Construction Quality Field Guide

CITY OF LINCOLN NEBRASKA

Public Works & Utilities Department

VERSION Final –November 2012

PREFACE

This guide has been prepared for the City of Lincoln Public Works & Utilities Department (PW&U) for use by the construction City Engineering Inspector (Inspector) assigned to PW&U construction projects. Its purpose is to improve quality of the constructed project by outlining PW&U's policies, establishing uniform procedures, and providing a comprehensive, user-friendly field reference that is specifically applicable to PW&U construction projects. The Inspector should become familiar with the contents of this guide and follow its guidelines and recommendations as closely as possible.

Reference to City of Lincoln Construction Specifications, Lincoln Standard Plans (LSP), Special Provisions, Policies, City of Lincoln PW&U Safety Manual, Guiding Principles and Procedures (GP&P), and other requirements are made throughout this guide to align construction activities with the appropriate specification or requirement governing the activity. The reader should become familiar with these City of Lincoln Standards and how to access them through the PW&U website at http://lincoln.ne.gov/city/pworks/index.htm.
Additionally, other engineering, project management, and construction industry standards and specifications were used to ensure this field guide contains the most current and technically proficient guidelines. These include: EJCDC Contract Documents, AWWA, DIPRA, APWA, and many material standards (PVC, CPP, HDPE, etc.).

Because this guide is a living document and is expected to be updated on a regular basis, the reader is encouraged to submit suggested changes to the PW&U's Engineering Services (ES) Division, which is coordinating guide updates. Approved changes will be issued on an "as-needed" basis and each recipient of this guide is responsible for keeping an updated copy. Copies are available in both hard copy and electronic format. Any mention of trade names or commercial products in this manual does not constitute endorsement for their use.

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This construction quality field guide is presented with the intent that it will aid in maintaining the high quality construction standards that have been established over the years by the City of Lincoln PW&U.

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PREFACE

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CHAPTER 1: GENERAL INFORMATION

1.1 INTRODUCTION

PW&U Projects require planning and oversight

City of Lincoln (City) projects have many facets that require careful planning and execution in order to be successful -- meaning the project meets required specifications, quality requirements, and endures for the anticipated design life. During each phase of a project, there are many people involved who have important responsibilities and are integral to seeing a project through from initiation to completion. The focus of this field guide is to achieve consistency, efficiency, accountability, and sustainability for the City's construction projects. The role of the construction City Engineering Inspector (Inspector) is to see that plans and specifications of Public Works & Utilities Department (PW&U) projects are followed while the project is actively in the construction phase. The Inspector has an important responsibility to oversee quality issues and address any emerging problems before the construction is completed. To do this successfully, a thorough understanding of roles, responsibilities, and construction requirements are necessary. Additionally, the Inspector must develop and maintain good relationships and effective communication with the Contractor, Project Manager (PM), and the general public.

This job role demands knowledge, awareness, keen observation skills, and the ability to deal with all stakeholders. Good communication is key to successful construction oversight. Ensuring communication channels are established early will increase an Inspector's chance of success.

This guide serves as a centralized collection of construction oversight information that can be taken to the field. It includes background information, contacts, guidelines, procedures,

templates, forms, and checklists all designed to assist the Inspector in conducting thorough site visits and fulfilling construction management responsibilities. This guide does not establish new policies nor does it create any additional responsibilities. Rather, this field guide highlights established policies and procedures, outlines existing roles, and clarifies responsibilities for the Inspector.

1.2 PURPOSE & FORMAT OF GUIDE

This guide provides the Inspector a central location for much of the information, guidelines, and requirements needed to oversee PW&U water, wastewater, and stormwater projects. This guide does not cover road construction or other traffic related infrastructure, but does discuss restoration of pavement when disturbed for PW&U projects. It is a living document and will be modified and refined as necessary to provide the most current information and in the most user-friendly manner. This guide is broken up into sections based on the most common types of activities. Since there are three major categories of underground construction projects that the Inspector will be overseeing – water, wastewater, and stormwater – many of the chapters will address each category separately. Additionally, the guide includes a glossary, contacts, website links, and a number of templates, forms, and checklists to assist in providing thorough construction oversight. A copy of this guide will be given to each Inspector and will also be available in electronic format, which is accessible through the PW&U's Guiding Principles & Procedures (GP&P) webpage found at http://lincoln.ne.gov/city/pworks/engine/dconst/gpp/index.htm. A general reference section for links and resources is also included at the end of this chapter.

Using a field guide on a construction site

Chapter 2 discusses the importance of understanding the project environment including project management principles, the important role the Inspector plays in a successful project, establishing frequent effective communication, time management, and developing a coordinated approach through a job plan. Although there typically is a PM overseeing the entire project, an Inspector must be able to see how all pieces fit together in a project and what the responsibilities are before, during, and after the project is completed.

Chapter 3 pulls together the relevant reports, forms, notices, and other documents that may be most frequently used by the Inspector in field. Examples of how to fill each out are included at the end of the chapter.

Chapters 4 through 9 each discuss common elements of water, wastewater, and stormwater construction projects and provide the Inspector with the necessary technical information to observe construction and installation. These chapters cover the following: Surveying, Safety & Traffic Control, Open Trench Construction, Appurtenances, Trenchless Construction, and Pavement Restoration. Each of these chapters is based upon City specifications and standard plans.

Chapter 10 addresses environmental issues and potential enforcement actions. Additionally, as the "eyes and ears" in the field, Inspectors should be observant when travelling to and from a project site for environmental issues or violations on other City projects.

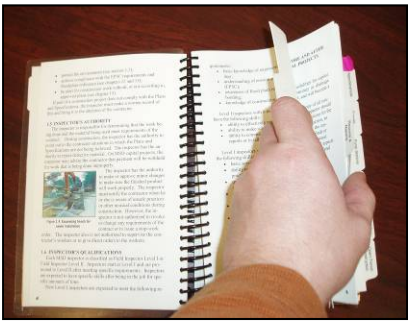
Chapter 11 discusses Private Construction Agreement (PCA) projects. PCA projects are broken out from traditional capital improvement projects (CIP) since they function quite differently with the private developer funding improvements and then turning assets over to the City once approved. Additionally, the developer takes responsibility for many of the typical PM and administrative duties. These projects must still meet City requirements and standards since the City is the ultimate owner. These projects must also adhere to local, state, and federal environmental standards. The Inspector has an important role in these projects since they may be the only representative from the City to confirm quantities and ensure requirements have been met. However, the Contractor

is still responsible for completion of the project per the plans and specifications whether or not the Inspector is present.

Chapter 12 outlines important closeout activities and responsibilities. Construction projects are not complete until all requirements are met, all deficiencies are corrected, a final site walkthrough has been conducted, the project owner has signed off, closeout documentation has been finalized and filed, and lessons learned are documented for future reference. During this phase of construction projects, it is important for Inspectors to coordinate with all divisions of PW&U and maintain effective and frequent communication.

Where appropriate, chapters will end with a review checklist for that particular chapter topic. These can be used initially to review material included within the chapter and later to develop job plans or checklists to review construction progress or completion.

Whether an Inspector is new to the job or has many years of experience, learning never stops. Every Inspector needs to refresh his/her knowledge from time to time and brush up on procedures that are used infrequently. This guide provides instructions, guidelines, reference information, and refresher information to arm PW&U Inspectors with the necessary resources to make informed decisions and provide the necessary oversight for a variety of construction projects. It should be noted that this guide is not intended to be all inclusive and Inspectors are encouraged to use other resources such as Lincoln Standard Plans (LPSs), Specifications, Special Provisions, personnel, technical manuals, procedures, policies, the AURIGO system, websites, and other guidelines. An excellent source of information includes manufacturer installation guides for approved pipe and other construction materials.



Construction quality field guide with easy to use tabs

1.3 BACKGROUND ON PUBLIC WORKS & UTILITIES DEPARTMENT (PW&U)

PW&U has primary responsibility for financing, design, construction, operation, and maintenance of Municipal Water, Waste Disposal, Drainage, and Transportation Systems. To accomplish this mission, PW&U is divided into seven divisions: Administration, Business Office, Engineering Services, StarTran, Wastewater & Solid Wastes, Water Production & Distribution (Lincoln Water System – LWS), and Watershed Management (including Stormwater). Collectively, PW&U works to "serve community growth, well-being and economic success" by working together to provide "quality services." The Inspector is a vital link in meeting that quality goal and serves an important role in construction projects. As the City's representative in the field, he/she ensures construction requirements are met, quality is achieved, and the resulting infrastructure remains functional for its anticipated life.

The ultimate goal is to provide customers – the rate payers and taxpayers – quality services in a safe, reliable, and cost-effective manner. Just as each division of PW&U has a different focus, each also has a mission or purpose statement that reflects these different responsibilities:

- **Water Production & Distribution (Lincoln Water System-LWS) -** Produce and distribute an adequate supply of quality water to meet the ever increasing demands of residential, commercial, and industrial customers within the City.
- **Wastewater & Solid Wastes:**
  - Wastewater - Provide a continuing and comprehensive effort to assure that proper collection and treatment of current and future wastewater flows and loads in an environmentally sound and cost effective manner that protects human health and environment, and that meets Federal Environmental Protection Agency (EPA) and State of Nebraska Department of Environmental Quality (NDEQ) National Pollutant Discharge System (NPDES) discharge permits, Clean Air Act permits, and other regulated operating requirements.

- Solid Waste – Provide responsible management of all solid waste generated within its service area for the protection of health, safety and welfare of the public and environment in a cost effective manner and in compliance with the solid waste management plan.

- **Watershed Management (including Stormwater) -** Provide leadership and guidance in watershed management, by utilizing new technology and ecologically-based engineering and planning practices. Its primary purpose is to improve water quality, stabilize streams, manage stormwater and reduce flood hazards, and to insure the City meets Federal requirements relative to stormwater quality.
- **Engineering Services -** Helping to build and maintain the foundation of the City to ensure that future growth is facilitated and is sustainable. Keeping traffic moving safely and efficiently is a priority for the Engineering Services Division of the City Public Works and Utilities Department. The Division is responsible for planning, building and maintaining City streets, traffic signs, traffic signals, guard rail and bridges. The Division also provides project management and quality control to numerous City construction projects.

1.4 COMMITMENT TO ENVIRONMENTAL PROTECTION

Protection of natural resources is a priority

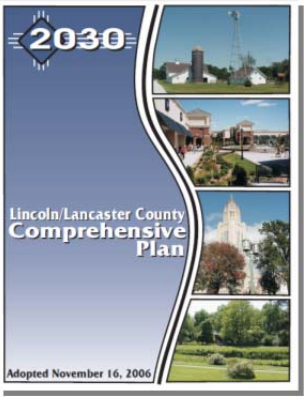
A common thread found throughout each of the mission/purpose statements in the previous section is a firm commitment to protect, and enhance the environment while providing essential services, infrastructure, and utilities. PW&U does this through sustainable use of natural resources, energy conservation, waste reduction and proper disposal, risk reduction, environmental restoration, and open communication that includes transparency and accountability to the public. Several City initiatives are

reflective of these environmental and sustainable principles and indicative of the level of commitment by the City. Examples include:

- **Cleaner Greener Lincoln** – Sustainable energy initiative supported with $2.4 million in stimulus funds (American Recovery and Reinvestment Act – ARRA) available through the Energy Efficiency and Conservation Block Grant program to improve energy efficiency and boost the use of renewable and clean energy technologies across the community.
- **Taking Charge: Progress Measures & Program Prioritization** – Culmination of a long and meticulous effort to develop goals including environmental protection for City and development of indicators to measure progress toward these goals. Environmental quality was ranked as Priority #6 in the citywide outcome assessment.
- **Groundwater Guardian Designation** - This designation is given by The Groundwater Foundation and recognizes local efforts to protect groundwater and provides a framework for community action. Groundwater Guardians make community education and groundwater protection local priorities.
- **Recovery Go Green** – ARRA funds and the Federal Americorp Program provide the resources for this initiative that hired 24 volunteers to work on environmental projects in the community.
- **Tree City USA Designation** - One of the hallmarks of Lincoln's quality of life is its community forest, which is a prominent feature of its landscape. It is also an important resource for the health and well-being of the environment and society. Trees lower heating and air conditioning costs, prevent erosion, provide wildlife habitats, reduce stormwater runoff, increase property values and make our neighborhoods more livable. Lincoln's designation as a "Tree City USA" for over 30 years is testament to its environmental commitment.
- **Mayor's Water Conservation Task Force** – Formed in 1988 to promote voluntary water conservation, this task force works with individuals and businesses to encourage and support conservation practices. Lincoln Water System (LWS) works closely with this task force and has designed its rate schedule to

encourage conservation – the more water used, the higher the rate.

- **Watershed Master Plans** – These are plans for major drainage basins within the City and surrounding area for improving water quality, maintaining stream stability, and reducing flood impacts. They also provide updated floodplain mapping and guidance for future development.
- **City of Lincoln Comprehensive Plan** – The comprehensive plan for the City includes a section on environmental resources and further emphasizes the commitment to environmental protection and enhancement. It also ties this commitment to development and planning issues. The environmental stewardship vision for the plan reads as follows:



> "Clean air, clean water, parks and open space, mature space, signature habitats, and prime and productive farmlands are valuable assets. Conservation areas, floodplains, green spaces, and parks define and help to create linkages between neighborhoods and surrounding population centers. The Comprehensive Plan takes into consideration the effects of natural phenomena not only upon localized development, but also upon the community as a whole, upon private ownership issues, and upon recreational opportunities. The plan thus commits Lincoln and Lancaster County to preserve unique and sensitive habitats and endorses creative integration of natural systems into developments."

