at the time such facilities and equipment were installed so as not to impair their usefulness. In removing its plant, structures and equipment a registered user shall refill, at its own expense, any excavation necessarily made by it and shall leave all rights-of-way in as good condition as that prevailing prior to such removal without materially interfering with any electrical or telephone cable or other utility wires, poles or attachments. The city shall have the right to inspect and approve the condition of the rights-of-way, cables, wires, attachments and poles prior to and after removal. The liability, indemnity and insurance provisions of this article shall continue in full force and effect during the period of removal and until full compliance by a registered user with the terms and conditions of this section. Notwithstanding anything to the contrary set forth in this article, a registered user may abandon any underground facilities in place so long as it does not materially interfere with the use of the rights-of-way or with the use thereof by any public utility, cable operator or other registered users.

(g) Public nuisance abatement. The city may require the removal or abatement of any facility determined by the city to cause a public nuisance. The city shall give registered user written notice of the required removal or abatement. No later than thirty (30) calendar days after the registered user receives such written notice, the registered user shall remove such facility or abate the public nuisance to the satisfaction of the city. If the registered user notifies the director in writing within such thirty (30) day period requesting additional time for such removal or abatement, or that the registered user is unable to remove or abate such facility for specified reasons, the director may, but is not required to, grant additional time to the registered user or negotiate alternate arrangements with the registered user. If the registered user does not so notify the city and fails or refuses to act, the city may remove or abate the facility, at the sole cost and expense of the registered user, all without compensation or liability for damages to the registered user.

Sec. 15-195. Construction permits.

(a) Permit required. No person shall perform any construction, repairs, maintenance or installation of facilities in the rights-of-way without obtaining a construction permit from the city hereunder. The permit will be in the name of the person who will own the facilities to be constructed. The permit application must be completed and signed by a representative of the owner of the facilities to be constructed. During the term of the permit the permittee shall be liable for the acts or omissions of any entity used by the permittee when such entity is involved directly or indirectly in the construction and installation of the permittee's facilities to the same extent as if the acts or omissions of such entity were the acts or omissions of the permittee. The provisions of this section are solely for the benefit of the city and the registered user and are not intended to create, grant or affect any rights, contractual or otherwise, to or of any other person.

(b) Emergency exception. Emergency responses related to existing facilities may be undertaken without first obtaining a permit; however, the department shall be notified within two (2) business days of any construction related to an emergency response including the provision of a reasonably detailed description of the work performed in the rights-of-way. An updated map of any facilities that were relocated, if applicable, shall be provided within ninety (90) calendar days.

(c) Other exceptions. The phrase "construction or installation of facilities" does not include the repair or maintenance of existing facilities or the installation of facilities necessary to initiate services to a customer's property unless such repair, maintenance or installation requires the breaking of pavement, or boring, or the closure of a non-residential traffic lane. If the closure of a non-residential traffic lane does not require breaking of pavement, excavation or boring, then such closure is not included in the phrase "construction or installation of facilities" if such closure is for no longer than six (6) consecutive hours.

(d) Application required.

(1) A written application shall be filed with the city for a permit pursuant to this article. An applicant shall assert in its application that it is in compliance with all requirements of this article and with all applicable laws.

(2) To be acceptable for filing, a signed original of the application shall be submitted to the appropriate city official and contain all required information. The permit fee shall be submitted with the application. All applications shall include the names and addresses of persons authorized to act on behalf of the applicant with respect to the application.

(3) All applications accepted for filing shall be made available by the city for public inspection. However, if plans of record submitted in an application include information expressly designated by the applicant as a trade secret or other confidential information protected from disclosure by state law, the director may not disclose that information to the public without the consent of the applicant, unless otherwise compelled by an opinion of the attorney general pursuant to the Texas Open Records Act, as amended, or by a court having jurisdiction of the matter pursuant to applicable law. This subsection may not be construed to authorize an applicant to designate all matters in its application as confidential or as trade secrets. If the city receives a request pursuant to the Texas Open Records Act for information designated as a trade secret or confidential information by the applicant, the city will promptly notify the applicant of such request. If deemed appropriate and necessary by the city, the city will request an opinion from the state attorney general as to whether the requested information may be withheld. The applicant shall be responsible for supporting its claim of confidentiality.

(e) Information in application. An application for a construction permit shall contain the following information:

(1) The proposed, approximate location and route of all facilities to be constructed or installed and the applicant's plan for rights-of-way construction.

(2) Engineering plans on a scale of not to exceed one (1) inch equals one hundred (100) feet unless otherwise approved by the department. In all events plans shall be legible when

reduced to one-half (1/2) scale of original sheet size on sheets measuring eleven (11) inches by seventeen (17) inches.

(3) Detail of the location of all rights-of-way and utility easements that applicant plans to use.

(4) Detail of all existing city utilities in relationship to applicant's proposed route.

(5) Detail of what applicant proposes to install such as pipe size, number of interducts, valves and similar information.

(6) Detail of plans to remove and replace asphalt or concrete in streets (include standard construction details).

(7) Drawings of any bores, trenches, handholes, manholes, switch gears, transformers, pedestals, etc., including depth.

(8) Handhole and/or manhole typicals of type of manholes and/or handholes applicant plans to use or access.

(9) A description of trench safety measures to be utilized in all excavations over five (5) feet in depth.

(10) Complete legend of drawings submitted by applicant which may be provided by reference to previously submitted documents provided such documents are current and up-to-date.

(11) Three (3) sets of engineering plans must be submitted with permit application.

(12) If known, the name, address and phone numbers of the contractor or subcontractor who will perform the actual construction including the name and telephone number of an individual with the contractor who will be available at all times during the construction.

(13) A description of the construction and installation methods to be employed for the protection of existing structures, fixtures and facilities within or adjacent to the rights-of-way and the estimated dates and times work will occur, all of which (methods, dates, times, etc.) are subject to the approval of the director.

(14) A statement that the insurance and bonding requirements contained herein are met.

(f) Permit fee. To be acceptable for filing, an application shall be accompanied by a permit fee in the following amount as appropriate:

(1) For certificated telecommunications providers providing access lines (as defined in V.T.C.A., Local Government Code, Ch. 283):	no fee
(2) For persons occupying the rights-of-way of the city under a franchise ordinance or agreement:	no fee
(3) For all other applicants:	no fee

(g) Processing of application. Within five (5) working days after receipt of a complete application and permit fee, if applicable, the city shall issue a construction permit.

(h) Applicant in noncompliance. The city may refuse to issue a permit to applicant if city determines that the applicant is presently in a state of noncompliance with this article or if applicant has failed to adequately respond to any notice or request for action from the city under this article. The city may continue to refuse to issue a permit until applicant has corrected its noncompliance or has otherwise adequately responded to such notice or request for action from the city.

Sec. 15-196. Construction work--Regulation by city.

(a) Existing facilities. Before initiating construction on rights-of-way a permittee will make all reasonable efforts to attach its facilities to existing poles and to share existing conduit space as appropriate. Nothing contained in this article shall be construed to require or permit the attachment on or placement in a permittee's facilities of any electric light or power wires, or facilities or other systems not owned by the permittee. If the city desires to attach or place electric light or power wires, communications facilities or other similar systems or facilities in or on the permittee's facilities, then

a further separate, noncontingent agreement with the permittee shall be required. Nothing contained in this article shall obligate the permittee to exercise, or restrict the permittee from exercising, its right to enter voluntarily into pole attachment, pole usage, joint ownership or other wire space or facilities agreements with any person authorized to operate in the rights-of-way of the city.

(b) Traffic disruptions. The permittee shall endeavor to minimize disruptions to the efficient use of the rights-of-way by pedestrian and vehicular traffic, and rights-of-way shall not be blocked for a longer period than shall be reasonably necessary to execute all construction, maintenance and/or repair work. All lane closures must comply with the Texas Manual on Uniform Traffic Control Devices.

(c) Pole placement. All poles placed shall be of sound material and reasonably straight, and shall be set so that they will not interfere with the flow of water in any gutter or drain, and so that they will not unduly interfere with ordinary travel on the streets or sidewalk. The location and route of all poles, stubs, guys, anchors, conduits, fiber and cables placed and constructed by the permittee in the construction and maintenance of its facilities in the city shall be subject to the lawful, reasonable and proper control, direction and/or approval of the city.

(d) Work in accordance with permit. All construction and installation in the rights-of-way shall be in accordance with the permit for the facilities. The director shall be provided access to the work and to such further information as he/she may reasonably require to ensure compliance with the permit. A copy of the
construction permit and approved engineering plans shall be maintained at the construction site and made available for inspection by the city at all times when construction or installation work is occurring.

(e) Time for completion. All construction or installation work authorized by permit must be completed in the time specified in the construction permit. If the work cannot be completed in the specified time periods, the permittee may request in writing an extension from the director. So long as the written extension request is made before the permit has expired, work may continue pending a decision by the director on the extension request.

(f) Prior notification. The department must be notified twenty-four (24) hours in advance that construction is ready to proceed by either the permittee, its contractor or other representative. If not previously provided, such notice shall include information required in section 15-195(e)(12). All construction shall be in conformance with all city codes and applicable local, state and federal laws.

(g) Signage. Legible information signs stating the identity of the person doing the work, telephone number and permittee's identity and telephone number shall be placed at the location where construction is to occur at least twenty-four (24) hours prior to the beginning of work in the rights-of-way and shall continue to be posted at the location during the entire time the work is occurring. An information sign will be posted at both ends of the construction area unless other posting arrangements are approved or required by the director.

(h) Erosion and storm water controls. Erosion control measures (e.g., silt fence) and advance warning signs, markers, cones and barricades must be in place before work begins. Permittee shall be responsible for storm water management erosion control that complies with city, state and federal guidelines. Upon request permittee may be required to furnish documentation submitted or received from federal or state governments.

(i) Lane closures. Except in the event of an emergency lane closures on major thoroughfares will be limited to after 8:30 a.m. and before 4:00 p.m. unless the department grants prior approval. Arrow boards will be required on lane closures with all barricades, advanced warning signs and thirty-six (36) inch reflector cones placed according to the specifications of the department. All barricading must comply with the Texas Manual on Uniform Traffic Control Devices.

(j) Responsibility of permittee. Permittees are responsible for the workmanship and any damages by contractors or subcontractors. A responsible representative of the permittee shall be available to the department at all times during construction. The provisions of this section are solely for the

benefit of the city and the registered user and are not intended to create, grant or affect any rights, contractual or otherwise, to or of any other person.

(k) Damage to utilities. Permittee, contractor or subcontractor shall notify the department immediately of any damage to other utilities either city or privately owned.

(l) Cuts. Except in the event of an emergency when a street or sidewalk cut is required, prior approval must be obtained from the department and all requirements of the department shall be followed. Repair of all street and sidewalk removals shall be made promptly to avoid safety hazards to vehicle and
pedestrian traffic.

(m) City utilities. Installation of facilities must not interfere with city utilities in particular gravity dependent facilities.

(n) Installed depth. New non-municipal facilities must be installed to a depth approved by the department.

(o) Boring. All directional boring shall have a locator place bore marks and depths while bore is in progress. The locator shall place a mark at each stem with a paint dot and shall mark the depth of at least every other stem.

(p) Working hours. Except in emergencies the working hours in the rights-of-way are the time period between one (1) hour after sunrise and until sunset Monday through Friday. Non-emergency work that needs to be performed outside these hours must be approved in advance. Any non-emergency work performed on Saturday must be approved forty-eight (48) hours in advance by the department. Directional boring is permitted only Monday through Friday from 7:00 a.m. to 6:00 p.m. unless approved in advance. No work will be done except for emergencies on Sundays or city holidays.

(q) Line locations. Permittees working in the rights-of-way are responsible for obtaining line locates from all affected utilities or others with facilities in the rights-of-way prior to any excavation. Use of geographic information system or the plan of record does not satisfy this requirement. Permittee shall be responsible for verifying the location, both horizontal and vertical, of all affected facilities prior to any excavation or boring with the exception of work involving lane closures as set forth above. Permittee shall provide location data of its facilities to all other utilities when requested to do so by other utilities preparing to work in the area of such facilities. Requested for location of city-owned utilities shall be made no later than forty-eight (48) hours in advance of construction. The permittee shall properly mark the proposed location of its facilities in order that city locators can appropriately mark city-owned utilities.

(r) Manholes. Placement of all manholes and/or handholes must be approved in advance by the department. Handholes or manholes will not be located in sidewalks unless approved by the director.

(s) Pumping. Construction that requires pumping of water or mud shall be contained in accordance with city ordinances, federal and state law, and the directives of the department.

(t) Restoration.

(1) Restoration of rights-of-way shall be to the reasonable satisfaction of the department. Restoration shall be made in a timely manner as specified by approved department schedules and to the satisfaction of the director.

(2) If restoration is not satisfactory or is not performed in a timely manner, all work in progress, except that related to the problem, including all work previously permitted but not complete may be halted and a hold may be placed on any permits not approved until all restoration as required herein is complete. If restoration work is not completed in a timely manner, the registered user is subject to the criminal penalties described in section 15-202, and the additional following procedures shall be followed:

a. The city shall provide the permittee with reasonable notice of failure to act and request restoration.

b. If the permittee continues to delay the director and the permittee will jointly review the restoration request in an expeditious manner to establish a mutually acceptable completion date for the restoration.
c. If the permittee continues to delay or does not meet the revised completion date, the director shall provide not less than five (5) calendar days' written notice to the permittee advising of the city's intent to perform the restoration.
d. If after expiration of the written notice required by the preceding sentence the permittee continues to delay, the city shall have the right to perform the restoration. The city shall not be liable to the permittee for any damage to any of its facilities and shall not be liable in any event for any consequential damages relating to service interruptions. If the restoration performed by the city involves the construction or improvement of base or pavement of rights-of-way, permittee shall not thereafter disturb such rights-of-way for a period of three (3) years after completion of such improvements except when necessary in the event of an emergency.

(3) Permittee shall warrant all pavement repairs for a period of two (2) years after restoration has been complete. The restoration shall include but not be limited to:
a. Replacing all ground cover with the type of ground cover damaged during work, or better, by sodding as directed by the department;
b. Installation of all manholes and handholes as appropriate;
c. All bore pits, potholes, trenches or any other holes shall be filled in or covered daily unless other safety procedures are approved by the department;
d. Leveling of all trenches and backhoe lines (all trench backfill must comply with density requirements per the city standards and the city must be provided with a copy of all density reports); and
e. Restoration of all landscaping, ground cover and sprinkler systems to the original condition.

Sec. 15-197. Indemnification.

(a) General provisions.

(1) Registered users who are not certificated telecommunications providers as defined in V.T.C.A., Local Government Code, Ch. 283 shall indemnify and hold the city, its officers and employees harmless from all claims, lawsuits, judgments, costs, liens, losses, expenses, fees (including reasonable attorneys' fees and costs of defense), proceedings, actions, demands, causes of action, liability and suits of any kind and nature, including but not limited to personal or bodily injury (including death), property damage or other harm for which recovery of damages is sought that may arise out of or caused by the registered user's negligent act, error or omission of the registered user, any agent, officer, director, representative, employee or subcontractor of the registered user, and their respective officers, agents, employees, directors and representatives while in the exercise of or performance of the rights or duties under this article. The indemnity provided for in this paragraph shall not apply to any liability resulting from the negligence of the city, its officers or employees in instances where such negligence causes personal or bodily injury, death or property damage. In the event the registered user and the city are found jointly liable by a court of competent jurisdiction, liability shall be apportioned comparatively in accordance with the laws of the state, without, however, waiving any governmental immunity available to the city under state law and without waiving any defenses of the parties under state law. The provisions of this paragraph are solely for the benefit of the parties hereto and not intended to create or grant any rights, contractual or otherwise, to any other person or entity.

(2) Registered users who are certificated telecommunications providers as defined in V.T.C.A., Local Government Code, Ch. 283, as amended, shall indemnify the city as provided in V.T.C.A., Local Government Code, § 283.057, as amended.

(b) Notice. The city shall give the registered user written notice of any claim for which the city seeks indemnification. The registered user shall have the right to investigate, defend and compromise any such claim. The registered user shall promptly advise the city in writing of any claim or demand against the city or the registered user known to the registered user related to or arising out of the registered user's activities under this article.