Collectively, these initiatives and formal mission/purpose statements combined with proven actions by the City provide demonstrated commitment to environmental protection, restoration, and sustainability. PW&U Inspectors must keep this commitment in mind during their work.

1.5 THE CONSTRUCTION PROCESS AND PROJECT MANAGEMENT

Project requirements guide construction activities

PW&U construction projects are performed under contract. The Contractor agrees to do work that meets specific standards and requirements. The Contractor is paid by the owner, who is either the City or a private land developer. There are many types of contracts and it is important for the Inspector to understand which type of contract the project is operating under since it may assist in monitoring time, quantities, and cost. Contracts generally include many documents, but the Inspector is concerned mainly with three of them: the plans, special provisions, and specifications. These three documents describe requirements that must be followed during a construction project. It is beneficial for the Inspector to become familiar with these documents and have a copy available while onsite whether in printed form or through online access. The quality of the finished project depends on these requirements and on the ability of the Contractor to meet these requirements and fulfill responsibilities. The Contractor does not get final payment and the contract is not closed until these requirements are met.

Although it would be uncommon that the Inspector would also serve in the role of the PM, it is still important to have an overall understanding of the entire project and basic project management principles. This allows the Inspector to gain a better understanding of their role and its importance in a successful project. The project lifecycle includes five stages commonly referred to as “process groups”: Initiation, Planning, Execution, Monitoring & Controlling, and Closing. Although it is a good idea for the Inspector to be familiar with all five, the Execution, Monitoring & Controlling, and Closing process groups represent the areas of most importance to the Inspector. They represent the points in a project lifecycle where oversight of construction takes place to

check if specifications have been followed and requirements met. Once construction is substantially complete, the Inspector has responsibility for project close-out activities including completion of "punch list" items and proper documentation such as lessons learned and final paperwork (i.e. required reports, forms, or As-Built Plans).

1.6 ROLES & RESPONSIBILITIES

The Inspector represents the "eyes and ears" of PW&U in the field for the construction phase of projects. They serve in a quality control role ensuring that specifications are being followed during construction and requirements have been met at completion. In most cases, no one else has this responsibility or the opportunity to witness construction and identify any problems before completion. This is particularly important when working with underground utilities that can only be checked before they are buried without incurring additional effort and expense. The importance of an Inspector's role cannot be emphasized enough as quality construction can mean the difference between enduring, functional infrastructure and infrastructure plagued with chronic problems or failure due to defective construction or installation.

PW&U will not reprimand employees who report unusual situations or dangerous conditions to management or the appropriate authorities and encourages employees to be proactive in helping maintain safe working conditions. PW&U is committed to:

- Open and Honest Communication.
- Promotion of Team Successes.
- Respect for One Another and Valuing Differences.
- Protecting and Improving the Environment.
- Supporting Local Government Partnerships.
- Encouraging Public-Private Partnerships.

Frequent communication is imperative for project success. The Inspector must establish effective lines of communication with Contractors, PMs, the public, and other project stakeholders to determine who needs to know what and when. By determining appropriate contacts prior to commencement of construction and understanding the proper chain(s) of command, better information

exchange and more effective communication can occur. Inspectors generally report to a PM who is the first line of communication for all non-emergency situations and the PM should be updated on a frequent basis beyond daily report logs. Various reports have been developed to assist with communication and documentation processes.

In essence, the Inspector follows each step of the construction process and makes sure it is completed according to the contract documents. The Inspector is responsible for the following:

- Construction work is of high quality.
- Construction meets requirements including specifications for the project.
- Environmental issues addressed and sensitive areas protected (see Section 1.4).
- The stormwater pollution prevention plan (SWPPP) is implemented and components installed and maintained.
- Floodplain ordinances are followed.
- Identifying deficient construction work and noncompliance with approved plans.
- Personal safety on job site.

If part of a construction project does not comply with the plans and specifications, the Inspector must make a written record of the issue, contact the PM, and bring it to the attention of the Contractor. Chapter 3 contains several forms that can assist with documentation of issues.

Reviewing plans in the field

1.6.1 Relationship with the Contractor

Establishing good relations and effective communication between the Inspector and the Contractor is important to the success of every project. When dealing with the Contractor and their workers, the Inspector should be friendly but firm, confident, and impartial in making decisions. The Contractor is responsible for the means and methods of construction, while the Inspector

facilitates communication, interprets specifications, and assures design intent is maintained. The Inspector must avoid supervising the construction activities. This is neither the Inspector's role nor responsibility. The PM should be informed if the Inspector has difficulties with the Contractor. Issues that arise and the subsequent steps taken to resolve them should be documented according to PW&U guidelines and policies. Several forms have been developed to assist with the documentation process and can be found in Chapter 3.

The Inspector should try to understand the project from the Contractor's point of view, yet be aware of the primary responsibilities and role as the representative of the PW&U. Under no conditions should the Inspector permit a reduction in quality in the interest of quantity. As long as quality remains acceptable, the Inspector should support the Contractor's efforts to do the work as expeditiously as possible. If there is any question in regard to quality and quantity, always contact the PM for clarification. Issues regarding overtime, weekend and holiday work, evening work, and other scheduling issues should be discussed prior to commencement of construction and should be agreed upon by all parties. Unforeseen issues that impact schedule should be handled with pre-established policies and procedures generally with the oversight of the PM. It is imperative that the Inspector plan ahead by coordinating schedules with the Contractor each week, check weather forecasts, and stay in contact with the Contractor's crew.

1.6.2 Relationship with the Public

How the Inspector interacts with the public greatly affects the public's perception of PW&U and the City, since this is often the only contact the public has with the City. The Inspector must be professional, knowledgeable, courteous, and patient. Many PW&U projects result in inconveniences for people whose homes and businesses are near construction sites. When listening to concerns or complaints about PW&U projects, the Inspector must try to see the situation from the viewpoint of the individual, while remaining patient and respectful even when dealing with upset people who can be very emotional and expressive. The Inspector

must convey a genuine interest in resolving the issue and refrain from escalating the situation. If an individual becomes very upset and becomes verbally abusive, it is best to politely say you would be glad to speak with them later and walk away. Questions should be answered honestly based upon the Inspector's knowledge and complaints addressed promptly. If a question cannot be answered or a situation is at an impasse, the Inspector should find someone who can assist or offer to respond at a later time when the answer can be determined. Verbally abusive or potentially threatening situations may require involvement of the PM or other party and the Inspector should remove himself/herself from any situation that escalates to a level of concern.

1.6.3 Relationship with Others

During a construction project, the Inspector may have contact with agencies such as the police and fire department, local health departments, county planning and zoning officials, and state or federal management and regulatory agencies such as the EPA, NDEQ, and a variety of others. The Inspector must be courteous and cooperative in dealing with these agencies and should be aware of various health and safety issues. Prior to construction, these authorities should be identified and contact information documented for future reference. Some agencies may require contact prior to commencement of construction. If it is determined that one of these agencies should be contacted, contact the PM first unless it is an emergency situation. When appropriate, the Inspector should also be in contact with other divisions of PW&U such as LWS, Wastewater, Operations & Maintenance, Traffic, and Watershed Management to discuss concerns and keep all stakeholders informed.

1.7 AUTHORITY

The Inspector is an appointed agent of the PM to inspect all work done. The Inspector will keep the PM informed as to the progress of the work, and the manner in which it is being completed. During construction, the Inspector has the authority to call the attention of the Contractor to faulty work or lack of compliance with the plans or specifications. The Inspector has the authority to reject defective material until the PM is notified. On

PW&U funded projects, the Inspector may advise the Contractor that payment will be withheld for work that is being done improperly.

Prior to construction, the Inspector and PM should discuss specific roles, responsibilities, and authorities for that specific project. The Inspector also has the authority to make or approve minor changes depending on field experience and authority granted by the PM. The Inspector is not authorized to revoke or change any requirements of the project or to issue a stop-work order. The Inspector is also not authorized to supervise the Contractor's workers or to give direct orders to the workers.

Construction activities typical of what an Inspector would observe

1.8 QUALIFICATIONS

Depending upon the division within PW&U, an Inspector is classified as one of the following: Associate Engineering Specialist, Engineering Specialist, Senior Engineering Specialist, Project Manager (PM), or temporarily assigned by another department to serve in the role of Inspector. There are two levels of Inspectors (associate and senior) progressively based upon the level of education, experience, and skills. The distinction is made here only to show that some personnel serving in this role may have more independent responsibility due to their background and experience. These categories do not create additional job titles nor change any official position classifications. For purposes of the remainder of this guide, all levels of the Inspector position (associate and senior) will be collectively referred to as "Inspector."

To serve in the role of Inspector, all personnel must meet a minimum level of qualifications and have a background in project construction. Because Inspectors must be knowledgeable in so

many areas, they often receive cross training in various aspects of construction for water, wastewater, and stormwater projects. Specific qualifications for each level are outlined below:

- **Associate Level City Engineering Inspectors** – This category includes Associate Engineering Specialists and other personnel who may assist with construction oversight as part of their responsibilities but not on a fulltime basis. Associate Inspectors are expected to have the following knowledge, abilities, and skills:
    - Knowledge of the construction field.
    - Knowledge of fundamental technical principles, practices, and techniques.
    - Some knowledge of research techniques, methods, and procedures.
    - Ability to apply technical principles, practices, and techniques.
    - Ability to analyze, interpret, and submit oral and written reports.
    - Ability to establish and maintain effective working relationships with governmental officials, co-workers, and the general public.
    - Some understanding of project management principles and construction management oversight.
- **Senior Level City Engineering Inspectors** – This category includes Engineering Specialists, Senior Engineering Specialists, and other experienced or senior level personnel. Requirements for this level include greater education, experience, and ability to work independently. In addition to Associate level requirements, senior level Inspectors are expected to have the following additional knowledge, abilities, and skills:
    - Considerable knowledge of the construction field.
    - Background/Experience with utility infrastructure projects.
    - Greater understanding of project management principles and construction management oversight.

- Ability to work with little or no supervision.
- Experience preparing schedules, budgets, and project plans.

1.9 SPECIFIC RESPONSIBILITIES

Specific responsibilities related to the Inspector role for both associate and senior level Inspector categories include, but are not limited to, the following areas:

- **Construction Observation** – Assist in the field with the observation of materials and construction operations and procedures used in order to ensure compliance with standard practice, specifications, plans, and special provisions. This will require some understanding of plans and specifications as the position is required to interpret technical data. Assist with processing observation reports and make the necessary routine computations in conformity to establish guidelines and procedures.
- **Material Sampling and Construction Testing** – Obtain and prepare samples according to prescribed procedures or coordinate with testing labs to take and analyze samples. Sets up, cleans, and maintains testing apparatus and equipment utilized in the field and laboratory. Observes and oversees construction tests and reports results.

Other Duties – Technical calculations, Computer Aided Drafting and Design (CADD), reporting, and investigations of American Disabilities Act (ADA) complaints.

1.10 PROJECT TYPES

An Inspector for PW&U will be exposed to a wide variety of projects involving water, wastewater, and stormwater infrastructure along with soil erosion and sediment control. It is important that the Inspector has an understanding of each of these individual areas, the various components of each

Use of multiple safety devices and PPE

and how they fit together, and a comprehensive view of the overall project they will be observing. Knowledge of basic project management is important in gaining this larger perspective for the Inspector. Training and cross-training between different disciplines is imperative for the Inspector to gain the necessary information, knowledge, and understanding to be prepared to make informed decisions and assessments. Taking time to observe water, wastewater, and stormwater construction activities is an excellent way to gain this comprehensive knowledge and experience, whether through a formal training/cross-training program or through professional development efforts.

1.11 HEALTH & SAFETY ISSUES

The health, safety, and welfare of PW&U employees, Contractors, and the general public are important for any and all projects. It is the Contractor's responsibility to conduct a thorough assessment of potential safety risks and then properly implement a safety plan or measures. The Inspector must discuss this with the Contractor before any construction even begins. This helps the Inspector to understand safety issues for the particular project and ensures the Contractor has or will have safety measures in place. It is not the responsibility of the Inspector to develop or implement a safety plan or measures. An excellent time to discuss this is during the pre-construction meeting.

The Inspector must have a basic understanding of governmental safety guidelines and regulations including awareness of ADA and other accessibility issues. It is also important that the Inspector has thorough knowledge of City policies, procedures, and requirements regarding health and safety issues. PW&U has an official "Safety Manual" and each employee is responsible for becoming familiar with the manual. As the onsite representative for the project owner, the Inspector must have the proper knowledge of health and safety issues to identify emerging issues before they become real problems or life-threatening situations. The Inspector should be aware of their surroundings including construction activities, hazards, and restricted areas to ensure his/her own safety.

It is not the responsibility of the Inspector to directly enforce safety requirements with the Contractor's employees or dictate the

means and methods of operation. It is highly recommended that the Inspector bring apparent health or safety issues to the attention of the Contractor as soon as discovered. The PM should be notified of any safety issues and any conversations noted in the Daily Activity Report. Imminent danger or emergency situations may require immediate action on the part of the Inspector either directly or through the proper authorities. Special personal protective equipment (PPE) such as hard hats, safety vests, footwear, hearing protection, or protective eyewear may be required for certain projects. Chapter 5 – Safety & Traffic Control has more details regarding health and safety issues.

1.12 GENERAL REFERENCES - LINKS & RESOURCES

In addition to this guide book, there are several other resources that may be useful and informative for the Inspector. These include:

1.12.1 City of Lincoln

- AURIGO Construction Management System
  - Contact: Shannon Ideus, Tech Support/Help Desk Service Coordinator
  - Direct Office Phone Number: (402) 441-5670
  - Website: https://aurigo.lincoln.ne.gov
- City of Lincoln Design & Construction Standards
  - Contact: Thomas Shafer, Manager – Engineering Services
  - Eng Services General Phone Number: (402) 441-7711
  - Direct Office Phone Number: (402) 441-7837
  - Website: http://lincoln.ne.gov/city/pworks/engine/dconst/standard/index.htm
- City of Lincoln Website (General – Mayor's Office)
  - Contact: Mayor Chris Beutler, City of Lincoln
  - Mayor's Office General Phone Number: (402) 441-7511
  - Website: http://lincoln.ne.gov/main/govern.htm
- Guiding Principles & Procedures (GP&P) for PW&U
  - Contact: Thomas Shafer, Manager – Engineering Services
  - Eng Services General Phone Number: (402) 441-7711
  - Direct Office Phone Number: (402) 441-7837

- Website: http://lincoln.ne.gov/city/pworks/engine/dconst/gpp/index.htm

- Lincoln-Lancaster County Health Department
  - Contact: Harry Heafer-Keep Lincoln Lancaster Co. Beautiful
  - Lincoln-Lancaster County General Phone Number: (402) 441-8000
  - Direct Office Phone Number: (402) 441-8032
  - Haz Mat Phone Number: (402) 441-6238
  - Website: http://lincoln.ne.gov/city/health/index.htm
- Public Works & Utilities (PW&U) Department
  - Contact: Miki Esposito, Director
  - PW&U General Phone Number: (402) 441-7548
  - Website: http://lincoln.ne.gov/city/pworks/index.htm
  - *Engineering Services Division*
    - Contact: Thomas Shafer, Manager
    - General Phone Number: (402) 441-7711
    - Direct Office Phone Number: (402) 441-7837
    - Website: http://lincoln.ne.gov/city/pworks/engine/index.htm
  - *Wastewater, Solid Waste, & Recycling Operations*
    - Contact: Karla Welding, Superintendent/ Solid Waste Operations
    - General Phone Number: (402) 441-7961
    - Direct Office Phone Number: (402) 441-7867
    - Website: http://lincoln.ne.gov/city/pworks/waste/index.htm
    - Contact: Brian Kramer, Superintendent/ Wastewater Collection
    - General Phone Number: (402) 441-7961
    - Direct Office Phone Number: (402) 441-7987
  - *Water Production & Distribution (LWS)*
    - Contacts: Nick McElvain, Sanitary Engineer/Operations Support
    - General Phone Number: (402) 441-7571
    - Direct Office Phone Number: (402) 441-5931

    - Website: http://lincoln.ne.gov/city/pworks/water/index.htm
  - *Watershed Management (Stormwater)*
    - Contact: Ben Higgins, Senior Engineer
    - Direct Office Phone Number: (402) 441-7589
    - Website: http://lincoln.ne.gov/city/pworks/watrshed/index.htm
- PW&U Projects Update
  - Website: http://lincoln.ne.gov/city/pworks/projects/index.htm

1.12.2 State of Nebraska

- State of Nebraska (General)
  - General Website: http://www.nebraska.gov/dynamicindex.html
  - *Department of Environmental Quality*
    - Main Phone Number: (402) 471-2186
    - Website: http://www.deq.state.ne.us/
  - *Nebraska Department of Health and Human Services*
    - Main Phone Number: (402) 471-3121
    - Website: http://www.hhs.state.ne.us/
  - *Game & Parks Commission*
    - Main Phone Number: (402) 471-0641
    - Website: http://www.ngpc.state.ne.us/
  - *Department of Natural Resources*
    - Main Phone Number: (402) 472-2363
    - Website: http://www.dnr.state.ne.us/
  - *Department of Roads*
    - Main Switchboard Phone Number: (402) 471-4567
    - Main Website: http://www.dor.state.ne.us/
    - Contractor's Corner Webpage: http://www.nebraskatransportation.org/letting/index.htm
    - Environmental Section Webpage w/ Contacts: http://www.dor.state.ne.us/environment/index.htm
  - *One Call – Nebraska Diggers Hotline*
    - Main Phone Number: (800) 331-5666
    - Website: http://www.ne-diggers.com/home/

1.12.3 Counties

- Cass County
  - Main Phone Number: (402) 296-9300
  - Website: http://www.cassne.org/
- Lancaster County
  - Main Phone Number: (402) 441-3095
  - Website: http://lincoln.ne.gov/cnty/index.htm
- Sarpy County
  - Main Phone Number: (402) 593-2100
  - Website: http://www.sarpy.com/
- Saunders County Planning Department
  - Main Phone Number: (402) 443-8101
  - Website: http://www.saunderscounty.ne.gov/

1.12.4 Rural Water Districts & Natural Resources Districts (NRDs)

- Lancaster County Rural Water District #1 (Bennet, NE)
  - Contact: Ken Halvorsen, District Manager
  - General Phone Number: (402) 782-3495
- Nebraska Association of Resources Districts (NARD – General)
  - Contact: Dean Edson, Executive Director NARD
  - General Phone Number: (402) 471-7670
  - General Website: http://www.nrdnet.org/
  - *Lower Platte South NRD (Lincoln-based)*
    - Main Phone Number: (402) 476-2729
    - Website: http://www.lpsnrd.org/
    - Stormwater Section
      - Contact: JB Dixon, Stormwater Specialist
        - Website:http://www.lpsnrd.org/docs/Stormwater/stormwater.htm
  - *Lower Platte North NRD (Wahoo-based)*
    - Main Phone Number: (402) 443-4675
    - Website: http://www.lpnnrd.org/
  - *Papio-Missouri River NRD (Omaha-based)*
    - Main Phone Number: (402) 444-6222
    - Website: http://www.papionrd.org/

1.12.5 Federal Agencies

- EPA Region 7 (Located in KC - Includes Nebraska)
  - Main Phone Number: 1 (800) 223-0425
  - 24-Hour Emergency Response Line: (913) 281-0991
  - Region 7 Website: http://www.epa.gov/region7/
- NRCS in Nebraska (Located in Lincoln)
  - Main Phone Number: (402) 437-5300
  - Website: http://www.ne.nrcs.usda.gov/
- OSHA Region 7 (Located in KC – Includes Nebraska)
  - Main Number / Fatality or Imminent Danger: 1 (800) 321-6742
  - KC Office Main Number: (816) 283-8745
  - Omaha Area Office Phone Number: (402) 553-8745
  - Nebraska On-site Consultation Office (Lincoln-based) Phone Number: (402) 471-4717
  - Region 7 Website: http://www.osha.gov/
- U.S. Army Corps of Engineers (Omaha District)
  - Main Phone Number: (402) 995-2417
  - Wetlands Permitting & Enforcement Sections: (402) 995-2451
  - Website: https://www.nwo.usace.army.mil/
- USGS Nebraska Water Science Center Website
  - Main Phone Number: (402) 328-4100
  - Website: http://ne.water.usgs.gov/

1.12.6 Emergency/Sever Weather Contacts

- Anytime there is a life-threatening emergency call 911 first. If 911 is accidently dialed, do not hang up. Let the operator know it was mistakenly dialed 911. If the situation is non-life threatening, consult the PM and refer to the numbers below:
- Lancaster County Sheriff
  - Non-Emergency Phone Number (To Report a Crime): (402) 441-6500
  - Business Office Main Number: (402) 441-8887
  - Website: http://lincoln.ne.gov/cnty/sheriff/index.htm
- Lincoln Fire & Rescue

- Non-Emergency Phone Number: (402) 441-7363
- Fire & Rescue Headquarters: (402) 441-7363
- Emergency Medical Management Services Business Office: (402) 441-8371

- Lincoln Police Department
  - Non-Emergency Phone Number (To Report a Crime): (402) 441-6000
  - Business Office Main Phone Number: (402) 441-7204
  - Website: http://lincoln.ne.gov/city/police/index.htm

- Lincoln-Lancaster County Emergency Management
  - Non-Emergency Phone Number: (402) 441-6000
  - General 911 Info Phone Line: (402) 441-7005
  - Business Office Main Phone Number: (402) 441-7441
  - Website: http://lancaster.ne.gov/cnty/civil/index.htm

- Nebraska State Patrol
  - Non-Emergency Phone Number: 1 (800) 525-5555 or *55 on cell
  - General Info Phone Line: (402) 471-4545
  - Website: http://www.nsp.state.ne.us/

- Road-Weather Info (Note – Affiliated with NDOR)
  - Main Info Line: 511 or 1 (800) 906-9069
  - Website: http://www.511nebraska.org/ndortip/index.jsp?MyMap=

CHAPTER 2: UNDERSTANDING THE PROJECT ENVIRONMENT

2.1 OVERVIEW

The Inspector is typically responsible for many PW&U construction projects at a time, and must possibly divide their time between several sites every day. Because of this, it is important for the Inspector to note which aspects of each project are the most important and require the most attention. Additionally, there are some construction activities that require the Inspector to be on site at a specific time. This is generally the case for underground utilities that will be buried or sealed. Inspectors must coordinate schedules with Contractors to ensure construction or installation of these utilities is not missed. Oversight of material quantities and quality is also an important role for the Inspector that requires close communication and coordination with the Contractor. An Inspector should try to be out of the office and on construction sites as much as possible during the construction season. A general rule of thumb is that a minimum of 60% or greater of one's time during the construction season is spent on construction sites observing construction activities.

2.2 PROJECT MANAGEMENT

Generally, a project requires more than one person to carry it out including a Project Manager (PM) and various team members such as an Inspector. Projects are governed by what are termed the "triple constraints" which are independent variables including cost, time, and scope. Often quality is called the 4th constraint but it really is dependent upon the other three. Quality is planned into a project, but it is the responsibility of the Inspector to monitor and oversee construction activities to ensure requirements are met, including quality. Risk can impact

any of these constraints and must be accounted for during the planning stages.

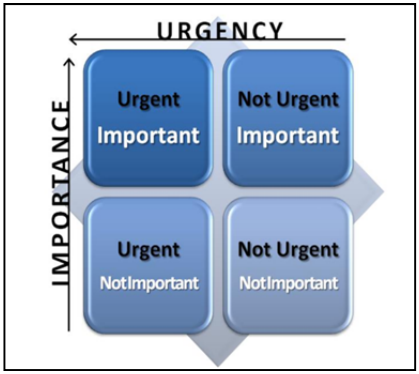
Although the Inspector does not typically serve in the additional role as PM, it is both beneficial and imperative that a basic understanding of project management principles and the project lifecycle is established. Inspectors are just one of many project team members involved in a successful project, and failure by any team member can mean failure of the project. Delays in any stage of a project may result in direct impacts on the project such as increased costs and shifting of resources, as well as impacts on normal business operations and other PW&U projects. In addition, there could be legal or regulatory issues if deadlines are not met.

Often a Work Breakdown Structure (WBS) is developed by PMs to help visualize and organize the elements of a project. This hierarchy of project components helps break the project down into smaller and smaller "work packages" or activities that can then be assigned. Inspectors should be aware if a WBS has been developed since it can provide both an overall view of the project and specific assignments.

One important responsibility for the Inspector is to help coordinate activities and communication between the Contractor and PW&U. The Inspector should always be on the lookout for issues, problems, and ways to improve efficiency of the project. Just being active, visible, and connected to all stakeholders provides great value to the project. In particular, coordinating with the Contractor is extremely important so the Inspector can observe and oversee construction and installation of infrastructure, utilities, and appurtenances that may only be visible for a short period before they are buried or sealed. It is vital that the Inspector coordinate with the Contractor to be available and onsite for these occurrences. Schedules can change for a variety of reasons at a moment's notice and an installation planned for tomorrow can be bumped up to today if construction gets ahead or weather dictates. The Inspector needs to be onsite to validate progress and oversee quality since they may be the ONLY one who can do so on behalf of PW&U. It is important that the City gets what is paid for and that requirements are met so the infrastructure endures for its design life.

2.2.1 Time Management

Time management simply refers to effectively and efficiently managing time to help ensure the project is completed according to schedule. Complexities arise for many reasons - some external and out of personal control and others within one's ability to manage.



Managing time becomes extremely important while working on several projects and the Inspector needs to become adept at prioritizing activities. Inspectors must be proactive in anticipating and managing potential time delays or adjusting to impacts of delays such as weather, decisions made up the chain of command, or manufacturing and delivery delays. Inspectors do not work alone and must coordinate schedules with that of all stakeholders including the Contractor and lab technicians who may be assisting in conducting acceptance tests. The need to remain somewhat flexible is also important to accommodate last minute schedule changes and ensure vital site visits are conducted.

Developing a thorough schedule that incorporates goals and prioritizes planned activities is one approach to time management. A way to do this is to create a "To Do List" that is updated weekly and refined each day. High priority items such as site visits or specific construction milestone activities that are time-dependent would be highlighted as high priorities, and items that can wait receive a lower priority ranking.