(c) In the event the director determines, based upon reasonable grounds, that a bond is necessary to protect the public assets, or the health and safety of the public, then the director may require a registered user to post financial security in an amount not to exceed one hundred thousand dollars ($100,000.00). The director shall consult with the city's finance director prior to imposing the financial security requirement on a registered user. Factors to be considered in determining reasonable grounds may include, but are not limited to, a conviction for violation of this article, a general pattern of substandard adherence to the provisions of this article, a failure to provide prompt resolution of claims, or the failure to comply with this article. If three (3) years pass from the date that the director requires financial security from a registered user and it has not been necessary for the city to seek performance under the financial security, then financial security will no longer be required pursuant to this section, unless the director makes an additional determination that such security is required. The form of financial security shall be, at the registered user's option, one (1) of the following:

(1) A surety bond from a surety company authorized to do business in the state with a registered agent for service in the county. All bonds shall be on city approved forms;
(2) An unconditional and irrevocable letter of credit issued to the city by a bank with a location in the county; or
(3) A cash deposit.

(d) Security provided by a cash deposit shall be made to an interest bearing accounting during the term of the deposit. At the end of the deposit period, all unused amounts, plus interest, shall be refunded to the registered user.

(e) Failure of the registered user to comply with its obligations under this article or the permit as determined by the city shall entitle the city to draw against the financial security required by this section. The rights reserved to the city with respect to the financial security are in addition to all other rights of the city whether reserved by this article or authorized by law, and no action, proceeding or exercise of a right with respect to such financial security shall affect any other rights the city may have.

(f) Financial security provided by a surety bond shall not expire or be materially altered without forty-five (45) calendar days' written notice and without securing and delivering to the city a substitute, renewal and replacement bond in accordance with this article, consistent with the replacement and continuous coverage requirements for insurance found in section 15-198 hereof. In the event the city draws monies against the bond, city shall so notify registered user. Within ten (10) calendar days after such notification the registered user shall pay such funds to the bonding company as necessary to bring the bond back to the original or adjusted principal amount where it shall continue to be maintained at all times. The bond shall contain the following endorsement:

> "It is hereby understood and agreed that this bond may not be reduced, altered or canceled by the registered user or the bonding company without forty-five (45) calendar days written notice by certified mail to the city."

(g) In the event the city draws monies against financial security provided by a letter of credit, the city shall so notify registered user. Within ten (10) calendar days after such notification the registered user shall deposit funds in the bank under the letter of credit sufficient to bring the balance

available under the letter of credit back to the original or adjusted principal amount where it shall continue to be maintained at all times.

(h) If the city draws monies out of a cash deposit, the city shall so notify registered user. Within ten (10) calendar days after such notification the registered user shall deposit additional funds in such account sufficient to bring the balance available back to the original or adjusted principal amount.

Sec. 15-198. Insurance requirements.

(a) Certificate of insurance. In order to comply with the registration requirements of this article and prior to the issuance of a construction permit, the applicant shall furnish a completed certificate of insurance to the department which shall be completed by an agent authorized to bind the named underwriter(s) and their company to the coverage, limits and termination provisions shown thereon, and which shall furnish and contain all required information referenced or indicated thereon. Neither the registration nor the construction permit shall be issued until such certificate shall have been delivered to the department, and no officer or employee shall have the authority to waive this requirement.

(b) Coverage amounts. A registered user and a permittee shall obtain and maintain in full force and effect for the duration of the use and occupancy of the rights-of-way or of the work to be performed under the permit, respectively, at the registered user's or permittee's sole expense, insurance coverage written on an occurrence basis by companies authorized and admitted to do business in the state and rated A or better by A. M. Best Company and/or otherwise acceptable to the city in the following types and amounts as evidenced by a certificate of insurance filed with the city:

Type	**Amount**
(1) Workers' Compensation/ Employers' Liability	Statutory: $100,000.00 per occurrence
(2) Commercial (Public) Liability, Including But Not Limited To:	Bodily Injury: $1,000,000.00 per person $2,000,000.00 per occurrence and
a. Premises/Operations b. Independent Contractors c. Personal Injury d. Products/Completed Operations e. Contractual Liability (Insuring Below Indemnity Provisions)	Property damage: $1,000,000.00 per occurrence with General Aggregate of $2,000,000.00
(3) Automobile Policy:	Combined Single Limit: $1,000,000.00

(c) Required provisions. All insurance contracts and certificates of insurance will contain the following required provisions:

(1) A cancellation provision in which the insurance company is unconditionally required to notify the city in writing not fewer than thirty (30) days before canceling, failing to renew or reducing policy limits.

(2) The certificate shall state the policy number, the name of the insurance company, the name and address of the agent or authorized representative of the insurance company, the name, address and telephone number of the insured, the policy expiration date and specific coverage amounts.

(3) The certificate shall name the city as an additional insured on general liability.

(4) A waiver of subrogation in favor of the city on both general liability and workers' compensation.

(d) Self-insurance. With respect to the registered user's and permittee's obligations to comply with the requirements for commercial general (public) liability insurance coverage, the city may allow the registered user or permittee to self-insure upon annual production of evidence that is satisfactory to the city. With respect to the registered user's or permittee's obligations to comply with the requirements for automobile liability insurance and for workers' compensation insurance, the registered user or permittee may self-insure, provided the registered user or permittee tender satisfactory evidence of self-insurance as
contemplated by the state motor vehicle financial responsibility law, Tex. Transp. Code § 601.124, and the Texas Workers' Compensation Act, Tex. Labor Code § 407.001, et. seq.

(e) Registered users with franchise agreements or licenses from the city may meet the above insurance and bonding requirements if their current franchise adequately provides for insurance or bonds, or provides an indemnity in favor of the city.

Sec. 15-199. Accounts, records, reports and investigations.

(a) In addition to any requirements that may be contained in a franchise agreement, upon written request, the registered user shall provide the city information as to all matters in connection with or affecting the construction, reconstruction, removal, maintenance and repair of its facilities performed by the registered user in the rights-of-way within ten (10) calendar days of such request.

(b) Use by city of plans. The city will use the information provided by permittees and registered users pursuant to this section only for the purposes of protection and management of the public rights-of-way.

Sec. 15-200. Transfer or assignment of facilities.

(a) Within thirty (30) calendar days after the effective date of a transfer of ownership or control of the facilities in the rights-of-way, the transferee shall register with the city in accordance with the provisions of this article.

(b) The acceptance by the city of the registration of the transferee does not constitute a waiver or release of any of the rights of the city under this article whether arising before or after the date of the transfer.

Sec. 15-201. Notices.

All notices required herein shall be in writing and shall be delivered in person to the respective parties or sent by certified mail at the addresses set forth in the registration or the permit application.

Sec. 15-202. Violations.

(a) Each violation of this article shall be punishable by a fine up to five hundred dollars ($500.00) for each violation. Each day upon which there exists a violation of this article or a failure to abide by or comply with any provision or requirement of this article shall constitute a separate occurrence, and may subject the offender to additional penalties.

(b) In addition to the criminal penalties set forth herein, the city may seek termination of the permit and a suit in court to compel compliance in accordance with the following procedures.

(1) If the city has reason to believe that the registered user/permittee is in violation of this article, the city shall notify the registered user/permittee in writing of the violation setting forth the nature of such violation. Within thirty (30) calendar days of receipt of such notice the registered user/permittee shall respond in writing to provide explanation or documentation to support that the violation did not occur. Registered user/permittee shall be allowed thirty (30) calendar days to cure violations after written notice is received from the city by taking appropriate steps to comply with the terms of this article and any lawful regulations. If the nature of the violation is such that it cannot be fully cured

within thirty (30) calendar days, the period of time in which the registered user/permittee must cure the violation shall be extended for such additional time necessary to complete the cure provided that:

a. Registered user/permittee shall have promptly commenced to cure; and
b. Registered user/permittee is diligently pursuing its efforts to cure.

(2) Upon evidence being received by the city that violations of this article, any City Charter provisions or any ordinances lawfully regulating registered user/permittee in the construction and operation of its facilities have occurred or continue to occur after the thirty (30) calendar day period and any additional time necessary to cure, the city may cause an investigation to be made. If the city finds that such a violation continues to exist or has occurred, then the city may take any action authorized by law including termination of the permit and a suit in court to compel compliance.

(c) Failure by the city to enforce any rights under this article does not constitute a waiver of such rights.

(d) If a registered user is a franchise of the city and such franchise expires or is otherwise terminated, if a registered user fails after receiving written notice from the city to renew its registration as required in section 15-193(a), or if for any other reason a registered user abandons its facilities in the rights-of-way, then to protect the public health and safety and to the extent authorized by law, the city may require the registered user to remove its facilities and equipment at the registered user's expense upon fifteen (15) days' written notice. If the registered user fails to do so within a reasonable period of time, the city may have the removal done at the registered user's expense.

Sec. 15-203. Miscellaneous.

(a) The obligations and undertakings of the parties in this article shall be performed at the city. Venue of any suits arising hereunder shall be the county.

(b) The director, either directly or through a duly appointed designee, shall have the responsibility for overseeing the day-to-day administration of this article. The director shall be empowered to take all administrative actions on behalf of the city except for those actions specified in this article that are reserved to the city council. The director may recommend that the city council take certain actions with respect to the permit.

(c) A registered user/permittee shall have the right to appeal to the city council any decision of the director relating to such registration or permit. Such appeal must be made by written request within fifteen (15) calendar days of the director's decision that the registered user/permittee seeks to appeal.

Sec. 15-204. Reservation of rights.

(a) The city reserves the right to amend this article as it shall find necessary in the lawful exercise of its police powers.

(b) Any additional regulations adopted by the city shall be incorporated into this article and complied with by all permittees within thirty (30) calendar days of the date of the adoption of such additional regulations.

APPENDIX C. SAMPLE TRENCHLESS TECHNOLOGY SPECIFICATIONS

This appendix contains sample specifications from many cities and states that have been used in practice and have proven successful. Although continual improvement is desirable, these samples have proven to be useful to those agencies that developed them. Some of these specifications are in draft format, but have been used on a limited basis.

City of Houston Standard Specification – Section 02441 – 01 July 1997.

Section 02441
MICROTUNNELING AND PIPE-JACKED TUNNELS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Tunnel construction of sewers by one-pass methods with or without man entry. The construction methods involve jacking pipe following a hand-shield excavation or a tunnel boring machine (TBM) or micro-tunnel boring machine (MTBM), with the pipe serving as both the tunnel liner during construction and the sewer pipe after completion of construction.
B. Contractor may select centrifugally-cast fiberglass pipe (FRP), vitrified clay pipe (VCP), reinforced concrete pipe (RCP) for storm or sanitary sewers. Use plastic-lined RCP for sanitary sewers. Unlined RCP or RCP lined with a liner other than that specified in Section 02427 - Plastic Liner for Large-diameter Concrete Sewers and Structures will not be allowed for sanitary sewers.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.
   1. The length of the sewer installed will be measured by linear foot along the center line of the completed sewer from center line to center line of manholes, as designated on the Drawings; and to the end of stubs or the termination of the pipe; and to the inside face of lift station and treatment plant works. The installation of the sewer within the limits of a structure other than manholes will not be considered for measurement and payment at the unit price bid.
   2. Payment will include and be full compensation for labor, equipment, materials, and supervision for construction of the sewer and excavation, complete in place including disposal of excess materials, sheeting, shoring or bracing, dewatering, utility adjustments, connections to existing sewers, grouting (if required), tests, backfilling, clean-up, and other related work necessary for construction as specified or as shown on the Drawings.
   3. Payment for the installation of the sewer will be authorized by the City Engineer in two parts. Pay estimates for partial payments will be made as measured above according to the following schedule:
      a. 95 percent payment will be made for jacked pipe installed but not yet grouted, in cases where grouting is specified.
      b. 100 percent payment will be authorized on a linear foot basis for the amount of jacked sewer pipe installed, including grouting when specified.
   4. Monitoring will be paid for at the lump sum price for installations, observations, and reporting.
B. Stipulated Price (Lump Sum): If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the Total Stipulated Price.

1.03 REFERENCE STANDARDS

A. American Railway Engineering Association (AREA) Manual for Railway Engineering.
B. American Association of State Highway and Transportation Officials (AASHTO).

C. Occupational Safety and Health Administration (OSHA).
D. National Electrical Code - (NFPA 70).

1.04 DEFINITION

A. Jacked Pipe. A method for installing sewer pipe that serves as initial construction lining and tunnel support, installed for stability and safety during construction, and as the sewer pipe. The pipe is shoved forward, or jacked, as the tunnel is advanced.
B. Microtunneling. A method of installing pipe by jacking the pipe behind a microtunnel boring machine which is connected to and shoved forward by the pipe being installed, generally precluding man entry.
C. Tunnel Boring Machine (TBM). Mechanized excavating equipment that is a steerable, guided and articulated, connected to and shoved forward by the pipe being installed, with man entry.
D. Microtunnel Boring Machine (MTBM). Mechanized excavating equipment that is remotely-controlled, steerable, guided and articulated, connected to and shoved forward by the pipe being installed, usually precluding man entry.
E. Tunneling Methodology. A written description, together with supporting documentation that defines Contractor's plans and procedures for the microtunneling or pipe jacking operations.
F. Zone of Active Excavation. Area located within a radial distance about a surface point immediately above the face of excavation equal to the depth to the bottom of the excavation.
G. Critical Structure. Any building, structure, bridge, pier, or similar construction partially or entirely located within a zone of active excavation.

1.05 TUNNEL SUBMITTALS

A. Submittals shall be made in accordance with Section 01330 - Submittal Procedures.
B. The following submittals are required:
   1. Tunneling Methodology. A brief description of proposed tunnel methodology for review. The description should be sufficient to convey the following:
      a. Proposed method of tunnel construction and type of face support.
      b. Manufacturer and type of tunneling equipment proposed; type of lighting and ventilation systems.
      c. Number and duration of shifts planned to be worked each day.
      d. Sequence of operations,
      e. Locations of access shafts and work sites.
      f. Method of spoil transportation from the face, surface storage and disposal location.
      g. Capacity of jacking equipment and type of cushioning.
      h. Identify critical utility crossings and special precautions proposed.
   2. Drawings and Calculations: Submit for record purposes, drawings, and calculations for any tunnel support system designed by the Contractor. Drawings shall be adequate for construction, and include installation details. For pipe jacking and microtunneling, show pipe and pipe joint detail. Documents must be signed and sealed by a Professional Engineer registered in the State of Texas. Calculations shall include clear statement of criteria used for the design as described in Paragraph 1.06, Design Criteria.
   3. Quality Control: Submit for review a brief description of quality control methods including:
      a. Method and frequency of survey control.
      b. Example of tunnel daily log.
   4. Geotechnical Investigation: When geotechnical investigations are conducted by the Contractor, submit results to the City Engineer for record purposes.
   5. Monitoring Plans:
      a. Instrumentation Monitoring Plan: Submit for review, prior to construction, a monitoring plan that includes a schedule of instrumentation design, layout of instrumentation points,

equipment installation details, manufacturer's catalog literature, and monitoring report forms.

b. Surface Settlement Monitoring Plan. Submit a settlement monitoring plan for review prior to construction. The plan shall identify the location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

6. Structures Assessment. Preconstruction and postconstruction assessment reports shall be provided for critical structures, namely those located within the zone of active excavation from the proposed tunnel centerline. Photographs or a video of any existing damage to structures in the vicinity of the sewer alignment shall be included in the assessment reports.
7. The readings of all monitoring shall be submitted to the City Engineer.
8. Daily Reports: The shift log as defined in Paragraph 3.04, Pipe-jacked Tunneling Data, subparagraph 3.04A, shall be maintained by the Contractor, and must be made available to the City Engineer on request.

1.06 DESIGN CRITERIA

A. Contractor is responsible for selection of the appropriate pipe and pipe joints to carry the thrust of any jacking forces or other construction loads in combination with overburden, earth and hydrostatic loads. Design of any pipe indicated on the Drawings considers in-place loads only and does not take into account any construction loads. The criteria for longitudinal loading (jacking forces) on the pipe and joints shall be determined by the Contractor, based on the selected method of construction.
B. The jacked pipe shall be designed to withstand the thrust from the MTBM, TBM or shield and pipe advance without damage or distortion. The propulsion jacks shall be configured so that the thrust is uniformly distributed and will not damage or distort the pipe.
C. Take into account loads from handling and storing.
D. The criteria to be used at railroad crossings shall be Cooper E-80 locomotive loading distributions in accordance with AREA specifications for culverts. In the design, account for additive loadings due to multiple tracks.
E. The criteria to be used for truck loading shall be HS-20 vehicle loading distributions in accordance with AASHTO.
F. Provide pipes of diameter shown on the Drawings. Substitution of pipe with larger diameter to suit MTBM or TBM equipment availability will only be permitted if the Contractor can demonstrate to the City Engineer’s satisfaction that design flows and velocities can be achieved.