Designating a certain time each day or a limited amount of time (e.g. 30 or 60 minutes) for operational or non-priority activities such as filing, checking e-mails, or organizing can be beneficial. These items may be best reserved for early or late in the day or for a rainy day when no construction is occurring. Additional time cannot be created, only managed. Components of time management include:

- **Prepare/Plan** – Time spent in advance to prepare goals and plan a course of action can increase focus and efficiency. Putting thoughts and ideas to paper can also help layout this plan.
- **Communicate** – This recurring theme is a must with all stakeholders (including Contractors and their field representatives) to determine needs, requirements, approaches, timelines, and other important project components.
- **Organize & Coordinate** – Once all of the pertinent information is gathered, the Inspector needs to organize it and coordinate with other stakeholders. This includes determining specific requirements and coordinating schedules both for stakeholders and specific activities that may require site visits.
- **Prioritize, Forecast, & Schedule** –Inspectors must prioritize activities which are "must-do's" and those which can wait. Creating a daily, weekly, or longer term "To Do List" that is prioritized is essential for good time management. Flexibility and time for contingencies and unplanned issues must be incorporated, and should typically account for 15-25% of one's time. A good rule of thumb is to update weekly, revise daily, and save low priority items for early and late in the day. Time cannot be managed properly without frequently communicating with the Contractor to confirm schedules.
- **Risk Management** – How Inspectors prepare for risks and respond to planned and unplanned problems can impact the efficiency and effectiveness of their time. Some project plans may have a risk assessment and management section that lists potential risks and suggested risk management responses. It is advisable to review this information if possible with the PM before construction for each project.

2.2.2 Time Management Tools & Techniques

There are a variety of well-established and time-tested time management methodologies and tools that can prove beneficial. PW&U or the PM may have specific tools, techniques, or methodologies to track and manage time beyond a timesheet. Spreadsheets or simple forms such as time logs can be used and tailored to specific needs. Software designed for time or project

management can also be used to help create a schedule or a more complex Gantt chart that includes deliverables, deadlines, and resources.

2.3 DEVELOPING A JOB PLAN

An easy way to keep track of the important aspects of each job is to develop a "job plan" that incorporates a variety of best practices. Each project should include a job plan that formalizes and organizes tasks, activities, schedules, and project requirements. A job plan can take many forms, but essentially it is a tailored, organized plan of action to accomplish construction goals and fulfill responsibilities in order to meet all requirements of the project. Development of a job plan should be initiated before any construction begins and should start with a thorough review of the contract documents and other important documents. It is also important to have a discussion with the PM regarding any special provisions, requirements, and questions that may arise. The initial site visit is a great way to help identify priority items and other considerations to include.

The job plan embodies many of the components and processes (collectively best practices) discussed throughout this chapter – project management, time management, and communication. Job plans should be linked between multiple projects to coordinate activities and develop a master schedule. Ultimately, this information can be used to create a prioritized "To Do" list. The Inspector can customize the job plan to fit their needs, but certain components are essential. These may include, but are not limited to, the following:

- Contacts.
- Schedules.
- PW&U Protocol, Procedures, & Requirements.
- Marked-up Plans and Specifications.
- Pertinent Regulations.
- Safety and Traffic Control Considerations.
- General Public Issues (e.g. access, property issues, notifications).
- Assumptions and Constraints.

- Special Provisions and Conditions (e.g. unusual conditions, site features, unique project requirements, etc.).
- Type of Construction – (e.g. piping, appurtenances, trenches, etc.).
- Scheduled Construction and Installation Priority Timeframes (e.g. pipe, appurtenance, or other underground utility installation).
- Materials Quantities and Quality Requirements.
- Environmental Considerations (e.g. erosion and sediment control, wetlands, hazardous substances, etc.).
- Reporting Requirements including Required Forms/Reports/Checklists.

Inspector time requirements vary depending upon the stage of a project and a job plan can help coordinate all of these variables. Initial stages of a project such as mobilization may include getting to know the Contractor or learning the Contractor's approach to the project. Delivery of materials may also need to be monitored for quality and require the Inspector onsite. As actual construction begins, a high level of oversight and monitoring (60% or greater time spent onsite) might be the goal. As work progresses, the types of construction activities will dictate onsite time requirements for the Inspector. In addition, when high priority items occur simultaneously at multiple project sites, the Inspector should request help from the PM or other PW&U personnel to ensure someone from PW&U is onsite to observe and document these activities. Proper communication and coordination with the Contractor and PM, as well as strong effort to follow the job plan for multiple projects, will help the Inspector from feeling overwhelmed.

DRAFT

Daily Tracking Report

Date _____

Project: _____ Contract #: _____

Contractor: _____ Ph.Number: _____

On-Site Supervisor: _____

Personnel/ Equipment: _____

Subcontractor: _____ Ph.Number: _____

Supervisor: _____

Personnel/ Equipment: _____

Weather Conditions: _____

Visitors: _____

Work Performed:

Deficiencies observed today: _____

Materials received on-site Communications Issues:

Signature _____ Date _____

Owner Quality Representative

Sample Daily Activity Report

The job plan provides guidance and helps remind the Inspector of the important aspects of the project that need observation or inspection as the project progresses. One important aspect is early identification of work that is deficient or incomplete. This is a very important responsibility for the Inspector and should be on-going throughout the project lifecycle. A list of this incomplete work should be developed and accumulated as construction progresses and shared with the Contractor prior to the point of "substantial completion" and final walkthrough. An Incomplete Work List form is available to assist the Inspector in Chapter 3. This list is not the official "punch list" (See Chapter 12), which is developed during the final walkthrough, but rather a working list that identifies and addresses deficient and incomplete work early. The Contractor is encouraged to develop a list of incomplete work as well to compare to the Inspectors. Consistently employing this practice should help reduce the size of the "punch list" and assist in more timely completion of the project.

2.4 COMMUNICATION

One of the most important roles that an Inspector plays is the communication link between the Contractor and PW&U. Establishment of effective communication channels early is vital to a successful project, and this process starts early in the planning stages, not just when construction begins. A prime opportunity to gather and exchange necessary information such as numbers, e-mails, contacts, and the best methods to communicate with all stakeholders is at the pre-construction meeting. Communication ranks as the top attribute for PMs and project team members, even above technical skills.

2.4.1 Communications Requirements and Expectations

Understanding communication requirements and expectations is important for an Inspector. One of the best places to start is with the PM. PMs may have had pertinent discussions with stakeholders by the time the construction phase commences and thus will have a good indication of proper communication channels. An effective communication process will include the following:

- **Stakeholder Identification** – Who is involved in the project (stakeholders), contact information, and who needs to know what.
- **Managing Stakeholder Expectations** – Identifying how to meet stakeholder expectations/needs and how to address issues as they arise.
- **Communications Planning** – How to communicate with each stakeholder (communication channels), formulating a plan of action, identifying gaps, and revisiting the plan to update and improve.
- **Report Performance** – Conveying progress, status, and needs using reports, measurements, forecasts, and other pertinent information.
- **Information Distribution** – Disseminating information according to plan.
- **Documenting and Formalizing Communications** – Some communications need to be more formal in nature and documented due to regulatory, legal, or procedural requirements, as well as complexity and nature of content to meet all project requirements.

2.4.2 Communication Considerations

Communication is complex and each project has a different set of parameters governing how information should be exchanged. The following communication considerations should be addressed prior to the start of any project:

- Internal versus External.
- Formal versus Informal.
- Vertical versus Horizontal.
- Official versus Unofficial.
- Written and Oral.
- Verbal and Non-verbal.

Complex projects require coordination between all stakeholders

Generally, a communication "lead" is identified to serve as the hub for official communications such as responses to the media, issues related to scope changes, stakeholder requests, required reports and updates, memos,

privileged or sensitive information, and other important communications. Usually, the PM is designated as the lead. The Inspector should be the focal point for any field related communications.

It is important to maintain effective contact with other PW&U divisions (Watershed Management, Wastewater Solid Waste, Engineering Services, Water Production & Distribution-LWS), other City of Lincoln/Lancaster Departments who assist with construction observation activities (Lincoln Building & Safety Dept, Lancaster Co Health Dept) and external agencies and organizations involved in regulatory and monitoring functions when appropriate. Due to the complex nature of construction projects and regulatory and reporting requirements, involvement of all stakeholders in the decision-making process is important to project success.

2.4.3 Tools & Techniques

City of Lincoln PW&U website

Technology has provided us with many communication tools including cell phones, PDAs, e-mail, internet/online access, but one of the best is still face-to-face communication. Miscommunication is too often a reason for mistakes, omissions, and misinterpretations of intent and can occur because the sender does not understand the most effective way to communicate with the receiver. The AURIGO System provides some additional construction management support using an online electronic format. Forms and report templates can be found in Chapter 3 and topical checklists can be found at the end of each chapter. Many of the forms, reports, and checklists in this manual will be available online through PW&U website, which can be accessed at http://lincoln.ne.gov/city/pworks/index.htm. It should also be noted that documentation is important anytime a site is visited. A Daily Activity Report form is available to assist with properly documenting onsite visits. Daily activities may be recorded in a

field notebook and then later transferred to an official Daily Activity Report form. Even for small projects, Daily Activity Reports and shared electronic project folders (i.e. shared hard drives, ftp sites) can provide necessary common tools for PW&U project team.

2.5 RESPONSIBLITIES

The Inspector plays a variety of important roles in the field such as overseeing installation, coordinator, liaison, communicator, and the "eyes and ears" of PW&U. It has also been stressed that the Inspector have a basic understanding of project management principles and be familiar with the various components of a project. Besides understanding job responsibilities, it is also important to understand when to serve in different roles and what to look for before, during, and after construction.

2.5.1 Pre-Construction

Reviewing plans on a job site prior to construction

Prior to construction, the Inspector should get a copy of all contract documents and other pertinent project information from the PM. The Inspector should review the plans, specifications, special provisions (if any), and should look for important aspects of construction as well as errors or potential problems. The Inspector should notify the PM regarding any constructability issues or errors found or any part of the documents not fully understood.

The Inspector should also become familiar with any constraints and assumptions of the project. Issues such as regulations, weather, accessibility, deadlines, funding, the political climate, and many others can constrain the project. The primary project constraint (budget, schedule, or requirements) should be identified and understood by all prior to construction.

2.5.1.1 Review of Contract Documents

The contract documents control the work to be completed by the Contractor and should be used to resolve disputes and ensure

requirements are met. Although the collective term "contract documents" includes a large set of documents, this section will focus on the ones most important to the Inspector: Plans, Specifications, and Special Provisions. These three are described in more detail below:

- **The Plans** are drawings, standard plans, profiles, cross sections and detailed illustrations of items to be constructed or installed during the project. All of these items can be considered a part of the contract documents, whether they are attached to the plans or separate.
- **The Specifications** describe materials (quality and quantity), dimensions, workmanship (method and manner of performance), and testing methods required for the project. The Specifications are regularly reviewed and revised, so it is important for the Inspector to stay in frequent contact with the PM and maintain communication with the Contractor regarding changes. In some cases, a project may utilize older specifications or have new requirements due to recent specifications changes.
- **Special Provisions** describe unusual aspects of the project or special agreements such as easements. They often include additions to the Specifications or other details about the Specifications.

2.5.1.2 Review of Permits, Easements, and Other Agreements

The Inspector should acquire and review copies of all permits, easements, or any other appropriate agreements from the PM. Armed with this knowledge and information, the Inspector should be observant of any unusual conditions or obvious violations pertaining to these agreements and report these issues to the PM. The Inspector should note the occasional special arrangements with property owners listed in easement agreements along with any easements that have not been obtained before construction starts. It is important to notify the Contractor when these easements are obtained. If construction is expected to be delayed because of problems acquiring easements, the Inspector should work with the PM and Contractor to manage and revise schedules and activities.

2.5.1.3 Site Visit

Prior to commencement of construction, the Inspector should visit and walk the construction site with the plans in hand to become familiar with the site and the planned locations of all structures. Items to look for during the site visit include:

Pre-construction site visit

- Utilities that are not marked on the plans which might cause problems during construction (i.e. power poles).
- Errors in the location of wastewater lines, water lines, drains, or other structures.
- Location of any trees or other plants marked "Do Not Disturb" on the plans. NOTE – The Inspector should remind the Contractor to mark these with flagging.
- Obstacles to construction, unusual conditions, or potentially dangerous situations.
- Traffic patterns, public accessibility issues, and safety concerns.
- Location of streams, ponds, riparian and other aquatic areas, steep slopes, active sedimentation areas, or other site features susceptible to erosion and sedimentation and areas that will require protection. NOTE – The Inspector should document the condition of these features before construction in case of damage or impairment during construction.

The Inspector should mark the plans to note possible problems and important aspects that should be watched closely. After the site visit, the Inspector should report any possible errors or problems to the PM and address any issues at the pre-construction conference.

2.5.1.4 Pre-Construction Conference (Meeting)

Before construction starts, it is good practice to have a meeting with all stakeholders often including the PM, Inspector, the Project Engineer (if different from the PM), additional owner

representatives, utility representatives, the Contractor/Consultant, and any major subcontractors. On projects that require road closings, the meeting may include representatives with the city, county, or state road agencies plus representatives from the emergency medical service (EMS), police and fire department. Other specialty professionals may also be invited including stormwater specialists, watershed managers, arborists, or other environmental professionals on projects that involve environmentally sensitive or unique areas. Generally, items discussed at the meeting include, but are not limited to: schedules and time tables, safety and traffic control, erosion and sediment control, environmental issues, special considerations, and utility conflicts. During the meeting the Inspector should take notes on any important topics or items. For more information on pre-construction notes, see Chapter 3.

Discussion at a pre-construction meeting

2.5.1.5 Development of a Job Plan

Development of a job plan should be initiated before any construction begins and should start with a thorough review of the project plan and other important documents along with mark-up of the project plans. For more information, see Section 2.3.

2.5.1.6 Contact Property Owners

As soon as possible, the Inspector should contact all property owners whose property will be significantly affected by the project. The Inspector should identify himself/herself, provide a business card, and ask that any complaints or questions regarding the project be directed to them.

2.5.1.7 Site Photographs/Video

The contract documents typically require the Contractor to take photographs or a video recording of the project area before construction starts. This is done to document conditions of the

work area before construction in case of a dispute after construction. In these cases, the Inspector should make sure that the video or photos are of good quality, include damaged, critical, or environmentally sensitive features, and are delivered to the PM for inclusion in the project file. It is also appropriate to take additional photos or request photos from the Contractor for any damage to property or valuable property that is in jeopardy.

2.5.1.8 Environmental Issues

The Inspector should be familiar with any environmentally sensitive areas such as wetlands, erosion-prone slopes, water bodies, critical habitat, or other areas that require special protection or consideration. The Inspector should ensure that soil erosion and sediment control practices are installed before any land disturbance.

Environmentally-sensitive area in subdivision

2.5.2 During Construction

The Inspector has many responsibilities during construction, including overseeing quality control in the field, verifying quantities, overseeing environmental compliance, and ensuring safety, traffic control, and accessibility. The Inspector also needs to follow the job plan to ensure all responsibilities are met and there is coordination between projects. Specific duties are outlined in individual topical chapters in this guide.

2.5.2.1 Field Change Management

Field changes are a process developed to address change in items in the project scope including quantities, locations, materials, or even quality. Any requested changes shall be reported to the PM. Few experienced field personnel are given the authority to grant changes that impact quality and have minimal impact on project scope. It is ultimately the PM who has the responsibility to address field changes. Prior to commencement of construction, it is important for the Inspector to discuss this topic with the PM and

determine the level of authority granted. When in doubt, the Inspector should consult the PM and document all change requests and any resulting changes made to the project. Two forms provided in Chapter 3 are helpful in documenting change order requests and field modifications: (1) Daily Tracking Report, and (2) Change Order Worksheet.

2.5.3 Post-Construction

Following construction, the Inspector must make sure that all aspects of the job have been completed, all requirements met, and that all necessary documents and records are submitted to the PM and incorporated into the project file archive. Specific project closing responsibilities are discussed in greater detail in Chapter 12. Refer to individual chapters for specific checklists.

2.6 CHAPTER CHECKLISTS

The following checklist includes items for the Inspector to ensure have been completed or installed. Only pre-construction items are included. Checklists to use during construction can be found at the end of each topical chapter. Checklists to use 'Post' construction (at closeout) can be found in Chapter 12.

- Has a copy of the project Specifications, Special Provisions, and Plans been acquired from the PM? Have they been reviewed carefully and important aspects of construction or any errors, omissions, or other problems noted? Has the PM or Contractor been notified of any problems or questions?
- Has the site been visited? Were the locations of all underground utilities and other structures carefully checked? Has any potential problems with existing utilities been noted? Has the Contractor been reminded to mark trees/vegetation that should not be disturbed? Have any errors or other problems with the Plans been noted? Has the locations of features requiring soil erosion and sediment control been noted? Have plans been made to adequately protect environmentally-sensitive areas?
- Has a pre-construction meeting been held? Were notes about items pertaining to construction oversight of the project taken? Was a copy of the official minutes of the meeting acquired? If

no pre-construction meeting was arranged, has a meeting been set up with Contractor onsite?

- Is all contact information for Contractor's personnel who will be working on this project acquired?
- Has copies of all permits pertaining to the project been acquired from the PM? Have the permits and other pertinent agreements been reviewed?
- Have special conditions been included in the easements? If so, have they been reviewed?
- Have all property owners who will be affected by the project been contacted?
- If required, has the Contractor submitted pre-construction photographs and/or a video recording?

CHAPTER 3: RECORDS & REPORTING

3.1 OVERVIEW

Construction records provide documentation of data, activities, transactions, problems, scope changes, material quantities and quality, and verbal communication relating to the project. Examples include lab reports, daily activity reports, checklists, memos, maps, diagrams, photos, videos, correction notices, contract documents, easement agreements, and many more. Records enable PW&U personnel, such as PMs and Design Engineers, who are not directly involved with project construction, to monitor and assess the work as it progresses. The records also provide permanent documentation of the work and may be used for payment purposes, resolution of disputes, and re-creation of the job history and lessons learned. These records and reports may be considered part of the official project file and thus may be requested by the courts in legal actions. Records and reports:

- Must be accurate, neat, organized, and consistent;
- Should be written promptly while the Inspector can still easily recall details or, in the case of photos and videos, labeled and logged promptly.
- Should not be erased - errors or mistakes should be crossed out with single lines so that the original words or numbers are still legible.
- Should use professional language, not slang terms.
- Should include facts only - personal opinions should be avoided.
- Must be properly filed when completed.
- Should be distributed to respective stakeholders including other PW&U Divisions, when required.

3.2 GENERAL GUIDELINES

3.2.1 Importance of Record-Keeping

Proper documentation is an important fundamental component of any project for a variety of reasons including: as an official account or record of the project process, legal or contractual considerations, regulatory requirements, for repeatability, to ensure all requirements have been met, resolve conflicts, distribute

information and data, and as part of the communication process. Items such as field notes, meeting minutes, photos, videos, material quantities and quality assessments, incidents, test results, and such should be documented for later inclusion in the formal project file. Much of this information can be captured in forms, reports, checklists, and memos, many of which are available in this guide or online. For small projects or PCA projects, reports may be abbreviated or dispensed with entirely. It may be beneficial to have copies of certain documents such as contract documents in the field for reference and verification purposes. It is important to discuss record-keeping requirements with the PM prior to commencement of construction, so the Inspector is clear on specific requirements for each project.

3.2.2 AURIGO System & Use in Construction Management

The AURIGO System was adopted by the Engineering Services (ES) Division of PW&U as a construction management system tool. This system allows City employees and Consultants (with permission) to view and submit information such as daily reports, quantities, and contract documents online. With this system, the Inspector has access to electronic forms and other resources accessible in the field from a laptop. PW&U encourages increased usage of this system to provide consistency, accuracy, and completeness of record-keeping. The *Executive Order for Private Construction Agreements – Expectations and Responsibilities* (REV August 22, 2007, p. 2) specifically requires the Construction Engineer (or PM) to submit daily electronic observation notes into the AURIGO system. Since the Inspector generally oversees construction, it would be his/her responsibility to submit this required information.

This system may not have all forms, reports, and checklists available, therefore, the Inspector may need to access and/or submit information by other means. AURIGO will continually be updated, and could potentially allow attachment of documents, forms, checklists, photos, and other information. The AURIGO System can be accessed online at https://aurigo.lincoln.ne.gov. The Inspector must acquire a user name, password, and certificate to

access AURIGO. For contact information, see the General References - Links & Resources in Chapter 1.

3.2.3 Obtaining Forms, Report Templates, & Checklists

Forms, report templates, and checklists are available from several sources including this field guide, the AURIGO System, and through the general PW&U website found at: http://lincoln.ne.gov/city/pworks/engine/dconst/gpp/index.htm. Sample completed forms are included at the end of this chapter.

A best practice is to make a checklist prior to commencement of construction to itemize what forms or reports are needed for the project. Discussions with the PM and a review of similar past projects and lessons learned may assist in determining which reports or forms will be needed. Some projects may require special or additional forms due to the nature of the project such as regulatory requirements, the type of project (i.e. water, wastewater, or stormwater), environmental issues, or special requirements by a particular division of PW&U. Once a checklist is developed, hard copies of the forms should be obtained even if a laptop is used in the field. Low batteries or weak internet signal may render the laptop useless, making hard copies necessary. Many field personnel use a field notebook that has water-resistant paper to gather field information and then they later transcribe the information into the proper format such as a "Daily Activity Report." Completed forms may be scanned and converted into electronic format and attached to Daily Progress Reports or filed in an electronic project folder or both.

3.2.4 Emergency Conditions

Emergency conditions generally require more expeditious action than going through any type of lengthy documentation process to reduce unsafe or dangerous situations. Imminent danger may require the Contractor or City to shut down the construction work until the situation has been remedied. Chapter 5 discusses in more detail specific actions to be taken. Always consult the PM to determine how to handle these types of situations. Both the "Daily Activity Report" and the "Contractor Notification Form" can be used as guides to document these situations.

3.3 PRE-CONSTRUCTION NOTES & DISCUSSION ITEMS

Documentation of project activities for the Inspector begins much sooner than commencement of construction. A good practice is to take notes at every stage of the project. This includes at preliminary meetings with the PM, other stakeholders, and the Contractor. There is no official format for documenting pre-construction activities, but many field personnel use a project-specific field notebook. Information recorded in this notebook can later be transferred to other formats such as electronic forms, memos, or minutes. The field notebook pages could also be scanned and converted into electronic format if the information is extensive.

Preparing construction site

During the pre-construction conference with the consultant and other stakeholders, the Inspector may be called upon to take minutes and/or document results of the conference and submit to the PM. Items and topics to cover for this conference are summarized below:

- Construction items and timetables.
- Items of concern.
- Verification that all special agreements involving easements are documented in the Special Provisions.
- Traffic control, public accessibility, and priority safety issues.
- Contractor's contact information.
- Property owner concerns or requirements.
- Erosion and sediment control and other environmental issues.
- Request for missing information or required documents.
- Follow-up meetings, the construction commencement date, and assignments.

Observation of unusual or potentially unsafe conditions should extend beyond just projects assigned to the Inspector. As the "eyes and ears" of PW&U, the Inspector should be observant as he/she

travels to and from project sites. If the Inspector sees something that appears to be a violation or just seems to be out-of-the-ordinary, the problem should be noted and followed-up with the PM or other designated PW&U representatives for that particular site or project. All spills that will impact surface water must be reported immediately to the Lincoln-Lancaster County Health Department (contact info in Chapter 1). The Inspector should let the appropriate City personnel handle any enforcement action unless assigned/instructed to do so. Observation activities described in this section are not additional responsibilities for the Inspector, but rather represent typical daily observation activities that fall within the purview of the Inspector position responsibilities and job description.

3.4 CONSTRUCTION FORMS AND WORKSHEETS

The following subsections describe typical forms or worksheets that the Inspector may use working on PW&U projects:

- Daily Activity Reports.
- Contractor Notification Forms.
- Quantity Worksheet.
- Field Change Order Worksheet.
- Incomplete Work List.
- Inspection Form for New Construction.
- As-Built Checklist Form.
- Sanitary Sewer Service Reconstructions
- Pressure Test Log (NDHHS records)

3.4.1 Daily Activity Reports

- When to fill out: Anytime onsite or engaged in project activities and as soon as possible after key information is made available. Additional information on completing Daily Activity Reports can be found in the *Guidelines to Inspector's Daily Activity Report*.
- Key information: Some items listed below are not itemized on the form, but should be included in one of the narrative sections.
  - Project-specific information – Project name/number, project phase (if applicable), contract number, other required identification numbers (i.e. budget code), project location,

type of project (i.e. water main, wastewater installation, etc.), and Inspector name.

- Site-specific information - Access information and any special information necessary to clearly describe the project site (i.e. soils, slopes, vegetation, water bodies, etc.).
- Environmental issues – Describe status of erosion and sediment control practices and any other environmental issues.
- PW&U Division information –Information such as the PM and other unique identifiers for the specific PW&U Division that is overseeing the project.
- Contractor Information – Name of the Contractor, hours onsite, and any subcontractors onsite that day and their supervisors.
- Weather – Note the daily high and low temperature, sky conditions, and the presence of rain, snow, or wind for the days worked.
- Date & Time – Include the date and time(s) of major activities, events, or milestones.
- Work completed – List the size, type, and location of pipe installed; discuss backfill placed; comment on pipe acceptance testing; record the quantity, location, and class of concrete placed, if applicable; note any quality issues with completed work; comment on the condition of appurtenances; and describe other types of work completed, such as the construction of valves, hydrants, and other appurtenances or conveyance channels, pavement, ground restoration, etc.
- Unusual occurrences – Describe any adverse conditions, delays, and controversial matters.

Site conditions and weather should should be recorded in daily reports

- Safety issues – Describe any potentially dangerous or alleged unsafe conditions, notifications made, and any remedies to correct issues.
- Instructions issued and received – Record any instructions issued or received.
- Number of personnel/major equipment – Report the type and quantity of resources used by the Contractor each day and any quality issues.
- Special requests – Record any special requests and details of request from Contractor, general public, or other stakeholders.
- Enforcement requests – Record details of requests for compliance with the plans, environmental issues, or regulatory requirements.
- Site visitors – Record each visitor to the site.
- Attachments – Photos, video captures, drawings, diagrams, charts, or other supplements should be attached to the report form or included in the field notebook if possible. Most items can now easily be digitized.
- Follow-up actions – Record any follow-up actions (e.g. discussions with PM on scope or plan changes) and "To Do" items.

- Signature: It is a good practice to sign and date Daily Observation Reports since this information could be considered a legal document; a field notebook should also be signed and dated at the end of each day and any space remaining on the current page lined out to show activities ceased for that day.
- Report submittal: The original should be filed in the official project file. Copy to the PM, AURIGO System, and other pre-determined stakeholders or PW&U employees; copy in the Inspector's project file. If the Inspector keeps a field notebook, copies of appropriate pages will need to be made and submitted to those listed or in the case of the AURIGO System, transferred to electronic format.
- Example: An example of a correctly filled out Daily Activity Report is included at the end of this chapter.