PART 2 P R O D U C T S

2.01 SEWER PIPE

A. Contractor shall be responsible for selecting appropriate pipes and pipe joints to safely carry the loads imposed during construction, including jacking forces. Pipe joints shall be flush with the outside pipe face when the pipes are assembled. Pipe materials shall be selected by Contractor from the following:
B. Centrifugally-cast fiberglass pipe, joints, and fittings to be in accordance with Section 02504 - Centrifugally-Cast Fiberglass Pipe.
C. Vitrified clay pipe, joints and fittings to be in accordance with Section 02508 - Extra Strength Clay Pipe.
D. Plastic-lined reinforced concrete pipe with joints and fittings to be in accordance with Section 02615 - Reinforced Concrete Pipe and Section 02427 - Plastic Liner for Large-diameter Concrete Sewers and Structures. Plastic liner is not required for storm sewers.
E. Use pipe that is round with a smooth, even outer surface, and has joints that allow for easy connections between pipes. Pipe ends shall be designed so that jacking loads are evenly distributed around the entire pipe joint and such that point loads will not occur when the pipe is installed.

Pipe used for pipe jacking shall be capable of withstanding all forces that will be imposed by the process of installation, as well as the final in-place loading conditions. Protect the driving ends of the pipe and joints against damage.

PART 3 E X E C U T I O N

3.01 CONSTRUCTION OPERATIONS CRITERIA

A. Use methods for microtunneling and pipe-jacked tunneling operations that will minimize ground settlement. Select a method which will control flow of water and prevent loss of soil into the tunnel and provide stability of the face under anticipated conditions.
B. Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA standards and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and the public.
C. Maintain clean working conditions wherever there is man access.
D. For tunneling under railroad embankments, highways, or streets, perform the installation so as to avoid interference with the operation of the railroads, highways, or streets, except as approved by the owner of the facility.

3.02 GROUND WATER CONTROL

A. Provide ground water control measures in conformance with Section 01578 - Control of Ground Water and Surface Water, when necessary to perform the Work.

3.03 EQUIPMENT

A. Full directional guidance of a shield, TBM, or MTBM is a prerequisite of this method of construction.
B. The Contractor shall be responsible for selection of tunneling equipment which, based on past experience, has proven to be satisfactory for excavation of the soils to be encountered.
C. The Contractor shall employ tunneling equipment that will be capable of handling the various anticipated ground conditions and is capable of minimizing loss of soil ahead of and around the machine and shall provide satisfactory support of the excavated face.
D. Tunnel Boring Machine (TBM). A TBM used for pipe-jacking shall conform to the shape of the tunnel with a uniform perimeter that is free of projections that could produce over- excavation or voids. An appropriately sized overcutting bead may be provided to facilitate steering. In addition it shall:
   1. Be capable of full face closure.
   2. Be equipped with appropriate seals to prevent loss of bentonite lubricant.
   3. Be capable of correcting roll by reverse drive or fins.
   4. Be designed to handle adverse ground conditions including ground water ingress.
   5. Be equipped with visual display to show the operator actual position of TBM relative to design reference.
E. Tunnel Shield. If a hand shield is used for pipe-jacked tunneling (with or without attached mechanized excavating equipment), the shield must be capable of handling the various anticipated ground conditions. In addition, the shield shall:
   1. Conform to the shape of the tunnel with a uniform perimeter that is free of projections that could produce over-excavation or voids. An appropriately-sized overcutting bead may be provided to facilitate steering.
   2. Be designed to allow the face of the tunnel to be closed by use of gates or breasting boards without loss of ground.
F. Microtunneling Equipment. In the case of MTBM, use a spoil transportation system which:

1. Either balances the soil and ground water pressures by the use of a slurry or earth pressure balance system; system shall be capable of adjustments required to maintain face stability for the particular soil condition and shall monitor and continuously balance the soil and ground water pressure to prevent loss of slurry or uncontrolled soil and ground water inflow, or, in the case of a slurry spoil transportation system:
    a. Provides pressure at the excavation face by use of the slurry pumps, pressure control valves, and a flow meter.
    b. Includes a slurry bypass unit in the system to allow the direction of flow to be changed and isolated, as necessary.
    c. Includes a separation process. Design it to provide adequate separation of the spoil from the slurry so that slurry with a sediment content within the limits required for successful tunneling can be returned to the cutting face for reuse. Appropriately contain spoil at the site prior to disposal.
    d. Uses the type of separation process suited to the size of tunnel being constructed, the soil type being excavated, and the work space available at each work area for operating the plant.
    e. Allows the composition of the slurry to be monitored to maintain the slurry weight and viscosity limits required.
2. In the case of a cased auger earth pressure balance system, the system shall be capable of adjustments required to maintain face stability for the particular soil condition to be encountered. Monitor and continuously balance the soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.
    a. In a cased auger spoil transportation system, manage the pressure at the excavation face by controlling the volume of spoil removal with respect to the advance rate. Monitor the speed of rotation of the auger flight, and the addition of water.
3. Remote Control System. Provide an MTBM which includes a remote control system with the following features:
    a. Allows for operation of the system without the need for personnel to enter the tunnel. Has a display available to the operator, at a remote operation console, showing the position of the shield in relation to a design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force, and cutter head torque; rate of advance and installed length.
    b. Integrates the system of excavation and removal of spoil and its simultaneous replacement by pipe. As each pipe section is jacked forward, the control system shall synchronize all of the operational functions of the system.
4. Active Direction Control. Provide an MTBM which includes an active direction control system with the following features:
    a. Controls line and grade by a guidance system that relates the actual position of the MTBM to a design reference (e.g., by a laser beam transmitted from the jacking shaft along the pipe to a target mounted in the shield).
    b. Provides active steering information which shall be monitored and transmitted to the operating console.
    c. Provides positioning and operation information to the operator on the control console.
5. Use generator which is suitably insulated for noise ("hospital" type) in residential or commercial areas.

G. Pipe Jacking Equipment. Provide a pipe jacking system with the following features:
1. Has the main jacks mounted in a jacking frame located in the starting shaft.
2. Has a jacking frame which successively pushes a string of connected pipes following the tunneling excavation equipment towards a receiving shaft.
3. Has sufficient jacking capacity to push the tunneling excavation equipment and the string of pipe through the ground. Incorporates intermediate jacking stations, if required.

4. Has a capacity at least 20 percent greater than the calculated maximum jacking load.
5. Develops a uniform distribution of jacking forces on the end of the pipe by use of spreader rings and packing, measured by operating gauges.
6. Provides and maintains a pipe lubrication system at all times to lower the friction developed on the surface of the pipe during jacking.
7. Jack Thrust Reactions. Use reactions for pipe jacking that are adequate to support the jacking pressure developed by the main jacking system. Special care shall be taken when setting the pipe guide rails in the jacking shaft to ensure correctness of the alignment, grade, and stability.

H. Air Quality. Provide equipment to maintain proper air quality of manned tunnel operations during construction in accordance with OSHA requirements.

I. Enclose lighting fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting, and other equipment.

J. Electrical systems shall conform to requirements of National Electrical Code - NFPA70.

3.04 PIPE-JACKED TUNNELING DATA

A. Maintain shift logs of construction events and observations. The City Engineer shall have access to the Contractor's logs with regard to the following information:
1. Location of boring machine face or shield by station and progress of tunnel drive during shift.
2. Hours worked per shift on tunneling operations.
3. Completed field forms for checking line and grade of the tunneling operation, showing achieved tolerance relative to design alignment. Steering control logs will generally be acceptable.
4. Maximum pipe jacking pressures per drive.
5. Location, elevation and brief soil descriptions of soil strata.
6. Ground water control operations and piezometric levels.
7. Observation of any lost ground or other ground movement.
8. Any unusual conditions or events.
9. Reasons for operational shutdown in the event a drive is halted.

3.05 EXCAVATION AND JACKING OF PIPE

A. Tunnel Excavation.
1. Keep tunnel excavation within the easements and rights-of-way indicated on the Drawings and to the lines and grades designated on the Drawings.
2. Perform tunneling operations in a manner that will minimize the movement of the ground in front of and surrounding the tunnel. Prevent damage to structures and utilities above and in the vicinity of the tunneling operations.
3. Open-face excavations:
   a. Keep the face breasted or otherwise supported and prevent falls, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.
   b. During shut-down periods, support the face of the excavation by positive means; no support shall rely solely on hydraulic pressure.
4. Closed-face excavation:
   a. Carefully control volume of spoil removed. Advance rate and excavation rate to be compatible to avoid over excavation or loss of ground.
   b. When cutting head is withdrawn or is open for any purpose, keep excavated face supported and stabilized.
5. Excavated diameter should be a minimum size to permit pipe installation by jacking with allowance for bentonite injection into the annular space.
6. Whenever there is a condition encountered which could endanger the tunnel excavation or adjacent structures, operate without intermission including 24-hour working, weekends and holidays, until the condition no longer exists.

7. The Contractor shall be responsible for damage due to settlement from any construction-induced activities.

B. Pipe Jacking
   1. Cushion pipe joints as necessary to transmit the jacking forces without damage to the pipe or pipe joints.
   2. Maintain an envelope of bentonite slurry around the exterior of the pipe during the jacking and excavation operation to reduce the exterior friction and possibility of the pipe seizing in place.
   3. If the pipe seizes up in place and the Contractor elects to construct a recovery access shaft, obtain approval from the City Engineer. Coordinate traffic control measures and utility adjustments as necessary prior to commencing work.
   4. In the event a section of pipe is damaged during the jacking operation, or joint failure occurs, as evidenced by inspection, visible ground water inflow or other observations, the Contractor shall submit for approval his methods for repair or replacement of the pipe.

C. Grouting. Grouting requirements are defined in Section 02431 - Tunnel Grout.

3.06 CONTROL OF LINE AND GRADE

A. Construction Control.
   1. The City Engineer will establish the baselines and benchmarks indicated on the Drawings. Contractor shall check baselines and benchmarks at the beginning of the Work and report any errors or discrepancies to the City Engineer.
   2. Use the baselines and benchmarks established by the City Engineer to establish and maintain construction control points, reference lines and grades for locating tunnel, sewer pipe, and structures.
   3. Establish construction control points sufficiently far from the work so as not to be affected by ground movement caused by pipe-jacked tunneling operations.

B. Bench Mark Movement. The Contractor shall ensure that if settlement of the ground surface occurs during construction which affects the accuracy of the temporary benchmarks the Contractor shall detect and report such movement and reestablish temporary bench marks. The locations of the permanent City of Houston monumentation benchmarks are indicated on the Drawings. Advise the City Engineer of any settlement affecting the permanent monumentation benchmarks.

C. Line and Grade.
   1. Check and record the survey control for the tunnel against an above-ground undisturbed reference at least once for each 250 feet of tunnel constructed.
   2. Record the exact position of the MTBM or TBM or shield after each shove to ensure the alignment is within specified tolerances. Make immediate correction to alignment before allowable tolerances are exceeded.
   3. When excavation is off line or grade, make alignment corrections to avoid reverse grades in gravity sewers.
   4. Acceptance criteria for the sewer pipe shall be plus or minus 6 inches in horizontal alignment from the theoretical at any point between manholes, including the receiving end, and plus or minus 1-1/2 inches in elevation from the theoretical.
   5. Pipe installed outside tolerances and subsequently abandoned shall first be fully grouted.

3.07 MONITORING

A. Instrumentation Monitoring. Instrumentation requirements are shown on the Drawings. Instrumentation specified shall be accessible at all times to the City Engineer. Readings shall be submitted promptly to the City Engineer.
   1. Install and maintain an instrumentation system to monitor and detect movement of the ground surface and adjacent structures. Establish vertical control points at a distance from the construction areas that avoids disturbance due to ground settlement.

2. Installation of the instrumentation shall not preclude the City Engineer, through an independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to the construction work. Access shall be provided to the work for such independent installations.
3. Instruments shall be installed in accordance with the Drawings and the manufacturer's recommendations.

B. Surface Settlement Monitoring
1. Establish monitoring points on all critical structures.
2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to an accuracy of 0.01 feet for each monitoring point location. Monitoring points should be established at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.
3. Ground surface elevations shall be recorded on the centerline ahead of the tunneling operations at a minimum of 100-foot intervals or at least three locations per tunnel drive. For sewers greater than 60-inch diameter, also record similar data at approximately 20 feet each side of the centerline. Settlement monitoring points must be clearly marked by studs or paint for ease of locating.
4. Railroads. Monitor ground settlement of track subbase at centerline of each track.
5. Utilities and Pipelines. Monitor ground settlement directly above and 10 feet before and after the utility or pipeline intersection.

C. Reading Frequency and Reporting. The Contractor shall submit to the City Engineer, records of readings from the various instruments and survey points.
1. Instrumentation monitoring results to be read at the frequency specified and unless otherwise specified, shall be started prior to the zone of active excavation reaching that point, and shall be continued until the zone of active excavation has passed and until no further detectable movement occurs.
2. Surface settlement monitoring readings shall be taken:
   a. Prior to the zone of active excavation reaching that point,
   b. When the tunnel face reaches the monitoring point (in plan), and
   c. When the zone of active excavation has passed and no further movement is detected.
3. All monitoring readings shall be submitted promptly to the City Engineer.
4. Immediately report to the City Engineer any movement, cracking, or settlement which is detected.
5. Following substantial completion but prior to final completion, make a final survey of all monitoring points.

3.10 DISPOSAL OF EXCESS MATERIAL

A. Remove spoil in accordance with Section 01576 - Waste Material Disposal.

3.11 ACCEPTANCE TESTING

A. Acceptance testing is to be carried out by methods described in Section 02533 - Acceptance Testing For Sanitary Sewer.

Florida DOT Draft Trenchless Technology Specifications

This is a draft version of the Florida DOT specifications, and as such, many of the final details such as section cross-references and other items have not yet been completed.

"EXPLANATION OF PROPOSED SPECS DOCUMENT"

The following specifications: **SECTION 555 - DRAFT DIRECTIONAL BORING, SECTION 556 - DRAFT JACK AND BORE, and SECTION 557 - DRAFT VIBRATORY PLOWING,**

are being made available for your review and comment on the FDOT Web Site before any formal process is begun (http://www.dot.state.fl.us/rddesign/utilities/files/utilities.htm). This is a chance for anyone to have input at the earliest possible time. Later, as "OFFICIAL DRAFTS" are developed, they will be re-published with a revision date for continued review and comment.

The Florida Department Of Transportation recently published the NEW 1999 Edition of the Standard Specifications. The language format was changed from the passive to active voice. The active voice is more direct and tends to be shorter. However, the draft specs mentioned above were pulled together using older specs and materials developed by the 1999 Statewide Value Engineering Boring Task Team. The Team was not concerned with any particular voice. For the purpose of beginning this spec development, it is believed these drafts will suffice solely for the initial "Un-Official" review of content.

The final specs must be re-written in the active voice final form. In order to expedite the review process and minimize re-writes associated strictly with voice, the intent is to first get reasonable agreement on the content. Afterwards we will concern ourselves with the voice and formatting issues. So you will know ahead of time there are other things that will need to be changed or included in final form are as follows:

1. Dual units (English and Metric) which are not contained herein must be added.
2. The Section called "SCOPE" will be eliminated and rolled more or less into the "Description" Section in accordance with the AASHTO specs development guidelines.

These proposed specs include some new issues and eliminate others. For example:

1. They do not contain a lot of material found in the old 1993 Utility Accommodation Manual such as permitting documentation requirements, and internal processes even though that was part of the old official spec. Internal processes still must be followed but they will be addressed in separate documentation.
2. Only construction documentation requirements are in the new specs.
3. Some new issues include better defined construction documentation, flagging of utilities, as-builts, making utilities traceable by electronic means, defining alignment tolerances, and responsibilities previously left to question.

Please submit any comments by July 3, 2000, through regular mail to Kenneth Weldon, State Utilities Engineer, Florida Department Of Transportation, 605 Suwannee St. - MS 32, Tallahassee, Fl. 32399-0450 or via the Internet to: Kenneth.Weldon@DOT.STATE.FL.US. Your comments will be considered in developing the first "OFFICIAL DRAFT " which will follow and be submitted to the Industry for review and comment in August 2000.

SECTION 555
DIRECTIONAL BORING

555 Scope.

The work specified in this Section documents the approved construction methods, procedures, and materials for Directional Boring, also commonly called Horizontal Directional Drilling (HDD).

555-1 Description.