3.4.2 Contractor Notification Form

- Purpose: Identify and document situations in which the Inspector believes that the Contractor is not meeting the contractual responsibilities. For example, issues such as trench width exceeding the design maximum or failure to implement proper traffic control or public accessibility should be noted on this form.
- When to fill out: The Inspector should first ask the Contractor to correct the condition. This conversation should be documented in the Daily Activity Report. If the Contractor does not take action to correct the situation after verbal warnings, the Inspector should then complete this form. This form should address situations when the Contractor is not following plans and specifications, unusual or potentially unsafe conditions, issues, or other out-of-the-ordinary situations that are observed. If the situation presents an immediate danger, the Inspector should contact the PM or other designated enforcement officer and follow the steps discussed in Chapter 5.

Impacts of no soil erosion and sediment control

- Key information:
  - Names/titles of people contacted at the site (i.e. Contractor representatives, general public, authorities, other stakeholders).
  - Time, date, and location where the Inspector observed the condition.
  - Actions taken by the Contractor after the Inspector expressed concern.
  - Remarks made at the site.
  - If possible, attach photographs, video captures, diagrams, or drawings.
  - The form should not state a solution to the problem.

- Violations related to SWPPP, wetlands, illicit discharge or other specific environmental issues can be reported on this form, but may have additional reporting requirements. For more information on each, see Chapter 10.

- Report submittal: The original should be submitted to the PM and/or the designated enforcement officer; copy to Contractor; copy in the Inspector's project file; copy in official project file.
- Example: An example of a correctly filled out Contractor Notification Form is included at the end of this chapter.

3.4.3 Quantity Worksheet

- Purpose: Verify the quantity of work completed on the project.
- When to fill out: Daily for each pay item installed.
- Key information: Description of the pay item and/or the pay item number from the contract, the quantity installed for the pay period, and the total to date.
- Special instructions:
  - Before filling out this worksheet, the Inspector must become familiar with all pay items included in the contract.
  - After completing this worksheet, the Inspector should meet with the Contractor and agree on the amount of work completed during the pay period. The PM will then submit the pay estimate.

Quantities requested via change orders need to be tracked

- Report submittal: This form is only for the use of the Inspector.
- Example: An example of a correctly filled out Quantity Worksheet is included at the end of this chapter.

3.4.4 Field Change Order Worksheet

- Purpose: Provide information to the PM regarding a field change. This worksheet is the precursor to the Change Order.
- When to fill out: Anytime a change to the project requires field measurement or to provide help with defining purpose or need for a change.

- Key information:
  - A clearly written description and cost of each pay item, when possible.
  - The specific location of the work to be performed.
- Special instructions: This form will typically be completed at the PM's request. Input from the Contractor's onsite supervisor is encouraged.
- Report submittal: Original to the PM; copy in the Inspector's working file.
- Example: An example of a correctly filled out Field Change Worksheet is included at the end of this chapter.

3.4.5 Incomplete Work List

- Purpose: List and notify Contractor of incomplete or deficient work items. This is not a "punch list" but rather a preliminary list of items that should be addressed prior to Substantial Completion.
- When to fill out: On an on-going basis for work that is deficient or incomplete. This form tracks these issues as construction progresses and the Inspector periodically submits to Contractor for completion. This form can also be used to develop the final punch list created after the substantial completion walkthrough with the PM and Contractor.
- Key information:
  - Includes a clearly written listing of each incomplete or deficient work item.
  - May reference item locations (i.e. hydrants, vaults, manholes, etc.) and number of items.
  - Reference to the specific requirement deficiency when pertaining to quality issues.
- Special instructions:
  - Offered as help to Contractor in preparation for final walkthrough.
  - Inspector should emphasize that this list is general in nature and should be combined with the Contractor's work list to bring project to completion.

- Report submittal: Original to Contractor; copy to the PM; copy in the Inspector's project file; copy in official project file.
- Example: An example of a correctly filled out Incomplete Work List is included at the end of this chapter.

3.4.6 Inspection Form for New Construction

- Purpose: Notify other PW&U Divisions of completed projects in order for the other Divisions to inspection the project and approve completed as needed.
- When to fill out: After the Final Completion Date. This form should include a copy of as-built drawings. Larger projects should include a set of red lined plans for the final inspection.
- Key information:
  - All key information is included on the form.
- Special instructions:
  - Existing form used to ensure communication between other PW&U Divisions of project completions.
- Report submittal: Original to all required PW&U Divisions; copy to the PM; copy in the Inspector's project file; copy in official project file.
- Example: A correctly filled out Inspection Form for New Construction is included at the end of this chapter.

3.4.7 As-Built Checklist Form

- Purpose: Update original plans to as-built plans.
- When to fill out: After all work has been completed. These plans document all recordable changes from the original plans.
- Key information:
  - All key information is included on the form.
- Special instructions:
  - Offered as help to the Inspector for consistency in creating As-Built plans.
  - Inspector compare notes with Contractor to ensure all data is correct and up to date. Any discrepancies should be discussed with the Contractor and PM.
- Report submittal: Original in official project file, Copy to Contractor and PM.

- Example: An example of a correctly filled out As-Built Checklist Form is included at the end of this chapter.

3.4.8 Sanitary Sewer Service Reconstructions

- Purpose: Document the reconstruction of sanitary sewer services.
- When to fill out: Prior to work beginning. This form documents the location and work to be completed.
- Key information:
  - All key information is included on the form.
- Special instructions:
  - Existing form used to document reconstruction of sanitary sewer services.
- Report submittal: Original in official project file, Copy to Contractor and PM.
- Example: An example of a correctly filled out Sanitary Sewer Service Reconstructions Form is included at the end of this chapter.

3.4.9 Pressure Test Log (NDHHS records)

- Purpose: To notify NDHHS of the pressure test results for water or wastewater lines.
- When to fill out: After all pressure testing has been completed. This form documents the location and results of all pressure tests.
- Key information:
  - All key information is included on the form.
- Special instructions:
  - Existing form used to inform NDHHS of pressure test results.
- Report submittal: Original in official project file, Copy to NDHHS, PM, as well as LWS or LWWS.
- Example: An example of a correctly filled out Pressure Test Log is included at the end of this chapter.

3.5 TESTING AND ACCEPTANCE FORMS

Testing and acceptance reports are used to record the results of any tests conducted in the field and to verify proper installation of project components. Generally, the Contractor performs the following tests and the Inspector observes and records results:

- Low-pressure air and deflection tests on gravity wastewater pipes, and flexible non-pressure pipes.
- Hydrostatic tests on force mains.
- Infiltration/exfiltration tests on gravity wastewater.
- Air pressure tests on water mains.

Air test in progress

In some cases where the Inspector is unavailable or does not have the technical knowledge, other PW&U personnel such as lab technicians assist with testing particularly for soils compaction and concrete strength tests. These assisting personnel should be given adequate advance notice, and should be reminded in advance of the scheduled test.

All testing performed in the field must comply with the contract documents. Test reports generally should be reviewed with the PM or other designated PW&U representative such as a Project Engineer after completion of the tests. In some cases, "passed" tests may not require any additional supervisory review and construction activities should continue to move forward. Check with the PM to determine if this is the case. Additional testing and other requirements may be necessary for failed tests. Copies of all test reports should be kept in the project file. For more information on each acceptance test, see Chapter 6.

3.5.1 Low-Pressure Air/Deflection Form

- When to fill out: During air pressure and deflection tests.
- Key information: Type of test (i.e. gravity wastewater); pressure level; size, type, and location of the pipe tested; time required for the air test; date and start time of test; specific details as required.
- Results: Indicated by "passed" or "failed"; may also indicate additional narrative to further explain test results and other characteristics of the test.
- Special requirements: If a pipe fails an air or deflection test, a passing retest must be performed and documented. The cause of failure should be recorded. Check with the PM or the Project

Engineer for additional or specific requirements for failed tests. PW&U requirements can also be found at http://lincoln.ne.gov/city/pworks/engine/dconst/index.htm.

- Report submittal: Failed test results should be distributed to the PM and, when applicable, the Project Engineer for review; copies to the official project file. Passed test results should be recorded in the Daily Activity Report.
- Example: An example of a correctly filled out form is included at the end of this chapter.

3.5.2 Infiltration/Exfiltration & Hydrostatic Form

- When to fill out: During infiltration, exfiltration, or hydrostatic tests.
- Key information: Type of test (i.e. infiltration, exfiltration, hydrostatic.); size, type, and location of the pipe tested; date and start time of test; specific details as required including testing pressure and Total Leakage for Test (TLT); allowable leakage; test results.
- Results: Indicated by "passed" or "failed"; may also indicate additional narrative to further explain repairs made prior to retest.
- Report submittal: Failed test results should be distributed to the PM and, when applicable, the Project Engineer for review; copies to the official project file. Passed test results should be recorded in the Daily Activity Report, and submitted to Lincoln Wastewater System.
- Example: An example of a correctly filled out form is included at the end of this chapter.

3.6 ADDITIONAL REPORTS & FORMS

3.6.1 Web Links to Forms/Templates & Instructions (Incl. AURIGO)

The following web links can provide additional forms, reports, checklists, and other templates:

- PW&U website portal- http://lincoln.ne.gov/city/pworks/index.htm
- AURIGO System - https://aurigo.lincoln.ne.gov

3.6.2 Examples

Pages 3-15 through 3-24 include examples of correctly filled out forms described in previous sections. Additional examples may be found on the PW&U website, from the PM, and in previous project files. Consult the PM to determine how to document and record construction project activities.

CITY OF LINCOLN
NEBRASKA

Contractor Notification

(Notice of Condition or Correction)

Date: 05/20/09

Project/Location: Upper Beal Slough Trunk Sewer

Contractor: Chris Harmon Phone #: 402-555-1055

On-Site Supervisor: Reliable Construction Cell #: 402-220-5050

The following site condition(s) exist and require your immediate attention and correction:

- ☐ Non-compliance with plans and specifications
- ☐ Non-compliance with ADA
- ☐ Code/failure to comply with approved plan (e.g. Traffic Control)
- ☑ Erosion Control (SWPPP)
- ☐ Other _____

Corrections/Observations:

Silt fence down and needs to be repaired. Conversations with Chris Harmon have not led to problem being addressed.

Take action immediately or notify with time table and corrective procedures. Upon completion, please notify _____ at _____ (Ph). Responsible party has 10 days to comply with notice. If no action occurs in the agreed time, additional action will be taken.

Jacob Rock _____ Date: 05/20/09 Phone: _____
Owner Quality Representative

Chris Harmon _____ Date: 05/20/09 Phone: _____
Contractor

Copy: Project Manager

CITY OF LINCOLN
NEBRASKA

Daily Activity Report

Date: 05/07/09

Project: Upper Beal Slough Trunk Sewer Contract #: 700924

Contractor: Chris Harmon Ph Number 402-555-1055

On-Site Supervisor: Reliable Construction

Personnel/ Equipment: Chris Harmon

Subcontractor: Josh Dixon Ph Number 402-876-5309

Supervisor: Jeremy Dau

Personnel/ Equipment: Eric Hanson - Laborer

Ian Blanding - Laborer

David Nylon – Operator (Back hoe)

Weather Conditions: Wet/ Wind NNW @ 25 mph

Visitors:

Work Performed:

Reliable Construction laid 24" PVC sanitary sewer pipe from station 54+59.65 to 57+61

Deficiencies observed today: Removed 3' of damaged pipe at station 3+76 and replaced.

Materials received on-site/Communications/Issues:

Signature Jacob Rock Date 05-07-09
Owner Quality Representative

EXAMPLE OBSERVATIONS:
Backfill (type, condition), Pipe (size, type), MH set, Service (line no.), Testing, Hydrants, Valves, Vaults

CITY OF LINCOLN
NEBRASKA

Daily Tracking Report
Labor, Material and Equipment

Date: 05/05/09

Project: Upper Beal Slough Trunk Line Sewer Contract: 700924

On-Site Supervisor: Reliable Construction

Work Performed: Laid approx 300' of 18" PVC sanitary sewer pipe

Owner Quality Representative: Jacob Rock

Labor:

Description/ Work performed	Hours	Totals
Jacob Dawson – General Labor	10	
Scott Thomas – General Labor	10	
Randall Earhart – General labor	10	
Brent Jensen - Operator	7.5	

Equipment:

Description	Hours	Totals
Back hoe	7.5	

Material:

Description/ Deliveries	Hours	Totals

Notes:

Contractor: Chris Harmon Date: 05/05/09

CITY OF LINCOLN
NEBRASKA

Field Change Order Worksheet

Date: 05/13/09

Project: Upper Beal Slough Trunk Sewer

Contract #: 700924

Owner Quality Representative : Jacob Rock

Contractor: Chris Harmon

Item	Description	Quantity	Station./Line	Location
30.0050	Seeding Type "B"	1.0 AC	5+34	

Item	Reason
30.0050	Seeding area was increased due to an enlarged staging area

Proposed changes will:

☑ Increase the total cost by $ 1,000

☐ Decrease the total cost by $ _____

Jacob Rock

Owner Quality Representative

Cell #: _____

CITY OF LINCOLN
NEBRASKA

Quantity Worksheet

Project:_____ Location:_____

Contractor:_____

Owner Quality Representative:_____

Date	Description (Pay Item)	Station to Station	Quantity Installed	Quantity To-Date	Comments

Owner Quality Representative: _____ Date: _____

CITY OF LINCOLN
NEBRASKA

Incomplete Work List

Project/Location: Upper Beal Slough Trunk Sewer

Contractor: Chris Harmon Date: 05/27/09

Person Notified: Chuck Norris

Deficient Items:

- Adjust manholes 2, 6, 7 and 9 to finish grade
- Adjust manhole 3 invert
- Seed final 300' of project

Jacob Rock Date: 02-27-09 Cell:

Owner Quality Representative

CC: Project Manager

CITY OF LINCOLN NEBRASKA	**Inspection Form for New Construction**	PROJECT MANAGER: Ben Hough	CONTRACTOR: Chris Harmon
		PROJECT INSPECTOR: James Wagner	SUPERINTENDENT: Chad Brown
		DATE ISSUED: Fri, May 22, 2009	DEADLINE DATE: Tue, June 09, 2009
PROJECT NAME: Upper Beal Slough Trench Sewer		PROJECT DESCRIPTION:	
PROJECT NUMBER: 0700924	PROJECT LOCATION: Lincoln, Nebraska	☑ Grading ☐ Water ☐ Traffic Signals ☐ Signing	☐ Storm Drainage ☐ Paving ☐ Landscaping ☑ Erosion Control
			☐ Waste Water ☐ Lighting ☐ Markings ☐ Misc:

To: Reliable Constrution

Date Issued: Fri, May 22, 2009

Inspected By: James Wagner

Date Inspected: Wed, May 27, 2009

I have inspected the project and found the construction: ☐ Satisfactory ☑ Unsatisfactory

I have found the following items unsatisfactory:
Silt fences were in need of repair and grading has not been completed as agreed upon.