HDD is a trenchless method for installing a product that serves as a direct conduit for liquids or gases, or as a duct for pipe, cable, or wire line products. It is a multi-stage process consisting of drilling a pilot bore along a predetermined path and then pulling the desired product back through the drilled space. The vertical profile of the bore alignment is typically in the shape of an inverted arc. When necessary, enlargement of the pilot bore hole to accommodate a product larger than the pilot bore cross section is accomplished by back reaming. This is done at the same time the product is being pulled back through the pilot bore space. Steering the bore is accomplished by proper orientation of the drill bit head as it is being pushed along an alignment by an above ground hydraulic jack. Orientation and tracking of the drill bit is determined by an above ground radio detection device which picks up a signal generated from a radio transmitter contained within the drilling bit. This radio signal is translated into depth and alignment. In order to minimize friction and provide a soil stabilizing agent, a drilling fluid is introduced into the annular space created during the boring operation. The rotation of the bit in the soil wetted by the drilling fluid creates slurry. This slurry acts to stabilize the surrounding soil and prevents collapse of the bore hole and loss of lubrication. Drilling fluids must be designed for the soil and ground water conditions. In order to confine any free flowing slurry at the ground surface during pull back or drilling, sump areas are created to contain any escaping slurry that might damage or be hazardous in surrounding areas. All residual slurry shall be removed from the surface and the site restored to preconstruction conditions.

555-2 Materials.

Materials must meet or exceed the following standards:

Material Standards for HDD Installation		
Material Type	Non-Pressure	Pressure
Polyethylene (PE)	ASTM D 2447	ASTM 2513 ASTM D 2447
High Density Polyethylene	ASTM D 2447 ASTM D 3350 ASTM F714	ASTM D 2447 ASTM D 3350 ASTM F714 ASTM 2513
Polyvinyl-Chloride (PVC)	ASTM F 789	N/A
Steel	ASTM A139 Grade B(1) API 2B(2)	AWWA C200 API 2B(2)

(1) No hydrostatic test required
(2) Dimensional tolerances only

555-3 Construction Site Requirements

(a) Excavation for entry, recovery pits, slurry sump pits, or any other excavation shall be carried out as specified in Section 120. Sump areas are required to contain drilling fluids.
(b) After completing installation of the product the work site shall be restored . The work site shall be cleaned of all excess slurry left on the ground. Removal and final disposition of excess slurry or spoils as the product is introduced, shall be the responsibility of the boring contractor.

(c) Excavated areas shall be restored in accordance with the Standard Specifications for Road and Bridge Construction and Roadway and Traffic Design Standards. The cost of restoring damaged pavement, curb, sidewalk, driveways, lawns, storm drains, landscape, and other facilities is borne by the Contractor / Permittee.
(d) The provisions of Chapter 556, FS must be complied with. Methods to be used for marking Utilities shall minimize impact on other construction or maintenance activities, including mowing operations, which may be conducted throughout the project on a cyclic basis. In order to accomplish this, marking by painting is preferred but not required. When and where flagging of existing Utilities is required, these facilities shall not be flagged through an area for a length ahead of what construction can be accomplished in 14 consecutive days unless approved by the Engineer.

555-4 Quality Control
(a) A representative of the Contractor / Permittee must be in control of the operation at all times. The representative must have a thorough knowledge of the equipment and the procedures to be performed, and is present at the job site during the installation.
(b) The Department must be notified 48 hours in advance of starting work. The installation shall not begin until the Department's representative is present at the job site and agrees that proper preparations have been made.

555-5 Specific Requirements
555-5.1 Drilling Fluids & Reamer Hole Diameter
A mixture of bentonite clay or other approved slurry and potable water shall be used as the cutting and soil stabilization fluid. The viscosity shall be varied to best fit the soil conditions encountered. Water shall be clean and fresh, with a minimum pH of 6.

No other chemicals or polymer surfactant is to be used in the drilling fluid without the written consent of the Engineer and after a determination is made that the chemicals to be added are not harmful or corrosive to the facility and are environmentally safe.

555-5.2 Testing
When there is any indication a pipe has sustained damage and may leak, the work is to be stopped and the damage investigated. The Engineer may require a pressure test. The testing may consist of one of the following methods but shall always meet or exceed Department testing requirements:

(a) Manufacturer's pressure testing recommendations for the type of pipe being installed are followed. The Department's Engineer shall be notified and at his option be present during the test for review of the test results for compliance. The pressure test shall be performed within 24 hours. A copy of the test results shall be furnished to the Department's Engineer. If the pipe is not in compliance with specifications, the Engineer may require it to be filled with flowable fill.
(b) Product carrier pipes installed without a casing must meet pressure requirements set by the Owner. If the Owner does not require pressure testing, the Engineer may require at least one test. A copy of the test results shall be furnished to the Department's Engineer. If the pipe is not in compliance with specifications the Engineer may require it to be filled with flowable fill.
(c) The Department requires that conduit or pipe must meet or exceed soil tight joint requirements when leakage would not cause failure or adversely affect the integrity of the roadway pavement or shoulders. Where leakage could adversely affect pavement or shoulder integrity, a water tight joint is required. Tests for joint integrity shall be conducted for 1 hour. The test for a soil tight joint allows up to 0.1 gallon of water leakage at a sustained pressure of 2 PSI. The water tight joint criteria allows no leakage at all for a sustained pressure of 5 PSI.

555-5.3 Locating and Tracking

The Contractor / Permittee shall describe the method of locating and tracking the drill head during the pilot bore. The Department recognizes walkover, wire line, and wire line with surface grid verification (i.e. True-Trac), or any other system as approved by the Engineer, as the accepted methods of tracking directional bores. The locating and tracking system shall be capable of ensuring that the proposed installation is installed as intended. If an area of radio signal interference is expected to exceed 5 feet, the Engineer may specify the use of a suitable tracking system.

The locating and tracking system shall provide information on:
(a) Clock and pitch information.
(b) Depth.
(c) Transmitter temperature.
(d) Battery status.
(e) Position (x,y).
(f) Azimuth, where direct overhead readings (walkover) are not possible (i.e. subaqueous or limited access transportation facility.)
(g) Before commencement of a directional drilling operation, proper calibration of the equipment (if required) shall be undertaken.
(h) Alignment readings or plot points shall be taken and recorded every five feet.

All facilities shall be installed in such a way that their location can be readily determined by electronic designation after installation. For non-conductive installations this shall be accomplished by attachment of a continuous conductive material either externally, internally, or integrally with the product. Either a copper wire line or a coated conductive tape for this material may be used. Any break in the conductor must be connected by electrical clamp of brass or solder and coated with a rubber or plastic insulator to maintain the integrity of the connection from corrosion.

555-5.4 Drilling Fluids
The Contractor / Permittee shall identify the source of fresh water for mixing the drilling mud. Approvals and permits are required for such sources as streams, rivers, ponds, or fire hydrants. Any water source other than potable water may require a pH Test.

Monitoring of the drilling fluids such as the pumping rate, pressures, viscosity, and density is required during the pilot bore, back reaming, and pipe installation stages, to ensure adequate removal of soil cuttings and the stability of the borehole. Relief holes can be used as necessary to relieve excess pressure down hole. To minimize heaving during pullback, the pull back rate is determined in order to maximize the removal of soil cuttings without building excess down hole pressure. Excess drilling fluids shall be contained at entry and exit points until they are recycled or removed from the site. Entry and exit pits shall be of sufficient size to contain the expected return of drilling fluids and soil cuttings.

The Contractor / Permittee shall ensure that all drilling fluids are disposed of or recycled in a manner acceptable to the appropriate local, state, or federal regulatory agencies. When drilling in suspected contaminated ground, the drilling fluid shall be tested for contamination and disposed of appropriately. Any excess material shall be removed upon completion of the bore.

Restoration for damage to any transportation facility or non-transportation facility caused by heaving, settlement, escaping drilling fluid (fracout) or the directional drilling operation, is the responsibility of the Contractor / Permittee. Any pavement heaving or settlement damage requires restoration/replacement of the pavement per Standard Index 307. Sidewalk or Turnouts will be reconstructed per Standard Index 310 and 515 respectively.

Maximum Back-Ream Hole Diameter	
Nominal Inside Pipe Diameter (Inches)	Back-Ream Hole Diameter (Inches)
2	4
3	6
4	8
6	10
8	12
10	14
12 and greater	Maximum Product OD plus 6"

555-5.5 Equipment Requirements
The Contractor / Permittee shall ensure that appropriate equipment is provided to facilitate the installation as follows:

HDD Equipment				
System Description	Pipe (1) Diameter (m)	Bore Length (feet)	Torque (ft/lbs)	Thrust / Pullback (lbs)
Maxi-HDD	18 & greater	1000 +	10,000 +	70,000 +
Midi-HDD	Up to 16	Up to 1000	1,900 to 9,999	20,001 to 69,999
Mini-HDD	Up to 6	Up to 600	Up to 1,899	Up to 20,000

Equipment shall be matched to the size of pipe being installed. Installations differing from the above chart must be approved by the Engineer. The Contractor / Permittee ensures that the drill rod can meet the bend radius required for the proposed installation.

Multiple pipe or conduit installations shall not exceed the total outside pipe diameters stated above.

555-6 Documentation Requirements
555-6.1 Boring Path Report
The Contractor / Permittee shall furnish a Bore Path Report to the FDOT within 14 days of the completion of each bore path. The completed As-Built-Plans shall be submitted to the Engineer within 30 calendar days. No payment will be made for directional boring work until the Bore Path Report has been delivered to the Department. The report shall contain:
(a) Location of project and financial project number including the Permit No. when assigned.
(b) Name of person collecting data, including title, position, and company name.
(c) Investigation site location (contract plans station number or reference to a permanent structure within the project right of way).
(d) Identification of the detection method used.
(e) As-built placement drawings showing roadway plan and profile, cross section, boring location and subsurface conditions as defined in Bore Path Drawings below. Plan elevations shown shall be referenced to a FDOT Bench Mark when associated with an FDOT project, otherwise to a USGS grid system and datum, or to the top of an existing FDOT head wall. These drawings shall be done to the same scale in black ink on white paper, of the same size and weight and as the contract plans. Submittal of electronic plans data in lieu of hard copy plans may be approved by the Engineer if compatible with the Department software.

555-6.2 Boring Path Drawings
Boring Path Drawings shall be dimensionally correct copies of the contract plans. Notes shall be included on each drawing stating the final bore path diameter, facility diameter, drilling fluid composition, composition of any other materials used to fill the annular void between the bore path and the

facility or facility placed out of service. If the facility is a casing, this shall be noted, as well as the size and type of carrier pipes to be placed within the casing as part of the contract work. The drawings shall be produced as follows:
(a) The contract plan view shall show the center-line location of each facility, installed or installed and placed out of service to an accuracy within 1 inch at the ends and other points physically observed. They show the remainder of the horizontal alignment of the center line of each facility installed or installed and placed out of service, and note the accuracy with which the installation was monitored.
(b) As directed by the Engineer, either a profile drawing for each bore path, or a cross section of the roadway at a station specified by the Engineer, or a roadway centerline profile, shall be provided. They shall show the ground or pavement surface and the crown elevation of each facility installed, or installed and placed out of service, to an accuracy within 1 inch at the ends and other points physically observed. It shall show the remainder of the vertical alignment of the crown of each facility installed, or installed and placed out of service, and notes the accuracy with which the installation was monitored. On profile drawings for bore paths crossing the roadway the contract plans stationing of the crossing shall be shown. On the profile drawings for bore paths paralleling the roadway the contract plans stationing are also shown. If the profile drawing for the bore path is not made on a copy of one of the contract profile or cross section
sheets, a 10 to 1 vertical exaggeration shall be used.
(c) If during installation an obstruction is encountered which prevents installation of the pipe in accordance with this specification, the pipe may be taken out of service and left in place at the discretion of the Engineer, and shall immediately be filled with flowable fill. A new installation procedure and revised plans must be submitted to and approved by the Engineer before work can resume. If a bore path is abandoned without installing a facility, the drawings shall show the abandoned bore path along with the final bore path. The abandoned bore path shall be noted as “Abandoned Bore Path.” They shall also show the location and length of the drill head and any drill stems not removed from the bore path. If conditions warrant removal of the materials installed in the abandoned bore path, as determined by the Department, during construction or in the future, the cost and responsibility shall be born by the permittee.
(d) On all the drawings, show the crown elevation, diameter and material type of all utilities encountered and physically observed during the subsoil investigation. For all other obstructions encountered during a subsoil investigation or the installation, show the type of material, horizontal and vertical location, top elevation and lowest elevation observed, and note if the obstruction continues below the lowest point observed.

555-7 Method Of Measurement
Fees paid the Contractor / Permittee shall be based on the actual length of the installation, measured in place along the surface of the ground, complete and accepted. No additions or deductions will be made for sweeps in either the vertical or horizontal direction to complete the installation.

555-8 Basis Of Payment.
Payment will be made under Item XXX-02-XXX Horizontal Directional Drilling per lineal foot of bore diameter, where:
555-XX-X01 < than 6 inches bore diameter
555-XX-X02 6.0 inches to < 12.0 inches bore diameter
555-XX-X03 12.0 inches to < 18.0 inches bore diameter
555-XX-X04 18.0 inches to < 24.0 inches bore diameter
555-XX-X05 24.0 inches to < 30.0 inches bore diameter
555-XX-X06 30.0 inches and greater bore diameter
No payment shall be made for abandoned bore paths, taken out of service or incomplete installations.

Payment to the Contractor / Permittee shall be full compensation for all work specified in this section. This includes all installations, from plan point of beginning to plan point of ending (i.e. pull box) at plan depth, removal of excavated materials and spoils, removal and disposal of drilling fluids, backfilling, and complete restoration.

SECTION 556
JACK AND BORE

556 Scope.
The work specified in this Section documents the approved construction methods, procedures, and materials for Jack And Bore (J&B), also known as auger boring. Micro tunneling (MT) is considered to be a hybrid of Jack and Bore for purposes of specifications.

556-1 Description.
J&B is a method for installing a product (often called a casing) that may serve as a direct conduit for liquids or gases, or as a duct for pipe, cable, or wire line products. It is a multi-stage process consisting of constructing a temporary horizontal jacking platform and a starting alignment track in an entrance pit at a desired elevation. The product is then jacked by manual control along the starting alignment track while simultaneous excavation of the soil is accomplished by a rotating cutting head operating in the leading edge of the product's annular space. The ground up soil (spoil) is transported back to the entrance pit by helical wound auger flights rotating inside the product. J&B typically provides limited tracking and steering as well as limited support to the excavation face.

MT is conducted similar to J&B with the exception it is a remotely controlled, guided pipe jacking process that provides continuous support to the excavation face. The guidance system usually consists of a laser mounted in the tunneling drive shaft which communicates a reference line to a target mounted inside the MT machine's articulated steering head. The MT process provides the ability to control the excavation face stability by applying mechanical or fluid pressure to counterbalance the earth and hydrostatic pressures.

The removal of excess material is the responsibility of the boring contractor as well as restoration of the site to the condition which existed prior to construction. The method for removal or final disposition of spoils is not covered under this specification. However, the cost of removal or final disposition shall be considered included in the cost of the boring.

556-2 Materials.
Materials approved for installation within the R/W shall be selected based on their suitability for the construction method as defined in the following table. After determining product suitability, individual material standards as contained in the subsequent table shall apply.

Product Suitability By Construction Method		
Type	Pipe / Casing Installation Mode	Suitable Pipe/Casing
J&B	Jacking	Steel
MT	Jacking	DI, FRPM, PC, PCCP, RCCP, RCP, Steel, VCP

Material Standards Acceptable for J&B and MT Installations		
Material Type	Non-Pressure	Pressure
Ductile Iron (DI)	AWWA C150/C151 ASTM A716, A747	AWWA C150/C151

Fiberglass Reinforced Polymer Mortar (FRPM)	ASTM D 3262	ASTM D 3517 AWWA C950
Polymer Concrete (PC)	DIN 54815-1 & 2	N/A
Prestressed Concrete Cylinder Pipe (PCCP)	N/A	AWWA C300
Reinforced Concrete Cylinder Pipe (RCCP)	N/A	ASTM C361
Reinforced Concrete Pipe (RCP)	ASTM C 79 ASCE xx-97	ASTM C 361 AWWA C300/C302
Steel	ASTM A139 Grade B(1) API 2B(2)	AWWA C200 API 2B(2)
Vitrified Clay Pipe (VCP)	ASTM C1208 EN 295-7	N/A

(1) No hydrostatic test required (2) Dimensional tolerances only

556-2.1 Steel Pipe Casing
The size of the steel casing shall be at least 6 inches larger than the largest outside diameter of the carrier pipe. The casing pipe shall be straight seam pipe or seamless pipe. All steel pipe may be bare inside and out, with the manufacturers' recommended minimum nominal wall thicknesses to meet installation and loading requirements. Coatings to extend the service life may be permitted. All steel casing pipe shall be square cut and have dead-even lengths which are compatible with the J&B equipment.

All steel pipe casings and welds shall meet or exceed the thickness requirements to achieve the service life requirements noted in the FDOT Drainage Manual Chapter 6. For purposes of determining service life, casings installed under roadways will be treated as cross drains and casings under driveways will be treated as side drain pipe installations. For purposes of material classification, steel pipe casing will be considered structural plate steel pipe. Steel pipe casing of insufficient length shall achieve the required length through fully welded joints. Joints shall be air-tight and continuous over the entire circumference of the pipe with a bead equal to or exceeding that required to meet the thickness criteria of the pipe wall. All welding shall be performed by a qualified welder.

556.2.2 Reinforced Concrete Pipe Casing
In addition to the above concrete pipe standards, the pipe shall comply with the following minimum requirements:

(a) 5,000-psi concrete compressive strength.
(b) Class III, IV, or V as required by load calculations, with a C-wall.
(c) Full circular inner and/or outer reinforcing cage.
(d) Multiple layers of steel reinforcing cages, wire splices, laps and spacers are permanently secured together by welding in place.
(e) Straight outside pipe wall with no bell modification.
(f) No elliptical reinforcing steel is allowed.
(g) Single cage reinforcement with a 1-inch minimum cover from the inside wall.
(h) Double cage reinforcement with a 1-inch minimum cover from each wall.
(i) Joints are gasket type.
(j) Additional joint reinforcement.

Upon installation, the Engineer may at his discretion require the contractor to perform concrete wiping or injection of the joints if it is believed the joints have not maintained their water tightness during the jacking operation. No additional payment will be made for this operation.

556-3 Construction Site Requirements
556-3.1 Excavation and Restoration
(a) Excavation for entry, recovery pits, or any other excavation shall be carried out as specified in Section 120. Sump areas are required to contain drilling or auguring fluids.
(b) After completing installation of the product, the work site shall be restored . The work site shall be cleaned of all excess slurry left on the ground. Removal of excess slurry or spoils as the product is introduced, shall be the responsibility of the boring contractor.
(c) Excavated areas shall be restored in accordance with the Standard Specifications for Road and Bridge Construction and Roadway and Traffic Design Standards. The cost of restoring damaged pavement, curb, sidewalk, driveways, lawns, storm drains, landscape, and other facilities is borne by the Contractor / Permittee.
(d) The provisions of Chapter 556, FS must be complied with. Methods to be used for marking Utilities shall minimize impact on other construction or maintenance activities, including mowing operations, which may be conducted throughout the project on a cyclic basis. In order to accomplish this, marking by painting is preferred but not required. When and where flagging of existing Utilities is required, these facilities shall not be flagged through an area for a length ahead of what construction can be accomplished in 14 consecutive days unless approved by the Engineer.

556-3.2 Ground Water Control
(a) When ground water level must be controlled, the system is compatible with the properties, characteristics, and behavior of the soils as indicated by the soil investigation report.
(b) Ground water may be controlled from sumps constructed inside the excavated areas (pits). When sump pumps are not sufficient to control the ground water, de-watering is required as specified in Section 455.28 and other local, state or federal regulations.

556-4 Quality Control
(a) A representative of the Contractor / Permittee must be in control of the operation at all times. The representative must have a thorough knowledge of the equipment and the procedures to be performed, and is present at the job site during the installation.
(b) The Department must be notified 48 hours in advance of starting work. The installation shall not begin until the Department's representative is present at the job site and agrees that proper preparations have been made.

556-5 Specific Requirements
556-5.1 Specific Micro-Tunneling Requirements
Continuous pressure shall be provided to the face of the excavation to balance groundwater and earth pressures. Shafts shall be of sufficient size to accommodate equipment, the pipe selected, and to allow for safe working practices. Entry and exit seals shall be provided at shaft walls to prevent inflows of groundwater, soil, slurry, and lubricants. Thrust blocks shall be designed to distribute loads in a uniform manner so that any deflection of the thrust block is uniform and does not impart excessive loads on the shaft itself, or cause the jacking frame to become misaligned.

The Micro-Tunneling boring machine (MTBM) shall meet the following minimum performance requirements:
(A) Capable of providing positive face support regardless of the MTBM type.
(B) Articulated to enable controlled sheeting in both the vertical and horizontal directions to a tolerance of plus or minus 1 inch from design alignment.

(C) All functions are controlled remotely from a surface control unit.
(D) Capable of controlling rotation. This is accomplished by a bi-directional drive on the cutter head or by using anti-roll fins or grippers.
(E) Capable of injecting lubricant around the exterior of the pipe being jacked.
(F) Capable of controlling heave and settlement to acceptable tolerances as indicated in the contract documents.

The main control system of the MTBM shall provide the following information to the operator as the minimum required for successful operation of the MTBM:
(A) Deviation of the MTBM from the required line and grade of the pipeline (normally by reference to a laser beam.)
(B) Grade and roll of the MTBM.
(C) Jacking load.
(D) Torque and RPM of the cutter head.
(E) Instantaneous jacking rate and total distance jacked.
(F) Indication of steering direction.

For slurry systems, the following is also required:
(G) The volume of slurry flow in both the supply and return side of the slurry loop.
(H) Indication of slurry bypass valve position.
(I) Indication of pressure of the slurry in the slurry chamber.

The jacking system shall have the capability of pushing the MTBM and pipe through the ground in a controlled manner and compatible with the anticipated jacking loads and pipe capacity. The jacking force applied to the pipe shall be monitored and not exceed the pipe manufacturer's recommendations.

The pipe lubrication system shall be functional at all times and sufficient to reduce jacking loads. Pipe lubrication systems shall include a mixing tank, holding tank and pumps to convey lubricant from the holding tank to application points at the rear of the MTBM. Sufficient fluids shall be maintained on site so as not to allow loss of lubrication.

Power Distribution System shall be identified under the contract or permit provisions as well as any noise constraints.

Spoil removal capability and method shall be identified so as not to create a hindrance to other activities which may be necessary in the area.

556-5.2 Testing
Upon completion of any casing or non-casing carrier installation, the Engineer may require a pressure test. If there is any obvious damage or problems noted during the installation such as jacking obstructions which had to be cleared and may have altered the shape or alignment of the product in any way, testing is always required. The testing may consist of one of the following methods but shall always meet or exceed
Department testing requirements:

(a) Manufacturer's pressure testing recommendations for the type of pipe being installed are followed. The Department's Engineer shall be notified and at his option be present during the test for review of the test results for compliance. The pressure test shall be performed within 24 hours. A copy of the test results shall be furnished to the Department's Engineer. If the pipe is not in compliance with specifications, the Engineer may require it to be filled with flowable fill.

(b) Product carrier pipes installed without a casing must meet pressure requirements set by the Owner. If the Owner does not require pressure testing, the Engineer may require at least one test. A copy of the test results shall be furnished to the Department's Engineer. If the pipe is not in compliance with specifications the Engineer may require it to be filled with flowable fill.
(c) The Department requires that conduit or pipe meet or exceed soil tight joint requirements when leakage would not cause failure or adversely affect the integrity of the roadway pavement or shoulders. Where leakage would adversely affect pavement or shoulder integrity, a water tight joint is required. Tests for joint integrity shall be conducted for 1 hour. The test for a soil tight joint allows up to 0.1 gallon of water leakage at a sustained pressure of 2 PSI. The water tight joint criteria allows no leakage at all for a sustained pressure of 5 PSI.

556-5.3 Locating and Tracking
For all installations, the Contractor / Permittee shall submit sufficient information to establish his proposed strategy for providing:
(a) A positive indication of where the leading edge of the casing is located with respect to line and grade. This indication is provided with a water gauge (Dutch level), electronic transmitting and receiving devices, or other approved methods. The Contractor / Permittee indicates the intervals for checking line and grade, and a record is maintained at the job site.
(b) Equipment of adequate size and capability to install the project. This includes the equipment manufacturer's information for all power equipment used in the installation.
(c) A means for controlling line and grade.
(d) A means for controlling over cut to a minimum, with the maximum limited to a 3/4-inch space around the circumference of the casing pipe.
(e) A means for centering the cutting head inside the borehole.
(f) Providing a positive means for preventing the rear of the cutting head from advancing in front of the leading edge of the casing by more than 1/3 times the casing diameter in stable cohesive conditions not to exceed 8 inches. In unstable conditions, such as granular soil, loose or flowable materials, the cutting head is retracted into the casing a distance that permits a balance between pushing pressure, pipe advancement and soil conditions to assure no voiding takes place.
(g) Adequate casing lubrication with a bentonite slurry or other approved techniques.
(h) An adequate band around the leading edge of the casing to provide extra strength, which in loose, unstable materials when the cutting head has been retracted into the casing reduces skin friction as well as provides a method for the slurry lubricant to coat the outside of the casing.
(i) At least 20 feet of full diameter auger at the leading end of the casing. Subsequent auger size may be reduced, but the reduced auger diameter must be at least 75% of the full auger diameter.
(j) Water to be injected inside the casing to facilitate spoil removal. The point of injection is be no closer than 2 feet from the leading edge of the casing.

All the above options are required for major installations unless the Engineer has agreed in writing that they are not necessary. For both major and minor installations, the Contractor / Permittee is responsible for submitting to the Engineer information indicating his proposed strategy for providing compatible materials and equipment.

All facilities shall be installed in such a way that their location can be readily determined by electronic designation after installation. For non-conductive installations this shall be accomplished by attachment of a continuous conductive material either externally, internally, or integrally with the product. Either a copper wire line or a coated conductive tape for this material may be used. Any break in the conductor must be connected by electrical clamp of brass or solder and coated with a rubber or plastic insulator to maintain the integrity of the connection from corrosion.

556-7 Documentation

556-6.1 Boring Path Report

The Contractor / Permittee shall furnish a Bore Path Report to the FDOT within 14 days of the completion of each bore path. The completed As-Built-Plans shall be submitted to the Engineer within 30 calendar days. No payment will be made for directional boring work until the Bore Path Report has been delivered to the Department. The report shall contain:

(a) Location of project and financial project number including the Permit No. when assigned.

(b) Name of person collecting data, including title, position, and company name.

(c) Investigation site location (contract plans station number or reference to a permanent structure within the project right of way).

(d) Identification of the detection method used.

(e) As-built placement drawings showing roadway plan and profile, cross section, boring location and subsurface conditions as defined in Bore Path Drawings below. Plan elevations shown shall be referenced to a FDOT Bench Mark when associated with an FDOT project, otherwise to a USGS grid system and datum, or to the top of an existing FDOT head wall. These drawings shall be done to the same scale in black ink on white paper, of the same size and weight and as the contract plans. Submittal of electronic plans data in lieu of hard copy plans may be approved by the Engineer if compatible with the Department software.

556-6.2 Boring Path Drawings

Boring Path Drawings shall be dimensionally correct copies of the contract plans. Notes shall be included on each drawing stating the final bore path diameter, facility diameter, drilling fluid composition, composition of any other materials used to fill the annular void between the bore path and the facility or facility placed out of service. If the facility is a casing, this shall be noted, as well as the size and type of carrier pipes to be placed within the casing as part of the contract work. The drawings shall be produced as follows:

(a) The contract plan view shall show the center-line location of each facility, installed or installed and placed out of service to an accuracy within 1 inch at the ends and other points physically observed. They show the remainder of the horizontal alignment of the center line of each facility installed or installed and placed out of service, and note the accuracy with which the installation was monitored.

(b) As directed by the Engineer, either a profile drawing for each bore path, or a cross section of the roadway at a station specified by the Engineer, or a roadway centerline profile, shall be provided. They shall show the ground or pavement surface and the crown elevation of each facility installed, or installed and placed out of service, to an accuracy within 1 inch at the ends and other points physically observed. It shall show the remainder of the vertical alignment of the crown of each facility installed, or installed and placed out of service, and notes the accuracy with which the installation was monitored. On profile drawings for bore paths crossing the roadway the contract plans stationing of the crossing shall be shown. On the profile drawings for bore paths paralleling the roadway the contract plans stationing are also shown. If the profile drawing for the bore path is not made on a copy of one of the contract profile or cross section sheets, a 10 to 1 vertical exaggeration shall be used.

(c) If during installation an obstruction is encountered which prevents installation of the pipe in accordance with this specification, the pipe may be taken out of service and left in place at the discretion of the Engineer, and shall immediately be filled with flowable fill. A new installation procedure and revised plans must be submitted to and approved by the Engineer before work can resume. If a bore path is abandoned without installing a facility, the drawings shall show the abandoned bore path along with the final bore path. The abandoned bore path shall be noted as "Abandoned Bore Path." They shall also show the location and length of the drill head and any drill stems not removed from the bore path. If conditions warrant removal of the materials installed in the abandoned bore path, as determined by the Department, during construction or in the future, the cost and responsibility shall be born by the permittee.

(d) On all the drawings, show the crown elevation, diameter and material type of all utilities encountered and physically observed during the subsoil investigation. For all other obstructions encountered during a subsoil investigation or the installation, show the type of material, horizontal and vertical location, top elevation and lowest elevation observed, and note if the obstruction continues below the lowest point observed.

556-8 Method Of Measurement.
Fees paid the Contractor / Permittee shall be based on the actual length of the installation, measured in place along the surface of the ground, complete and accepted. No additions or deductions will be made for sweeps in either the vertical or horizontal direction to complete the installation.

556-9 Basis Of Payment.
Payment will be made under Item 556-01-XXX Jack & Bore- per lineal foot of bore diameter, where:
556-01-X01 < than 6 inches bore diameter
556-01-X02 6.0 inches to < 12.0 inches bore diameter
556-01-X03 12.0 inches to < 18.0 inches bore diameter
556-01-X04 18.0 inches to < 24.0 inches bore diameter
556-01-X05 24.0 inches to < 30.0 inches bore diameter
556-01-X06 30.0 inches and greater bore diameter

Payment will be made under Item 556-02-XXX Micro-tunneling- per lineal foot of bore diameter, where:
556-02-X01 < than 6 inches bore diameter
556-02-X02 6.0 inches to < 12.0 inches bore diameter
556-02-X03 12.0 inches to < 18.0 inches bore diameter
556-02-X04 18.0 inches to < 24.0 inches bore diameter
556-02-X05 24.0 inches to < 30.0 inches bore diameter
556-02-X06 30.0 inches and greater bore diameter

No payment shall be made for abandoned bore path, taken out of service or incomplete installations. Payment to the Contractor / Permittee shall be full compensation for all work specified in this section. This includes all installations, from plan point of beginning to plan point of ending (i.e. pull box) at plan depth, removal of excavated materials and spoils, removal and disposal of drilling fluids, backfilling, and complete restoration.

Texas DOT Boring and Tunneling Specification – 1993

ITEM 476

JACKING, BORING OR TUNNELING PIPE

476.1. Description. This Item shall govern for furnishing and in- stalling of pipe by the methods of jacking, boring or tunneling as shown on the plans and in accordance with this Item.

476.2. Materials. Pipe may be either corrugated metal pipe con- forming to Item 460, "Corrugated Metal Pipe", of the size, type, design and dimension shown on the plans, or reinforced concrete pipe, conforming to the special requirements for jacking, boring or tunneling of Item 464, "Reinforced Concrete Pipe", of the size, strength and dimension shown on the plans, or other types as may be specified by the Engineer or shown on the plans.

476.3. Construction Methods.

(1) General. If the grade of the pipe at the jacking, boring, or tunneling end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking, boring or tunneling operations and for placing end joints of the pipe. Excavations greater than five (5) feet in depth shall be protected as specified in Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring".

Where pipe is required to be installed under railroad embankments, highways, streets, or other facilities by jacking, boring or tunneling methods, construction shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure.

Pipe damaged in jacking, boring or tunneling operations shall be repaired in place to the satisfaction of the Engineer. Pipe damaged beyond repair will be removed and replaced. Repair or removal and replacement of damaged pipe will be done at the Contractor's expense.

The pits or trenches excavated to facilitate jacking, boring or tunneling operations shall be backfilled immediately after the installation of the pipe has been completed.

(2) Jacking. Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head and suitable bracing between the jacks and the jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. Joint cushioning material of plywood or other material may be used as approved by the Engineer. Plywood cushioning material shall be 1/2 inch minimum thickness for pipe diameters 30 inches and less and 3/4 inch minimum thickness for pipe diameters greater than 30 inches. Cushioning rings may be made up of single or multiple pieces. A suitable jacking frame or back stop shall be provided. The pipe to be jacked shall be set on guides, properly braced together, to support the section of the pipe and to direct the pipe in the proper line and grade. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. In general, the embankment material shall be excavated just ahead of the pipe, the material removed through the pipe, and the pipe forced through the embankment with jacks, into the space thus provided.