07/2008

CITY OF LINCOLN
NEBRASKA

Low-Pressure Air/Deflection Form

Date: 05/15/09

Project/Location: Private Construction Agreements Contract: 700924

Owner Quality Representative : Jacob Rock Cell: 402-555-8784

Contractor: Chris Harmon

On-Site Supervisor: Reliable Construction

Test Data

Pipe 8" PVC
Sta. 0+00 to Sta. 2+97.87
Time: 7 Min. 34 Sec.
Test Passed Retest
Deflection Test Passed
Start Pressure: 6 psi Finish Pressure: 6 psi

Pipe 8" PVC
Sta. 4+00.0 to Sta. 5+99.48
Time: 7 Min. 34 Sec.
Test Passed Retest
Deflection Test Passed
Start Pressure: 5 psi Finish Pressure: 5 psi

Pipe
Sta. to Sta.
Time: Min. Sec.
Test Retest
Deflection Test
Start Pressure: Finish Pressure:

Pipe
Sta. to Sta.
Time: Min. Sec.
Test Retest
Deflection Test
Start Pressure: Finish Pressure:

Pipe
Sta. to Sta.
Time: Min. Sec.
Test Retest
Deflection Test
Start Pressure: Finish Pressure:

Pipe 8" PVC
Sta. 2+97.87 to Sta. 4+00.05
Time: 7 Min. 34 Sec.
Test Passed Retest
Deflection Test Passed
Start Pressure: 7 psi Finish Pressure: 7 psi

Pipe 8" PVC
Sta. 5+99.48 to Sta. 6+10
Time: 7 Min. 34 Sec.
Test Passed Retest
Deflection Test Passed
Start Pressure: 8 psi Finish Pressure: 8psi

Pipe
Sta. to Sta.
Time: Min. Sec.
Test Retest
Deflection Test
Start Pressure: Finish Pressure:

Pipe
Sta. to Sta.
Time: Min. Sec.
Test Retest
Deflection Test
Start Pressure: Finish Pressure:

Pipe
Sta. to Sta.
Time: Min. Sec.
Test Retest
Deflection Test
Start Pressure: Finish Pressure:

Notes: Ground water elevation = 1257 @ manhole 1

CITY OF LINCOLN
NEBRASKA

Infiltration/Exfiltration and Hydrostatic Form

Date: 05/01/09

Project/Location: Upper Beal Slough Trunk Sewer Contract: 0700924

Owner Quality Representative : Jacob Rock

On-Site Contractor: Chris Harmon

1. Test Information

Pipe Description: PVC

Pipe Diameter (A): 24" in Inches

Pipe Length (B): 240' in Feet

Length of Test (C): 20 in Hours

Testing Pressure: _____ in PSI

Note: Testing Pressure Equals: 6 Feet

2a. Allowable Leakage

INFILTRATION/EXFILTRATION

Total Allowable Leakage (TAL): _____

TAL = 0.0016 x A x B x C,

_____ Gallons,

0.0016 Gallons per inch of Diameter, per

Lineal feet of pipe

2b. Allowable Leakage

HYDROSTATIC

Total Allowable Leakage (TAL): _____

TAL= 0.5 x A x (B ÷ 100) x

Test time (in hours) _____ Gallons

0.5 Gallons per inch of Diameter, per

lineal feet of pipe

3a. Test Results (Exfiltration)

Total Leakage for Test (TLT) = _____ Gallons (decrease in water level = _____ ft.)

(radius of manhole = _____ ft.)

FINAL RESULTS _____

Note: The Total Leakage for the Test (TLT) for the exfiltration test may be determined by measuring the decrease in the height of the water in the manhole. If this method is utilized, the following formulas may be used to calculate the TLT min terms of gallons:

TLT = Decrease in Water Level (in feet) x 3.14 x Manhole Radius (in feet) squared x 7.48

3b. Test Results (Hydrostatic)

Test Starting Time _____ Meter Reading _____ (D) _____ (in gallons)

Test Ending Time _____ Meter Reading _____ (E) _____ (in gallons)

Total Leakage for Test (TLT) = E – D = _____ - _____ = _____ (in gallons)

FINAL RESULTS (All Tests)

- ☐ PASSED
- ☐ NOT PASSED

Signature Jacob Rock
Owner Quality Representative

CHAPTER 4: CONSTRUCTION SURVEYING

4.1 OVERVIEW

Surveying is a vital part of the construction process. PW&U projects require accurate surveying so that newly constructed facilities will function as designed. Surveying equipment has greatly improved in recent years in increasing accuracy. It is common to see a global positioning system (GPS) utilized to survey control points in the field or to guide excavating equipment on earthmoving projects. Some types of construction, such as deep or large pipe projects and long trenchless installations, may require more extensive knowledge of construction surveying. If the Inspector feels they do not have adequate knowledge to monitor the project, the PM should be notified.

4.2 CONSTRUCTION SURVEYING

For the purposes of this field guide, we will restrict the discussion to construction surveying required to establish physical aspects of a PW&U project. The construction surveys are necessary to establish control for line and grade, to check conformity of construction to plans, and to establish any influence that occurs on facilities adjacent to the construction.

Prior to the start of any work, right-of-way (ROW), work areas, or construction limits and clearing limits should be laid out to define the project and assure protection of adjacent properties.

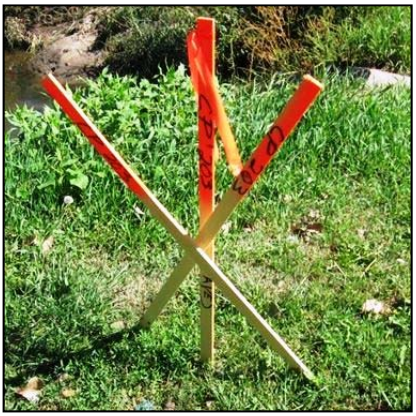
Prior to construction, control points are set to establish horizontal and vertical controls onsite. Any additional construction surveying is the responsibility of the Contractor. This includes using the construction stakes to establish locations and elevations of the structures and to maintain lines and grades of gravity pipes. The Contractor is ultimately responsible for assuring that all structures and pipes are located as shown on the project plans. One example is the need for extra care in laying out the orientation

Surveying a construction site

of fire hydrants and locating valves for water projects. If this is not done, the Inspector will want to give closer scrutiny to that aspect of construction to verify proper installations.

4.3 RESPONSIBILITIES

4.3.1 Control Points



Control point used for horizontal and vertical control

All construction surveying uses control points, which are fixed points at clearly identified locations. PW&U projects involve horizontal and vertical control points, as shown on the plans. Control points in the area of the project should be checked to assure they are referenced and can be replaced if necessary. The transfer of line and grade from control established by the design team is the responsibility of the Contractor. Additional temporary control points are sometimes utilized for construction staking. The Contractor is responsible for any additional control points, construction staking, and benchmarks necessary for completion of the project. Typical temporary control points are:

- Beginning and ending points.
- Points of Intersection (P.I.'s), which are shown on the Plans.

The City provides horizontal and vertical control points for the Contractor's use. These control points must be established prior to construction. In general, the following parties are responsible for establishing the initial vertical and horizontal control points:

- **PW&U** – For projects designed in-house by the City, principally in Engineering Services, a Professional Land Surveyor working as a survey Consultant would be responsible.
- **Design Consultant** – For projects designed for the City by a Professional Engineer working as a Consultant, a Professional Land Surveyor would perform the survey.

- **Developer** – For Private Construction Agreement (PCA) projects, the developer is responsible for employing a Professional Land Surveyor to establish the initial control points.

Vertical control, maintained by the City, is established by survey benchmarks on the North American Vertical Datum of 1988 (NAVD 88). Horizontal control, maintained by the County Surveyor, is established by section corners.

When new construction will connect to an existing pipe, manhole, or other facility, the surveyor should verify the exact location and grade of the point where the new construction will connect. Control points must be maintained during construction and must be referenced to permanent objects outside the construction limits. When the City is responsible for establishing the survey control, a survey party contracted by the City may be required to replace damaged points.

4.3.2 Cut Sheets

Cut sheets are often used to illustrate stations, grade stake elevations, invert elevations, and cut distances from original ground for mains, structures, and pipe stubs necessary for establishing and checking the grade of the pipe lines and/or underground improvements. These should be developed by the Contractor's staking crew. The Inspector should receive copies of all cut sheets developed for the project.

4.4 SURVEY EQUIPMENT

When checking construction surveying, the Inspector should be familiar with commonly used surveying instruments. On PW&U projects, the most frequently used instruments include the transit or total station, levels and rods, and GPS equipment. Brief descriptions of these instruments are as follows:

- GPS – This unit uses satellites to triangulate its position and calculate horizontal and vertical control. GPS equipment typically consists of a base unit and a rover. GPS systems can provide a high level of accuracy, and are typically run by a one man crew. Training is required to become familiar with GPS units to ensure they are calibrated, operating properly, and to

correctly establish horizontal and vertical control. Calibration should be done annually and the Inspector can ask for documentation.

Total Station being utilized for pre-construction staking

- Total Station– The total station is used for measuring horizontal and vertical angles, for setting points in a line, for measuring approximate distances, leveling, and as a compass.
- Levels and Rods – The level is an instrument used in conjunction with a rod to determine the difference in elevations of two points. Several different types of levels are used including laser levels and automatic levels. Automatic levels use a level rod that is read to the hundredth of a measurement unit. Laser levels create a known reference elevation that can be read off of a rod with a receiver attached. Laser levels permit instant grade checking throughout a site for multiple receivers, if needed. When checking elevations and grades, the rod must be held plumb for an accurate reading.

4.5 CONSTRUCTION SURVEYING PROCEDURES

4.5.1 Location of Offset Stakes

The staking of offsets is Contractor driven, and is often based on the type of equipment selected. As an example, excavators in Lincoln typically require offsets of approximately 13 feet.

Offset grade stakes should be spaced at a maximum spacing of 50 feet for straight segments and 25 feet on horizontal or vertical bends unless otherwise requested by the Contractor. Typically, all structures, intersections, turns, and changes of grade are identified by guard stakes. Two offset guard stakes are required for manholes at intersections and turns of gravity wastewater lines, one for each wastewater alignment. The locations of the stakes shall be denoted by offset (if applicable), station numbers, and a location description. Typically, hubs, flags, or guard stakes are used in unimproved ground while P.K. nails or paint are used on

concrete surfaces. Use of paint on sidewalks should be minimized where possible. For more information on guard stakes, see LSP 163.

4.5.2 Checking Elevations of Offset Stakes

Before construction, the Inspector should review that the offset stakes are set properly by checking a few key offset stakes. When a field review brings the layout to question, the Inspector should discuss with the PM to determine the best course of action. For more information on checking elevations of offset stakes, the Inspector should refer to the PM or Project Engineer.

4.5.3 Checking Line and Grade

Generally, for gravity pipeline construction, the horizontal alignment is established by measuring the distances from the offset stakes to the pipe with a tape and plumb bob, by sighting down the trench with a transit, or by using a laser. On large-diameter pipe, centerline stakes may be set in the trench bottom ahead of the pipe.

Checking line and grade

The vertical alignment is normally established by measuring elevations from offset stakes using a level and rod, or by using a laser set in the pipe or a manhole and adjusted to the proper grade.

The Inspector should witness the Contractor's surveyor checking the grade and alignment at intervals not exceeding 100 feet, if possible. The line should be checked by setting up a transit or level at the start of a run and sighting to the end of the run. A plumb bob can then be dropped in the line of sight to verify the pipe's alignment. Figure 4.1 and the following text illustrate how to determine the grade and invert elevation for a typical gravity pipeline.

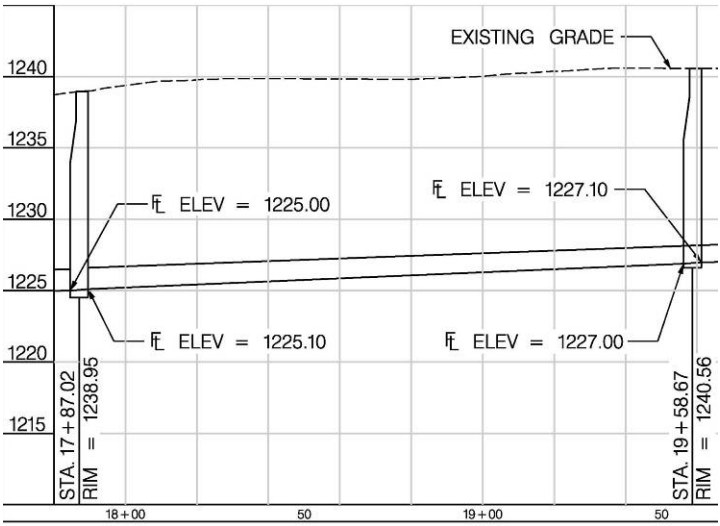


Figure 4.1. Typical gravity pipeline layout

Task: Determine the grade of the gravity pipe between the manholes and the invert elevation of the pipe at Station 19+00.