The Contractor shall furnish for the Engineer's approval, a plan showing the proposed method of jacking. The plan shall include the design for the jacking head, jacking support or back stop, arrangement and position of jacks, pipe guides, etc., complete in the assembled position.

The excavation for the underside of the pipe, for at least one-third of the circumference of the pipe, shall conform to the contour and grade of the pipe. Over-excavation to provide not more than two (2) inches of clearance may be provided for the upper half of the pipe. This clearance shall be tapered to zero at the point where the excavation conforms to the contour of the pipe. Over-excavation in excess of one (1) inch shall be pressure grouted the entire length of the installation.

The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but shall not exceed two (2) feet. This distance shall be decreased when directed by the Engineer.

Preferably, the pipe shall be jacked from the low or downstream end. The final position of the pipe shall not vary from the line and grade shown on the plans, or established by the Engineer, by more than one (1) inch in 10 feet. The variation shall be regular and in one direction and the final flow line shall be in the direction shown on the plans.

The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with inside angles or lugs to keep the cutting edge from slipping back onto the pipe.

When jacking of pipe has begun, the operation shall be carried on without interruption, insofar as practicable, to prevent the pipe from becoming firmly set in the embankment.

(3) Boring. The boring shall proceed from a pit provided for the boring equipment and workmen. The location of the pit shall be approved by the Engineer. The boring shall be done mechanically either using a pilot hole or by the auger method.

When the pilot hole method is used an approximate two (2) inch pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored.

When the auger method is used, a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation shall be used. Augers shall be of sufficient diameter to convey the excavated material to the work pit.

Excavated material shall be disposed of by the Contractor, as approved by the Engineer. The use of water or other fluids in connection with the boring operation will be permitted only to the extent necessary to lubricate cuttings; jetting will not be permitted.

In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade carefully processed bentonite may be used to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and immediate installation of the pipe.

Allowable variation from line and grade shall be as specified in Subarticle 476.3.(2). Overcutting in excess of one (1) inch shall be remedied by pressure grouting the entire length of the installation.

(4) Tunneling. Where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic sewer would make the use of tunneling more satisfactory than jacking or boring; or when shown on the plans, a tunneling method may be used, with the approval of the Engineer.

When tunneling is permitted, the lining of the tunnel shall be of sufficient strength to support the overburden. The Contractor shall submit the proposed liner method to the Engineer for approval. Approval by the Engineer shall not relieve the Contractor of the responsibility for the adequacy of the liner method.

The space between the liner plate and the limits of excavation shall be pressure-grouted or mud-jacked.

Access holes for placing concrete shall be spaced at maximum intervals of 10 feet.

(5) Joints. If corrugated metal pipe is used, joints may be made by field bolting or by connecting bands, whichever is feasible. If reinforced concrete pipe is used, the joints shall be in accordance with Item 464, "Reinforced Concrete Pipe".

476.4. Measurement. This Item will be measured by the linear foot between the ends of the pipe along the flow line.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

476.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Jacking or Boring Pipe", or "Jacking, Boring or Tunneling Pipe" of the type, size, and strength or design specified.

This price shall be full compensation for excavation, grouting, backfilling and disposal of surplus material; for furnishing all materials, including pipe liner materials required for tunnel operations; for all preparation, hauling and installing of pipe and pipe liner materials; and for all labor, tools, equipment and incidentals necessary to complete the work except that protection methods for excavations greater than five (5) feet in depth shall be measured and paid for as required under Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring".

San Antonio Pipe Bursting Specification

San Antonio Water System Standard Specifications for Construction

ITEM NO. 900
RECONSTRUCTION OF SANITARY SEWER BY PIPE BURSTING/CRUSHING REPLACEMENT PROCESS

900.1 DESCRIPTION: This specification includes requirements to rehabilitate existing sanitary sewers by the pipe bursting/crushing method. The pipe bursting/crushing process is defined as the reconstruction of existing sanitary sewers by the simultaneous insertion (breaking and expanding the old pipe) of liner pipe within the bore of the existing pipe. Also covered in this specification is pipe, pipe joining, manhole connections, connection of service laterals and stubs, point repairs, obstruction removals, television requirements, testing requirements, by-pass pumping criteria, site restoration, erosion control requirements, and warranty requirements.

The pipe bursting/crushing process involves the rehabilitation of deteriorated gravity sewer pipe by installing new pipe material within the enlarged bore created by the use of using a static, hydraulic, or pneumatic hammer "moling" device, suitably sized to break the existing pipe or by using a modified boring "knife" with a flared plug that crushes the existing sewer pipe. Forward progress of the "mole" or the "knife" may be aided by hydraulic equipment or other apparatus. Replacement pipe is either pulled or pushed into the bore. Sewer services are reconnected to the new pipe through small excavations from the surface. Sewage flows from the upstream line and from the services are pumped as required to prevent overflows and provide continual service. All excavations required for reconnecting and pumping service flows, entry pits, exit pits, obstruction removal, point repairs, among others, are to be kept to a minimum and all damage to surface and underground features, facilities, utilities and improvements are to be repaired.

900.2 MATERIALS

1. HIGH DENSITY POLYETHYLENE PIPE (HDPE) related to pipe bursting or pipe crushing for a sanitary sewer or related pipe line habilitation:

a. Solid wall HDPE pipe referred to as Drisco 1000, Drisco 8600, Quail Pipe, Poly Pipe, and Plexco Pipe that is in conformance with ASTM F714 and ASTM requirements stated herein are considered approved for this project. HDPE pipe on this project will further be required to have a minimum pipe stiffness of 46 psi for 12 inch to 48 inch diameter pipe and 115 psi for 8 inch to 10 inch diameters as required by SAWS and TNRCC.

   PIPE MANUFACTURE: All pipe and fittings will be high density polyethylene pipe and made of virgin material. No rework except that obtained from the manufacturer's own production of the same formulation will be used. The liner material will be manufactured from a High Density High Molecular weight polyethylene compound which conforms to ASTM D 1248 and meets the requirements for Type III, Class C, Grade P-34, Category 5, and has a PPI rating of PE 3408.

b. The pipe produced from this resin will have a minimum cell Classification of 345434C (Inner wall will be light in color) under ASTM D 3350. A higher number cell classification limit which gives a desirable higher primary property, per ASTM D 3350 may also be ac-

cepted by the Engineer at no extra cost to SAWS. The value for the Hydrostatic Design basis will not be less than 1600 PSI (11.03 MPA) per ASTM D 2837. Pipe will have ultraviolet protection.

c. PIPE COLOR AND QUALITY: For television inspection purposes, the polyethylene pipe will have light-colored interior achieved with a homogenous, light-colored material throughout or with a fully bonded light-colored interior liner meeting specifications above indicated. All pipe will be free of visible cracks, holes, foreign material, foreign inclusions, blisters, or other deleterious or injurious faults or defects. Pipe and fittings shall be as uniform as commercially practical in color, opacity, density, and other physical properties.

For interior lined pipe, the liner will be a minimum of 10 mils thick and co-extruded. The bond between the layers will be strong and uniform. It will not be possible to separate the two layers with a probe or point of a knife blade so that the layers separate cleanly at any point, nor will separation of the bond occur, between layers, during testing performed under the requirements of this specification.

d. PIPE DIAMETER: Polyethylene Plastic Pipe will meet the applicable requirements of ASTM F 714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, ASTM D 1248, and ASTM D 3550. Internal diameter of the pipe indicated on the plans will be the minimum allowable pipe size.

e. PIPE DIMENSION RATIOS: The minimum wall thickness of the polyethylene pipe will meet the following, as based on the deepest portion of a particular pipe pull, typically between manholes:

Depth of Cover (Feet)	Minimum SDR of Pipe
0 - 16.0	19
>16.1	17

Wall thickness shall be as indicated on the plans and will be in accordance with Chevron Plexco Industrial Piping System Pipe Data and Pressure Ratings Bulletin 301, or approved equal.

f. PIPE JOINING: Solid wall pipe shall be produced with plain end construction for heat-joining (butt fusion) conforming to ASTM D 2657.

The polyethylene pipe will be assembled and joined at the site using the thermal butt-fusion method to provide a leak proof and structurally sound joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used will be used in strict compliance with the manufacturer's recommendations. Fusing will be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment.

The butt-fused joint will be true alignment and will have uniform roll back beads resulting from the use of proper temperature and pressure. The joint surfaces will be smooth. The fused joint will be watertight and will have tensile strength equal to that of the pipe. All joints will be subject to acceptance by the Engineers and/or his representative prior to insertion. All defective joints will be cut out and replaced at no cost to SAWS. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, will not be used and must be removed from the site.

However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, if in the opinion of the Engineers and/or his representative any section of pipe has other defects, including those hereinafter listed, that may indicate damaged, improperly manufactured, faulty, or substandard pipe, said pipe will be discarded and not used. Defects warranting pipe rejection include the following: concentrated ridges, discoloration, excessive spot roughness, and pitting; insufficient or variable wall thickness; pipe damage from bending, crushing, stretching or other stress; pipe damage that impacts the pipe strength, the intended use, the internal diameter of the pipe, internal roughness characteristics; or any other defect of manufacturing or handling.

Clamps and Gaskets: Clamps shall be stainless steel, including bolts and lugs as manufactured by JCM Industries Type 108 or equal. Furnish full circle, universal clamp couplings with a minimum 3/16-inch thick neoprene, grid-type gasket. Select clamps to fit outside diameter of pipe. Use minimum clamp length of 30" for replacement pipes O.D. of 10.75 inches (10 inch nominal) or greater, and 18 inches for replacement pipe O.D. less than 10.75 inches.

Terminal sections pipe that are joined within the insertion pit will be connected with a full circle pipe repair clamp. The butt gap between pipe ends will not exceed one-half (½) inch.

g. FORCE MAINS: Where applicable, solid wall pipe for sanitary sewer force mains shall have a minimum working pressure rating of 150 psi, and an inside diameter equal to or greater than the nominal pipe size indicated on the Drawings.

h. AUGERING PIPE: HDPE pipe is not approved in applications requiring augering of sewer pipe.

i. PIPE MARKING: Each standard and non-standard length of pipe or fitting shall be clearly marked with pipe size, pipe class, production code, material designation and other relevant identifying information.

j. PIPE INSPECTIONS: The Engineer reserves the right to inspect pipes or witness pipe manufacturing. Such inspection shall in no way relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications. Should the Engineer wish to witness the manufacture of specific pipes, the manufacturer shall provide the Engineer with adequate advance notice of when and where the production of those specific pipes will take place. Approval of the products or tests is not implied by the Engineer's decision not to inspect the manufacturing, testing, or finished pipes.

900.3 CONSTRUCTION

1. PIT LOCATION: Location and number of insertion or launching pits will be chosen by the contractor, and will typically be located near existing or proposed manholes, P.I.'s in the line, at logical breaks in the construction phasing, or at locations to comply with access or maintenance requirements.

Pits shall be placed and located to minimize the total number of pulls and maximize the length of pipe replaced per pull, within the constraints of maintaining service and access and other requirements. Use excavations at point repair locations for insertion pits where possible.

2. OPERATIONS: The contractor shall provide equipment, planning, and job execution necessary to accomplish the work in an efficient manner and consistent with the objectives of this specifications, including preventing damage to existing infrastructure, maintaining pedestrian and vehicle access, and providing continual sewer service to customers.

Pipe shall be assembled and fused on the ground in sections equivalent to the length of the anticipated pull. During installation, all bending and loading the pipe shall be in conformance with manufacturers recommendations and shall not damage pipe.

Manholes shall be prepared so as to provide pipe installation at the lines and grades indicated on the plans. The invert in the manholes shall be removed as required to allow for pipe installation activities and to accommodate invert replacement. Manhole inverts shall be restored upon completion with 3000 psi grout so as to establish a minimum 4 inch thick bottom on the manhole after shaping per drawings.

3. EQUIPMENT: The Contractor shall utilize pipe bursting/crushing equipment with adequate pulling/pushing force to complete pulls in a timely manner. The contractor shall provide equipment on the pulling mechanism to verify the pulling/pushing force exerted on the pipe does not exceed the manufacturer's recommendation for allowable pulling force to prevent damage to the pipe. The pulling force may not exceed the following: 6 tons for 8.625" O.D.; 10 tons for 10.75"inch O.D.; 17 tons for 14" O.D.; 23 tons for 16 inch O.D.; 28 tons for 18 inch O.D. Allowable pulling force for all diameters shall be determined by the contractor depending on the pipe size, wall thickness, manufacturer, field conditions, pull distance, manhole integrity, bearing capacity of soils, adjacent infrastructure, related equipment and cable strength, and related considerations.

4. Equipment shall be configured with adequate knives or other appropriate devices to minimize interruptions in the installation process due to obstruction removal and other problems. Pipe shall be secured to the pulling/pushing device in accordance with standard practice. The diameter of the pulling/pushing head shall be equal or slightly greater than the pipe OD.

5. MINIMIZE NOISE IMPACT: Equipment used to perform the work will be located away from buildings so as not to create a noise impact. Provide silencers or other devices to reduce machine noise as required to meet requirements.

6. PROTECTION: The Contractor shall provide for the general safety of workers, pedestrians and traveling public throughout this project. Existing surface improvements and underground facilities and utilities shall also be protected. Damage caused by the Contractor shall be repaired at his own expense. Protection to be provided includes:

a. Provide barricades, warning lights and signs for excavations created by point repairs. Conform to requirements of TxDOT, City of San Antonio, and of contract documents.

b. Protection of Manholes: The Contractor will install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes, and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances will the pipes be stressed beyond their elastic limit.

c. Do not allow sand, debris, or runoff to enter sewer system.

d. Verify location of all underground utilities and facilities potentially impacted by rehabilitation related or other project activities and take necessary precautions to provide protection from damage. Damage caused by the Contractor shall be at his cost and responsibility.

e. Protect the new pipe and components during all phases of work, including hauling, installation, entry into the entry pit, and prevention of scarring or gouging of the pipe or components.

7. SEALING LINER IN MANHOLE:

a. Allow liner pipe to normalize to ambient temperatures as well as recover from imposed stretch before cutting to fit between manholes, sealing at manholes, and manhole invert shaping. Normalization usually takes at least 12 hours for polyethylene.

b. Cut liner so that it extends four inches into manhole. Make a smooth, vertical cut and slope area over top of exposed liner using non-shrink grout.

c. Seal the annular space between liner and sanitary sewer main at each manhole with a chemical seal and non-shrink grout. Place strips of oakum soaked in sealer (Scotchseal 5600 as manufactured by 3M Corporation, or equal) in a band to form an effective water-tight gasket in the annular space between liner and existing opening in manhole. Make width of the sealing band a minimum of eight inches or the thickness of the manhole wall, whichever is greater.

d. Finish seal with a non-shrink grout placed around annular space from inside manhole. Apply grout in a band not less than six inches wide.

e. Reshape and smooth the manhole invert. Form a smooth transition with a reshaped invert and a raised manhole bench to eliminate sharp edges of liner pipe, concrete bench, and channeled invert. Build up and smooth invert of manhole to match flow line of new liner.

8. FIELD TESTING

a. After the existing sewer is completely replaced, internally inspect with television camera and video tape as required. The finished tape will be continuous over the entire length of the sewer between two manholes and to be free from visual defects.

b. Defects which may affect the integrity or strength of the pipe in the opinion of the Engineer will be repaired or the pipe replaced at the Contractor's expense.

c. The Contractor shall smoke test to verify all sewer service connections.

d. The following items are excerpted from TNRCC Chapter 317 requirements for gravity sewer construction testing (§317.a.4). Compliance with these requirements is required unless the contractor obtains and provides written authorization from the TNRCC authorizing alternative testing and compliance procedures:

1. Testing of Installed Pipe: An infiltration, exfiltration or low-pressure air test shall be specified. Copies of all test results shall be made available to the executive director (TNRCC) upon request. Tests shall conform to the following requirements:

2. Infiltration or Exfiltration Tests: The total exfiltration as determined by a hydrostatic head test, shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours at a minimum test head of two feet above the crown of the pipe at the upstream manhole. When pipes are installed below the groundwater level an infiltration test shall be used in lieu of the exfiltration test. The total infiltration, as determined by a hydrostatic head test, shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours at a minimum test head of two feet above the crown of the pipe at the upstream manhole, or at least two feet above existing groundwater level, whichever is greater. For construction within the 25 year flood plain, the infiltration or exfiltration shall not exceed 10 gallons per inch diameter per mile of pipe per 24 hours at the same minimum test head. If the quantity of infiltration or exfiltration exceeds the maximum quantity specified, remedial action shall be undertaken in order to reduce the infiltration or exfiltration to an amount within the limits specified.

3. Low Pressure Air Test: The procedure for the low pressure air test shall conform to the procedures described in ASTM C-828, ASTM C-924, ASTM F-1417 or other appropriate procedures, except for testing times. The test times shall be as outlined in this section. For sections of pipe less than 36-inch average inside diameter, the following procedure shall apply unless the pipe is to be joint tested. The pipe shall be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure is stabilized, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be computed from the following equation:

T	=	time for pressure to drop 1.0 pound per square inch gauge in seconds
K	=	0.000419´D´L, but not less than 1.0
D	=	average inside pipe diameter in inches
L	=	length of line of same pipe size being tested, in feet
Q	=	rate of loss, 0.0015 cubic feet per minute per square foot internal surface shall be used

Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as follows:

4.

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Longer Length (seconds)
6	340	398	0.855(L)
8	454	298	1.520(L)
10	567	239	2.374(L)
12	680	199	3.419(L)
15	850	159	5.342(L)
18	1020	133	7.693(L)
21	1190	114	10.471(L)
24	1360	100	13.676(L)
27	1530	88	17.309(L)
30	1700	80	21.369(L)
33	1870	72	25.856(L)

5. The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure. Lines with a 27-inch average inside diameter and larger may be air tested at each joint. Pipe greater than 36 inch diameter must be tested for leakage at each joint. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing. The pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

6. Deflection Testing. Deflection tests shall be performed on all flexible pipes. For pipelines with inside diameters less than 27 inches, a rigid mandrel shall be used to measure deflection. For pipelines with an inside diameter 27 inches and greater, a method approved by the executive director shall be used to test for vertical deflections. Other methods shall provide a precision of ± two tenths of one percent (0.2 %) deflection. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of five percent. If a pipe should fail to pass the deflection test, the problem shall be corrected and a second test shall be conducted after the final backfill has been in place an additional 30 days. The tests shall be performed without mechanical pulling devices. The design engineer should recognize that this is a maximum deflection criterion for all pipes and a deflection test less than five percent may be more appropriate for specific types and sizes of pipe. Upon completion of construction, the design engineer or other Texas Registered Professional Engineer appointed by the owner shall certify, to the Executive Director, that the entire installation has passed the deflection test. This certification may be made in conjunction with the notice of completion required in §317.1(e)(1) of this title (relating to General Provisions). This certification shall be provided for the Commission to consider the requirements of the approval to have been met.

7. --Mandrel Sizing. The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe, all dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.

8. --Mandrel Design. The rigid mandrel shall be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.

9. --Method Options. Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test. A deflectometer may be approved for use on a case by case basis. Mandrels with removable legs or runners may be accepted on a case by case basis.

900.4 MEASUREMENT AND PAYMENT: Measurement and payment for items included in this specification shall be in accordance with the pay items listed below. Work included in these items shall include and the price provided by the Contractor will be considered as full compensation for

furnishing and placing of all materials, labor, tools, and equipment; cleaning, preparation, repairs, obstruction removal, inspection; and phasing, protecting, work execution and any other work necessary to complete the project.

1. INSTALLED PIPE: The inserted pipe will be paid for per linear foot of pipe installed using pipe-bursting/pipe crushing method for the pipe diameter, type, quantity, and depth specified and will include all pipe installation materials, all submittals, sealing materials at manholes and annulus (if required), launching pits, receiving pits, post testing, shoring, bedding, backfill, and all necessary, corresponding, and related work specified herein. (Item 900)

2. SERVICES: Locating and reconstruction of services and all connections of services will be paid for per each connection made, including fittings and pipe. Payment for abandoned services will be on a per each connection made basis. (Item 900.1)

3. POINT REPAIRS: Point repairs will be paid for on a per each basis, as needed. Extra length point repair will be paid based on the length of pipe replaced per repair beyond the length established for each single point repair item, as needed. Abandoned point repairs will be paid on a cubic yard basis, as needed. (Item 900.5)

4. OBSTRUCTION REMOVAL: Obstruction removal will be paid for on a per each basis, as needed. (Item 900.6)

5. STORM WATER POLLUTION PREVENTION AND EROSION CONTROL PLAN: Payment for this item will be based on the items and quantities of control measures included in the proposal on the basis indicated in the respective specification sections.

6. SITE RESTORATION: Except as associated with point repairs and obstruction removals, site restoration for all impacts to surface improvements will be on a linear foot basis of the rehabilitated line segment. For point repairs and obstruction removals, site repair will be on a per each basis.

7. TELEVISION INSPECTION: Payment will be made for television inspection of the sewer line prior to pipe rehabilitation in accordance with specifications Item 866 and cleaning will be in accordance with specification Item 868. There will be no additional or separate payment for “post-TV” video inspection, documentation, required submittals, and associated or related work.

8. BYPASS PUMPING: The cost of any necessary bypass pumping will be considered subsidiary to the appropriate pay items for pipe installation, television inspection, repair, or related work and will not be a separate pay item.

Wichita, Kansas Microtunneling Specification

SECTION 808
MICROTUNNELING INSTALLATION OF PIPE

808.1 DESCRIPTION

The Contractor shall furnish and install pipe by microtunneling as indicated and in conformity with this specification. The work includes, but shall not be limited to traffic control, excavation, dewatering, removal of all materials encountered in microtunneling operations, disposal of all material not required in the work, grouting, bulkheads, backfilling and site restoration.

The Contractor shall provide a microtunneling process which uses a remotely operated shield machine for installing pipes or pipe linings underground without the use of ground stabilization techniques. The intent of the process is to minimize surface disruption and allow installation of pipe without many of the constraints imposed by trenching or conventional tunneling methods.

808.2 MATERIALS

a) **Pipe -** Carrier pipe shall conform to the Supplemental Specification for Jacking Pipe of the size, type, materials, thickness and class indicated.
b) **Grout -** Grout for voids shall consist of 1 part Portland Cement and 4 parts fine, clean sand mixed with water.

808.3 EQUIPMENT

General:

The microtunneling system shall consist of five major, independently controlled components:

a) Microtunnel Boring Machine (MTBM)
b) Jacking system
c) Spoil removal system
d) Guidance and control system
e) Pipe lubrication system.

Description of the System:

a) The Contractor shall provide a microtunneling system for installing pipe behind a remotely controlled, steerable, guided, articulated Microtunnel Boring Machine (MTBM). The MTBM shall be connected to and followed by the pipe which is installed by jacking and shall be capable of fully controlling the rate at which the material is being excavated at all times.
b) The minimum depth of cover to the pipe being installed using the microtunneling process is normally six (6) feet or 1.5 times the outer diameter of the pipe being installed, whichever is the greater. With special precautions, and approval by the Engineer, this depth of cover may be decreased.
c) Microtunneling work shall be executed so as to minimize settlement or heave. Overcut shall not exceed 1" on the radius of the pipe being installed without the approval of the Engineer. The annular space created by the overcut may be filled with the lubrication material that is used to reduce the friction drag of the soil on the pipe.

Micro Tunnel Boring Machine (MTBM):

a) The MTBM shall be capable of controlling rotation or roll by means of bi-directional drive on the cutter head or by the use of fins or grippers. The MTBM shall be articulated to enable remotely controlled steering of the shield.
b) A display showing the position of the shield in relation to a design reference shall be available to the operator at an operation console together with other information such as face pressure, roll, pitch, steering attitude and valve positions.
c) The MTBM shall have a cutter face capable of supporting the full excavated area at all times, and may have the capability of setting a calculated earth balancing pressure and positively measuring the earth pressure at the face.
d) When soil conditions dictate, the tunnel shall be capable of removing cobbles and boulders. The excavation system shall be fully capable of excavating all material that it will encounter.

Automated Spoil Transportation:

a) The automated spoil transportation system shall match the excavation rate to the rate of spoil removal, maintaining settlement or heave within tolerances specified herein.
b) The balancing of ground water pressures shall be achieved by the use of a slurry pressure or auger earth pressure balance system. The system shall be capable of any adjustment required to maintain face stability for the particular soil condition to be encountered on the project. The system shall monitor and continuously balance the ground water pressure.
c) If a slurry spoil transportation system is used, the ground water pressure may be managed by use of the slurry pumps (which may be of variable speeds), pressure control valves and a flow meter. A slurry bypass unit shall be included in the system to allow the direction of flow to be changed and isolated, as necessary.
d) A separation process shall be provided when using the slurry transportation system. The process shall be designed to provide adequate separation of the spoil from the slurry so that the clean slurry can be returned to the cutting head for reuse. The Contractor shall identify the type of separation process to be used.

   If an Auger spoil transportation system is utilized, the ground water pressures may be managed by controlling the volume of spoil removal with respect to the advance rate (Earth Pressure Balance Method) and the application of compressed air. In soils with excessive ground water, approval of the Engineer may be required for earth pressure balance auger systems. Approval will be based on the evaluation of the equipments ability to balance soil and water pressures at the face, stability of the soils and the significance of the ground water present.

Pipe Jacking Equipment:

a) The main jacks shall be mounted in a jacking frame and located in the drive (starting) shaft. The jacking frame successively pushes the MTBM followed by a string of connected pipes toward a receiving shaft. The jacking capacity of the system shall be sufficient to push the MTBM and the string of pipes thorough the ground.
b) The main jacking equipment installed shall have a capacity greater than the anticipated jacking load. The hydraulic cylinder extension rate shall be synchronized with the excavation rate of the MTBM, which is determined by the soil conditions.
c) Intermediate jacking stations shall be provided by the Contractor when the total anticipated jacking force needed to complete the installation exceeds the designed maximum jacking force of the pipe or 80% of the capacity of the main jacks.
d) The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe by the use of spreader rings and packing.

Pipe Lubrication System:
A pipe lubrication system may be utilized when anticipate jacking forces on the pipe are expected to exceed the capacity of the main jacks or exceed the pipe design strength with the appropriate safety factor. An approved lubricant shall be injected at the rear of the MTBM and, if necessary, through the pipe walls to lower the friction developed on the surface of the pipe during jacking and thereby reduce the jacking forces.

Remote Control System:

a) A Remote Control System shall be provided that allows for the operation of the system without the need for personnel to enter the microtunnel.
b) In man entry sized pipes, intermittent entry of personnel will be permitted into the pipe for maintenance during the drive and for removal of equipment once the pipe installation is complete.
c) The control equipment shall integrate the method of excavation and removal of soil and its simultaneous replacement by the pipe. As each pipe section is jacked forward, the control system shall synchronize excavation and jacking speeds. The system shall provide complete and adequate ground support at all times.

Active Direction Control:

a) Line and grade shall be controlled by a guidance system that relates the actual position of the MTBM to a design reference (e.g. by a laser beam transmitted from the jacking shaft along the center line of the pipe to a target mounted in the shield). The microtunneling system shall be capable of maintaining grade to within plus or minus 1" and alignment to within plus or minus 1.5", unless otherwise approved by the Engineer.
b) The active steering information shall be monitored and transmitted to the operation console. The minimum steering information available to the operator on the control console shall include the position relative to the design reference, roll, indication, attitude, rate of advance, installed length, thrust force, and cutter head torque.

808.4 CONSTRUCTION METHODS
General:
The Contractor shall provide and maintain adequate microtunneling equipment, install support systems as required, provide and install carrier pipe, and faithful execution of work using microtunneling and installing pipe simultaneously. The Contractor shall have sole responsibility for safety of microtunneling operations and for persons engaged in the work.

The Contractor shall furnish shop drawings showing his proposed method of microtunneling, including design for microtunneling head, installation of microtunneling supports or back stop, arrangement and position of microtunneling machinery, pipe guides, grouting plan, intended disposal of excavated material, and a project safety plan for the Engineer's review.

Jacking and Receiving Shafts:
Shafts shall be of a size commensurate with safe working practices. The Contractor shall provide shop drawings showing the shaft locations for approval by the Engineer.

The design of the shafts shall ensure safe exit from the driving shaft and entry into the receiving shaft of the MTBM.

Shafts and jacking pit shall be adequately ventilated. Air monitoring of the shafts or pits shall be conducted by the Contractor on a continuous basis in accordance with the Contractor's Safety Plan.

Before beginning construction at any location, the Contractor must adequately protect existing structures, utilities, trees, shrubs and other permanent objects where visible or shown on the drawings.

The Contractor shall furnish and install equipment to keep the jacking shaft free of excess water. The Contractor shall also provide surface protection during the period of construction to ensure that surface runoff does not enter the driving shaft.

A thrust block is required to transfer jacking loads into the soil. The thrust block shall be designed to support the maximum jacking pressure developed by the main jacking system. Special care shall be taken when setting pipe guide rails in the jacking shaft to ensure correctness of the alignment, grade, and stability. If a concrete thrust block or treated soil zone is utilized to transfer jacking loads in to the soil, the MTBM is not to be jacked until the concrete or other material have attained the required strength.

During construction operations and until pits are backfilled, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained conforming to the Manual Uniform Traffic Control Devices (MUTCD).

When grade of pipe at microtunneling end is below ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the microtunneling operations and for joining pipe. Work shall be sheeted securely and braced to prevent earth caving and to provide a safe and stable work area. Minor lateral or vertical variations in final position of pipe from line and grade established by Engineer will be permitted at the discretion of Engineer provided that such variations shall be regular and only in one direction and that final grade of flow line shall be in direction indicated.

If trench bottom is unstable or excessively wet or when installation of water and wastewater pipe will result in cover less than six (6) feet or 1.5 times the outer diameter of the pipe being installed, whichever is the greater, the Contractor shall notify the Engineer. The Engineer may require the Contractor to install a concrete seal, cradle, cap or encasement or other appropriate action.

As soon as possible after carrier pipe(s) are completed, pits or trenches excavated to facilitate these operations shall be backfilled. The backfill in the street ROW shall be compacted to not less than 95 percent of the density conforming to ASTM D698. At the Contractor's option, flowable excavatable fill may be used up to three feet below the finished surface grade.

Where the characteristics of soil or size of proposed pipe would make use of tunneling more satisfactory that microtunneling, a tunneling method may be submitted for acceptance by Engineer. Tunneling shall conform to the requirements of the Standard Specifications.

Jacking Pipe:

In general, pipe used for jacking shall be round, have a smooth, even outer surface, and with joints that allow for easy connections between pipes. Pipe ends shall be square and smooth so that jacking loads are evenly distributed around the entire pipe joint, such that point loads are minimized when the pipe is jacked. Pipe used for pipe jacking shall be capable of withstanding all forces that will be imposed by the process of installation, as well as the final in place loading conditions. The driving ends of the pipe and intermediate joints shall be protected against damage as specified by the manufacturer. The detailed method proposed to cushion and distribute the jacking forces shall be described by the Contractor for each particular pipe material.

Pipe showing signs of failure may be required to be jacked through to the reception shaft and removed. Other methods of repairing the damaged conduit may be used, as recommended by the manufacturer and subject to approval by the Engineer. Repair or replacement of damaged pipe shall be performed by the Contractor at no additional cost to the City.

The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads. Jacking pipe is specified in other supplemental Specifications.

Installation:

Suitable pits or trenches shall be excavated for the purpose of conducting the jacking operations and for placing end joints of the pipe. Such work shall be sheeted securely and braced in a manner to prevent earth caving and to provide a safe, stable work area.

The microtunneling shall proceed from a pit provided for the microtunneling equipment and workmen. The location of the pit shall meet the approval of the Engineer. Excavated material shall be removed from the working pit and disposed of properly. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Jetting shall not be permitted.

In unstable soil formations, water or processed drilling fluid, containing colloidal material such as bentonite, may be used to consolidate the drill cuttings, seal the walls or the hold and furnish lubrication to facilitate removal of the cuttings from the bore. Water jetting shall not be permitted.

808.5 SUBMITTALS

The following material shall be submitted by the Contractor to the Engineer for review:

a) Manufacturer's literature describing in detail the microtunneling system to be used. Detailed description of projects on which this system has been successfully used.
b) Method of spoil disposal.
c) Anticipated jacking loads.
d) Method(s) of controlling ground water at shafts and by the MTBM.
e) Shaft dimensions, locations, surface construction, profile, depth, method of excavation, shoring bracing and thrust block design.
f) Verification that the pipe complies with the project specifications.
   This shall include literature describing the microtunneling pipe to be used on this project. The literature shall include allowable safe jacking loads with a safety factor of at least 2.5. A list of names, addresses, and telephone numbers of contacts on successfully completed microtunneling projects shall be provided for verification.
g) Proposed shaft locations and sizes.
h) Project Safety Plan.

All contractor submittals requiring structural design shall be signed and sealed by a Registered Professional Engineer in Kansas.

APPENDIX D. UTILITY EXCAVATION CONTROL CHECKLIST

This appendix is an example of a utility excavation control checklist for states, counties, and cities for developing controls on excavation within the jurisdiction's right-of-way.

1 ADMINISTRATION

1.1 Do you have a program to control utility excavation in the public rights-of-way?
1.2 Does your program apply to all utilities, including special districts and utilities owned by you?
1.3 Do you have a system of tracking who excavated where?
1.4 Is a separate permit required for each excavation?
1.5 Does the permit application require:
   a. Name of excavator?
   b. Authority to excavate?
   c. 24 hour telephone number?
   d. Plan showing location of excavation?
   e. Construction start date?
   f. Construction duration?
   g. Method of construction?
   h. Area of excavation?
1.6 Do you charge fees to recover the costs of:
   a. Permit issuance?
   b. Permit inspection?
   c. Loss of parking meter revenue?
   d. Obstruction of rights-of-way?
   e. Lost pavement life?
1.7 Are any of the above fees waived if work is done in conjunction with street paving?
1.8 Are any of the fees refunded if excavation work is cancelled?
1.9 Are fees deposited in a special fund and used solely for excavation regulation?
1.10 Do you process permit applications promptly in accordance with the State's Permit Streamlining Act?
1.11 Are permits non-transferable?
1.12 Do your excavation regulations require the excavator to indemnify, defend, and hold your jurisdiction harmless from events related to excavation?
1.13 Must liability insurance be provided to protect the municipality?
1.14 Do you establish a moratorium on excavation in newly paved streets for:
   a. One year?
   b. Three years?
   c. Five years?
1.15 Are there provisions for emergency excavation?
1.16 Are there regulations governing abandoned facilities?
1.17 Are there regulations for placement of utility equipment on the surface of sidewalks and streets?
1.18 Are there penalties for violation of rules and regulations?
1.19 Is there a process for revocation of permits?

2 INSPECTION

2.1 Must permits be kept at the job site and shown to inspectors on request?
2.2 Do you have inspectors dedicated solely to excavation control?
2.3 Do you require notice at various stages of construction so that work can be inspected?
2.4 Are there provisions for stopping dangerous or unpermitted work?

2.5 Is your inspection program supported by management and backed by your local law enforcement officials?

3 PLANNING

3.1 Do you require five-year plans showing major construction proposed by each utility?
3.2 Do you provide five-year plans showing your proposed paving program?
3.3 Do you require utilities to provide maps of existing facilities?
3.4 Do you require:
   a. Coordination of work?
   b. Joint trenching?
   c. Joint contracting?
3.5 Do you have a coordinating committee consisting of pavement and utility managers who meet to coordinate major construction work:
   a. Monthly?
   b. Quarterly?
   c. As needed?
3.6 Do you require notice of construction to adjacent property owners by:
   a. Using project signs?
   b. Posting notices in the vicinity of construction?
   c. Mailing notices to fronting property owners?
3.7 Do you place limits on hours of construction work?
3.8 Are there restrictions on construction noise?
3.9 Do you require notification of Underground Service Alert ("one call system") before excavating?
3.10 Do you specify traffic routing requirements during construction?

4 SAFETY

4.1 Is a safety plan required for major excavation projects?
4.2 Is testing required before entry into confined spaces?
4.3 Is there a requirement that a minimum of two people work on an excavation at all times?
4.4 Are there special rules for night work?
4.5 Do permit conditions require compliance with OSHA rules, especially for shoring of excavations?
4.6 Are there special provisions for excavation of hazardous materials?
4.7 Is the work site kept safe for pedestrians, bicycles, vehicular traffic, and people with disabilities?

5 EXCAVATION

5.1 During excavation do you require:
   a. Saw cutting of the pavement and pavement base before excavation?
   b. Saw cutting in neat, straight lines?
   c. Removal of remaining pavement sections less than three feet wide?
   d. Removal of excavated material from the job site at the close of each day?
   e. Off site stock piling of materials?
   f. Good housekeeping?
   g. Seventy two hour posting of tow away notices?
   h. Steel plating of open excavations at the end of each work day?
5.2 Do you limit the amount of trench that can be open at any one time?
5.3 Must excavation in sidewalks be to the nearest flag lines?

6 BACKFILL

6.1 Do you specify:
   a. Type of backfill material?

b. Types of flowable fill allowed?
c. Compaction requirements?

6.2 Do you require compaction testing by your jurisdiction or by an independent testing laboratory?
6.3 Do you require additional pavement removal when undermining occurs?

7 PAVING

7.1 Do you specify:
a. Type and thickness of restored pavement?
b. Matching of special pavement?
c. Compaction of pavement?
d. Smoothness of pavement?
e. How soon pavement must be restored?
f. When curb ramps for wheelchair access must be provided?

7.2 Do you require use of T sections in trench restoration?
7.3 Is traffic striping restored following paving?
7.4 Are the restored trenches marked to indicated which excavator is responsible?

8 WARRANTIES/GUARANTEES

8.1 Do you require payment and/or performance bonds?
8.2 Do you have a system of reinspecting trenches several years after construction?
8.3 Can you repair defective trenches and bill the excavators if they fail or refuse to make repairs?
8.4 Is the excavator responsible for trench defects:
a. For three years?
b. Until the next major street renovation?
c. Forever?

APPENDIX E. SURVEY RESPONSES

1. Fees charged for use of State-owned land (upland and submerged).

Georgia
One time easement fee is set based on fair market value of state owned land for both upland and submerged land. Independent appraisal is used for to determine fair market value. Fee varies per transaction and location.

Louisiana
ROW permit fee of $25 per rod (16 1/2 feet) is charged for the minimum 2" pipe (or fiber optic cable). Fee is collected one time and is good for 20 years. Permit can be renewed for a second 20 years with fee adjusted for last 20 years inflation based on Consumer Price Index. Fee was set in 1977. Same process for uplands and submerged lands.

Maryland
Natural Resources has negotiated two land licenses with two interstate gas pipeline companies who have current gas pipeline easements and are adding fiber optic facilities in same ROW corridor. 1st license charge was $3.50 per linear foot of conduit and capped the installed fiber strands at 200. Adding fiber stands over 200 would require the company to request Natural Resources to approve an increase. 2nd land license set fee at $3.50 per linear foot of conduit times the ratio of strand of fiber installed over 200. This was done to address changed technology that increased the number of fiber strands in the bundle. License is for 10 years with two 10-year renewal options. Natural Resources has not encountered submerged land issue but would not envision a different fee structure. Submerged lines only increase complexity of work and raise environmental restrictions that may increase company costs.

Mississippi
No fee is established at this time, but State must approve plans for use of public lands. State is trying to develop a fee policy. Applies to both uplands and submerged lands.

New York
No fee is charged for a permit, but an extensive permit review process is in place to protect state owned land especially for wetlands and environmentally sensitive areas of the state.

North Carolina
A one time administrative fee of $100.00 is charged for each crossing of public land and a one-time easement fee is collected based on the fair market value of the fiber corridor. Amount varies by location. Submerged land utility easement fee is $250 regardless of length. State has no policy to charge fees based on gross revenue of the fiber company.

Oregon
State land office charges a fee for each crossing of state land (with the least impact), the greater of: 100% of fair market value (FMV), $250 or the highest comparative compensatory payment. Permits for use of submerged land under State control such as "navigable rivers" are granted at no cost except in cities. In cities, the land use compensation is tied to adjoining appraisal property value of land on each side of river at the access corridor.

South Carolina
State Building and Property Management Dept charges a $200 a one time easement fee for fiber optic use of state lands-uplands or submerged. This is the only fee.

Texas
General Land Office charges a one time application fee of $50 to process an application to use state-owned land. An additional miscellaneous easement fee is also charged depending upon the location of the fiber optic corridor in the State. Assuming a bay/estuary corridor with both upland and submerged land, the fee for 0- 50 ft wide ROW corridor would be $10 per rod (16 1/2 feet) for 10 years with a $500 minimum charge for fiber optic use. In the Texas coast region, there is no difference in upland or submerged land use fees, but fees may vary by zone in other parts of the state.

Virginia
There does not appear to be central state land office that establishes common permit or easement fee. Each department that owns land sets its own fees to meet their unique requirements.

Washington
Land and Resources does not have a fee schedule for granting fiber optic companies use of public lands. All previous transactions were negotiated considering among others: the location, land value and beneficiaries. A new policy is being developed and is expected to be available in November 2000.

2. How does the State process requests?

Georgia
Company applies to the respective State dept who owns land. Dept. determines impact and sets corridor; Dept. refers to State Properties Commission for review & approval in the best interest of Georgia.

Louisiana
If proposed corridor is sent to Office of State Lands, they will identify state dept lands to be crossed. Company submits application for easement permit to Office of State Lands and provides engineering drawings, ROW plat maps and cross sections including lake crossings (high water to high water tide) and streams (low to low) Land office coordinates with affected departments and reviews proposals, sets fees and approves permit applications.

Maryland
Normally, each department owning state land receives and processes land license requests related to use of their land. However, these two licenses were processed differently because they qualified as high tech projects, and State had passed a new law to focus its efforts on high tech and established a separate review and approval process.

In both cases, companies submitted requests to Natural Resources to use fiber in state owned lands using previously granted gas line easements. After the company request was reviewed and processed, Natural Resources sent them to Budget and Management and Special Legislative High Tech Review Committee for approval. Furthermore, to fund high tech investment, the state created a "high tech fund" in which proceeds from all licenses of state lands from high tech ventures would be deposited (rather than to individual departments) and then made these funds available to improve the technological capabilities of state agencies.

Mississippi
Process under development; Any request, however, must first be sent to the dept in the state who owns the property for review and evaluation and then if they concur, State Public Lands Division sets terms and approves agreement.

New York
Company submits a standard application for a permit to use state owned lands to the department that owns the land. Assistance is available to assist in developing the least disruptive corridor in a pre-application conference. All requests for use of submerged lands (wetlands, protected bodies of water and streams) must be reviewed by Environmental Conservation and General Services Departments and potentially US Corps of Engineers.

North Carolina
Company submits application and plans to State Property Office for review. State determines the final corridor and independent appraiser sets market value for land easements. State does not provide guidance or dictate method to appraiser. State approves final plans and sets applicable fees.

Oregon
Company completes application, provides local plans and zoning compliance sign off; state land office processes application and coordinates with adjoining owners and other properties of interest. Any altering of state waterway requires special permit.

South Carolina
Company completes a State application for an easement, includes a copy of construction permit issued by Department of Health and Environment, 2 copies of plat, dated and signed off by land surveyor and sends packet to Property Management for processing and approval.

Texas
Companies submit an application for ROW use to the regional field office of General Land Office with documentation of the request, (engineering drawings, proposed route on plat maps, etc). Office coordinates review among other affected departments as needed, conducts field reports, determines and collects fees and issues permits.

Virginia
Each state department that owns land has established its own process for using its land.

Washington
New process is being developed.

3. Fees charged for use of highway right-of-way.

Alabama
State DOT does not charge a fee if the company is a PUC certified utility company. Company must complete a permit application to use ROW on state and US highways. No ROW use is permitted on interstates.

Company submits application to local district DOT office using a standard permit form. Must include set of plans and post bond to cover the cost of the work.

Alaska
DOT charges a one time utility permit fee of $400 for each major (parallel) crossing of highway plus for all distances over 200 ft, a $0.25/linear foot fee up to a maximum of $2500 and also $50 for each minor crossing.

California
CALTRANS charges a permit application fee to recover the costs for processing encroachment permit applications and administering permits. The permit fee is variable and is calculated depending on five components: hours, standard hourly rates, fieldwork, bridge tolls and miscellaneous fees. The fee varies with the complexity of the permit application. Encroachment permits are issued for use of conventional highway ROW but not for interstates or controlled assess highways.

Company submits application for an encroachment permit with supporting plats and engineering drawings to each district office in which cable passes. District office reviews requests, coordinates with other departments and approves permit for work in their district.

Georgia
DOT charges permit fees: in urban areas: single user: $5000/mile/year; joint use: $3750/mile/year;
In suburban areas, where average daily traffic volume is >2000 vehicles/day, fee is $2,000/mile/year and if <2,000 vehicles/day, fee is $1,000/mile/year. Suburban fee is reduced by 25% for joint use. In local aid hwy outside the area, fee is $1,000/mile/year. Fees set in 1986 and are under review.

Maryland
DOT negotiates all fees for fiber optic use of the ROW under a new approach begun recently. DOT has prepared an RFP for Resource Sharing of any Maryland's public ROW and state owned land and released it this year. The RFP is good for 5 years and requests fiber optic companies to submit proposals on how best to utilize the state land and highway ROW. DOT then evaluates each proposal as it's submitted and negotiates compensation based on Maryland's fiber optic needs for that specific project. Proposal follows the high tech review process previously mentioned.

New York
No permit fees, admin fees or fixed fees charged. Compensation is negotiated based on each company's proposal and use of public highway ROW for the benefit of the State. Rule of thumb is to recover approximately $1.00 per linear foot of fiber installed-assumed to be an industry standard 7-8 years ago. Fees and terms will vary depending on company proposal. State DOT continuously advertises in the NY Contract Reporter and seeks Requests for Proposals from fiber optic companies to use state highway ROW based on the State's Accommodation Plan for Fiber Optic Facilities. Each quarter the DOT Property Management Division receives and reviews proposals, negotiates terms and approves use of ROW for fiber.

North Carolina
NC DOT does not charge any type of fee for use of highway ROW for either utilities or fiber optic cable. However, they do tightly control and limit the access and use of ROW with a comprehensive plan review and approval process. State law (1930's circa) does not permit DOT to grant parallel access to interstate and controlled access highways.

Oregon
DOT does not charge a permit, administrative or application fee for use of the conventional highway ROW for fiber optic cable; however, companies must apply for and been granted a permit to install fiber optic cable in ROW. Companies submit a letter of request to the DOT district office in which the project is located and include plat map detailing starting and ending points, scope of work, traffic control plans, and engineering drawings certified by engineer. DOT reviews, coordinates and approves plans and issues permits.

Virginia
VA DOT charges a one time $40 permit fee (which includes the first 100 ft of fiber optic cable) to install fiber in highway ROW. The fee increases based on the length of the installed fiber and facilities at $5.00 per additional 100 linear feet and each crossing and pole setting at $5.00 each. Generally use of interstate ROW is prohibited, but Virginia makes an exception. Virginia DOT has also issued an RFP and awarded a sole source contract to Digital Teleport Inc of Virginia to provide fiber facilities and services using the interstate highway ROW to implement their smart highway system. Digital will sublease to other fiber optic and telecommunication carriers and provide Virginia compensation on barter arrangement in the form of infrastructure, equipment, duct space, and dark and lighted fiber to meet Virginia's needs. The agreement has a 20 year term and is renewable for another 20 years.

Washington
Washington State DOT charges a $250 permit fee to install fiber in ROW-same as other utilities. There are no other charges. DOT's process depends on the type of highway involved. State highway ROW is subject to permit and company applies to DOT for a permit. There is limited use of controlled access highway and no use of interstate highway ROW unless it goes thru the State approved company Universal Communications Network-Denver. This company was selected in response to RFP to provide fiber optic facilities and service using interstate highway right of way in 1998. Compensation for use of ROW was negotiated with combined cash (up-front-one time $3.6 million payment for approx 750 miles of fiber ROW and facilities) and barter arrangement for State use of fiber (lighted and dark) duct space and equipment. Term 25 years with option to renew for 15.years.

4. Describe the State's current methodology for valuing corridors (e.g. business costs, revenue, land values, etc.) and negotiating with fiber optic companies.

Georgia
Based on company's application for an easement, the Natural Resources Dept. uses independent appraisal to determine fair market value of proposed corridor on a case by case basis. Each one is negotiated. Based on company's application, DOT uses a fee schedule and length of fiber cable installed in ROW to determine ROW fee with no negotiation.

Louisiana
Office of State Lands uses the length of the fiber cable installed and per unit fee to determine permit fees. No relationship to adjacent property value or fair market value.

Maryland
Compensation for a corridor ranges from cash to bartered fiber infrastructure to a combination of both. DOT uses some of the following benchmarks to evaluate each proposal: past usage fees collected, what other states charge or what railroads charge, and also consider the current fiber facility needs for Maryland state government, the intelligent highway system or Network Mary-

land (extending fiber to all schools, libraries, etc.). Each compensation package will be different because timing and needs change.

North Carolina
Corridor value is determined by fair market value determined by independent appraisal.

Oregon
Fair market value is determined by use of real estate property tax roll (assumed to be market values) for adjoining property adjusted for placement; surface use: 100% of fair market value, and aerial and underground use: 1/3 of fair market value

Washington
Past policy of negotiating use of public lands is being reviewed and new policy will be developed. Land and Resources would not disclose proposed fees or process changes.

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