(1) Find the Grade:

$$\text{Grade} = \frac{\text{Change in Elev.}}{\text{Distance}} \text{ X } 100\%$$

$$\text{Grade} = \frac{1227.05 \text{ ft} - 1225.05 \text{ ft}}{19{+}58.67 \text{ ft} - 17{+}87.02 \text{ ft}} \text{ X } 100\% = \underline{1.17\% = 0.0117 \text{ ft/ft}}$$

(2) Find the flowline elevation at Station 19+00:
Flowline elev. @ 19+00 = (distance from manhole x grade)
+ Manhole Invert elev.
= (112.98 ft x 1.17%) + 1225.05 ft
= 1.32 ft + 1225.05 ft = 1226.37 ft

4.5.4 Use of Lasers

A laser is the most commonly used device to control line and grade on City projects. Normally, the laser is set up in a manhole or pipe invert and leveled, and the proper grade is dialed into the instrument. The laser is then set at the correct height above the invert.

The most critical time for the laser setup is at the beginning of a run where it is advisable for the Contractor to check grade early to assure the laser is properly calibrated and influences of climate, etc. The Inspector should periodically verify that the Contractor is checking the laser for accuracy. This is completed to prevent large deviations from line and grade from occurring.

The performance of lasers can be affected by varying temperatures, high humidity, and dust within the trench. The Inspector should make sure the Contractor is aware of these conditions and their effects on the equipment. Precautions may include using a blower in a manhole or wetting the bedding material.

4.5.5 Service Connections

Service connections (SCs) are any line off of the main that will service a commercial or private building. When SCs are constructed, the Inspector should check the following regarding construction staking location and grade:

- A SC should be constructed to the ROW line or easement line for each lot that is shown on the plans as receiving service.
- The upstream end of the SC should be set at a depth that will permit the property owner to hook into the system.
- Wastewater connections should be laid on a practical slope to allow for good flow characteristics or as shown on the plans, but no less than minimum slope of 1% (1/8 inch per foot).

On PCA projects, the wastewater service locations are typically in the center of the lot and depths of the SCs are generally selected in the field by the Developer's engineer. The Inspector should verify that each SC is directed toward the approximate center of the lot, as determined using the stations and property lines shown on the plans. It may be difficult to determine where the property corners are in relation to the centerline of the improvement in street curves and cul-de-sacs. If so, the Inspector should request that the Developer's surveyor provide stakes at the property corners, to ensure that the SCs are built at the correct locations.

4.6 CONSTRUCTION SURVEYING CHECKLIST

- Are all control points established and appear to be undisturbed?
- Is all necessary construction staking completed? Does it appear to be accurate?
- Do the elevations of offset stakes appear to be correct?
- Are offset stakes sufficient at maximum 50 foot intervals for straight segments and 25 foot intervals for vertical and horizontal curves, and at manholes, intersections, bends, and changes of grade? Are stakes denoted correctly?
- Are lasers being used properly? Are provisions being taken by the Contractor to reduce refraction of the beam (such as wetting bedding material and using a blower)? Has the Contractor occasionally checked the accuracy of the laser?
- Are service connections properly located?
- Are the depths of service connections sufficient to maintain a minimum 1% grade between the connecting facilities and the pipe? If not, have corrective measures been taken to adjust the grades?
- After construction, have all service connections been located horizontally and referenced to the survey baseline, both at its upstream end and at the “T” fitting? Has the depth of the upstream end of the SC been verified?
- Have all deviations from the plans or shop drawings been properly noted on the As-Built Plans?

CHAPTER 5: JOBSITE SAFETY

5.1 OVERVIEW

The personal safety of all City employees is a major concern of the City of Lincoln. The degree of safety is directly proportional to the effort put forth to control conditions, practices, and actions. To that end, PW&U has developed a Safety Program that includes a Safety Manual to assist in ensuring sound and consistent safety practices and safe work environments necessary for the protection of the health and welfare of all employees. This program also helps keep the City in compliance with local, federal, and state safety and health regulations. Information presented in this chapter focuses on jobsite safety and is derived from many sources such as City policies, regulations, and procedures, but relies considerably on the Safety Manual.

Safety on the jobsite and safe traffic control near the site must be maintained at all times. The Contractor has complete responsibility for safety precautions and safety programs at the site. The Inspector must consider his or her own safety first by showing caution and paying close attention heavy equipment movement and traffic on public roadways. The Inspector should be aware of the jobsite safety requirements for the Contractor and should notify the Contractor of apparent deficiencies regarding public safety (i.e. verifying the traffic control plan, American Disabilities Act – ADA access requirements, and safety fencing) and for the workers (i.e. shoring plans and personal protective equipment - PPE).

Lincoln requires all personnel on City construction projects to wear reflective/high visibility apparel as well as proper safety gear. The Contractor is responsible for ensuring all employees, subcontractors, utility crews, engineering personnel, flaggers, emergency responders and survey crews are in compliance.

Everyone at the construction site should “think safety” in order to have a safe jobsite. The Contractor shall ensure construction fencing, barricades, guards, light beacons, signage, and other City-approved devices are in place to warn and protect the public and pedestrians.

5.2 CITY OF LINCOLN PW&U SAFETY MANUAL

The PW&U Safety Manual is designed to be a comprehensive source of safety rules and regulations pertaining to PW&U activities and shall be provided and read by all Inspectors prior to visiting construction sites. Any questions should be directed to the PM and resolved prior to any site visits.

5.3 RESPONSIBILITIES

5.3.1 CONTRACTOR

Since the Contractor has the responsibility for directing the work on the construction site, the Contractor must provide a safe working environment and must ensure that the public is protected at all times— not just during working hours. The Contractor must comply with all applicable federal, state, and municipal safety laws and building codes to prevent injuries to people on or adjacent to, the area where the work is being performed. At each job site, the Contractor is required to identify a safety officer who is knowledgeable of safety rules and regulations, works to prevent injury, and is responsible for correcting unsafe conditions.

5.3.2 CITY ENGINEERING INSPECTOR

By being present on the job site, the Inspector should be aware of unsafe conditions, even though it is not the Inspector's direct responsibility. When the Inspector believes that an unsafe condition exists, the Contractor should be informed and the conversation documented in the Daily Activity Report. If possible, photographs should be taken and attached to the report. If unsafe practices persist, the Inspector should contact the PM to discuss specific corrective actions and/or general practices to improve safety at the site.

5.4 SAFETY ISSUES DURING CONSTRUCTION

5.4.1 General Issues

Open trench construction, jack and bore construction, and manhole or vault entry (confined space entry) are of particular concern with respect to safety. This chapter addresses these issues, but does not include every precaution that may be necessary. Refer to the PW&U Safety Manual for more specific safety precautions to ensure your personal safety when dealing with these high concern issues.

Examples of common construction site PPE

PPE is required by law for federally financed road projects. Currently, Federal Law refers to *Federal-aid highways*, which means highways on the Federal-aid highway systems and all other public roads not classified as local roads or rural minor collectors. Projects that improve or affect roadways should consider these requirements.

Contractors will be responsible for making sure all of their employees are in compliance with the all safety regulations regarding PPE at all times. With regard to subcontractors, contractors will exercise reasonable care to prevent and detect any violation by their subcontractors regarding PPE requirements. It is important to comply with those rules not only for protection of workers, but also to protect funding for future projects that might involve federal assistance.

A Material Safety Data Sheet (MSDS) should be available onsite from the Contractor for all chemicals that may be found onsite in pipelines, containers, or other vessels. These sheets should be posted in a prominent or easily accessible location.

5.4.2 Personal Safety

The Inspector is responsible for his or her own safety and must be alert, visible, and aware of construction activities at all times. The following should be observed:

- **Whereabouts** – Always notify your PM, Supervisor, or someone else when you are heading out to a job site and your anticipated return time. If going to a remote location, the Inspector should ensure they have a cell phone and notify others of his or her plans. It is best to have more than one person on very remote or potentially dangerous sites.
- **Personal Protective Equipment (PPE)** - The use of PPE such as hard hats, reinforced footwear, and hearing and eye protection is highly recommended and may be mandatory (Discuss with PM). The City has a zero tolerance policy for non-use of safety vests, so the Inspector must wear a brightly-colored, reflective safety vest at all times. This also sets a good example for the Contractor. For any line inspections, you should wear gloves, knee protection, and waterproof boots with running water. A waterproof flashlight should provide adequate lighting and keep out moisture when conducting inspections.

Inspectors must wear safety vests at all times when onsite

- **In and Near Traffic (public road or onsite)** - Always wear a brightly colored, reflective vest and face oncoming traffic as much as possible. When onsite, always stay visible and make the Contractor aware of you observation point particularly when there is equipment traffic. Never assume large equipment can see you.
- **Railroads** - When working near railroads, everyone including the Inspector should avoid the use of the color red (vests, clothing, red markers, flagging, and lights) since it signals “immediate danger” or “stop” to the train operator. If taking measurements across rail lines, caution must be exerted if using a metal tape to avoid contact and possibly electrocution.
- **Overhead Power Lines** - Tall equipment such as backhoes or long surveying rods can come into contact with overhead lines and should be a minimum of 10 feet from lines according to Nebraska and OSHA laws. There may also be shielding requirements to prevent electrical arcing. The Inspector should

stay clear of any construction that is in proximity of overhead lines.

- **Buried Utilities** – Prior to construction, the Contractor should have had all buried utilities marked by Nebraska One Call Service (Digger's Hotline – called minimum of 48 hours prior to construction). The Inspector should be aware of these markings and stay clear when there is excavation in and near marked areas. If digging within 18 inches of a live or pressurized line, the line should be exposed and protected before proceeding.
- **Contractor Equipment** – Never climb on or ride Contractor's equipment for any reason.
- **Vehicle** – Be prudent when parking or leaving your vehicle onsite or along a roadway. Be cautious when exiting and entering your vehicle and watch for traffic and equipment that may not see you. Never block traffic flow or park in front of intersections, gates, or construction entrances unless authorized to do so.
- **Cave-ins** – If you are about to be buried in a cave-in, yell for help, cover your face, refrain from struggling as it may embed you further, and wait calmly for assistance. If someone else is about to be buried, do not attempt to rescue them yourself and never enter the excavation. Notify others onsite and call for help. Have the Contractor shutdown all heavy equipment and move all other workers away from the cave-in. Let rescue workers help the victim.
- **Irate/Aggressive People** – If you feel uncomfortable about your safety remain calm, but cautious and follow these tips until you can call for assistance or leave the situation: 1) Do not allow person to grandstand in front of others 2) Listen to their complaints 3) Provide alternatives to the warfare 4) Do not allow the situation to escalate to verbal or physical abuse 5) Maintain eye contact 6) State opinions and directives forcefully 7) Maintain calm but firm voice 8) Use diversion such as asking person to sit down. If the situation starts to escalate, remove yourself from the situation and immediately contact your PM to determine what to do next. If physically threatened,

immediately get out of the situation and contact authorities. Do not provoke or taunt.

- **Running Water or Inlets/Outlets** – The Inspector should avoid any areas with swift running water (inlets, outlets, open channels) including times during heavy rains or melt runoff. Be very cautious of open bodies of water and running streams.
- **General Hazards** – The Inspector need to be aware of any site-specific hazards such as steep slopes, water bodies, dangerous/hazardous materials, poison ivy/oak, animals/wildlife, and many others. Check with your PM and the Contractor to determine these ahead of time.
- **Injuries** - Any injury should be reported to your PM and if there is a serious or critical injury call 9-1-1 and get help.

5.4.3 Pedestrian Safety/Americans with Disabilities Act (ADA)

Access for people with mobility or other physical limitations must be considered for all projects where pedestrians need access during or after construction. Detours, bike paths, sidewalks, and facilities used by the public can be affected or may become unsafe due to construction activity.

Projects that alter right-of-way (ROW) fall under federal requirements. An alteration is a change to a facility in the public right-of-way that affects or could affect access, circulation, or use. Projects altering the use of the public ROW must incorporate pedestrian access improvements within the scope of the project to meet the requirements of the ADA. These projects have the potential to affect the structure, grade, or use of the roadway. Alterations include items such as reconstruction, major rehabilitation, widening, and resurfacing.

Safety fence and barricades protect pedestrians

The Contractor has the responsibility to maintain access to any apartments, houses, or pedestrian accessible facilities

during construction. The Inspector should make sure this is completed and discuss any access concerns regarding permanent facilities with the PM.

5.4.4 Open Trench Construction

All open trench and trenchless construction used must have safe access. While monitoring pipe installation, the Inspector should pay particular attention to the total depth of the trench, the condition of the earth material exposed in the trench walls, and the use of shoring, sloping and benching, or ladders. If required to enter a trench for any reason, the Inspector must ensure that any trench more than five feet deep or eight feet long is properly shored. Ladders or others means of exit must be provided for trenches greater than four feet deep. Figure 5.1 illustrates pertinent open trench safety information.

In addition to Figure 5.1, the Inspector should be aware of the following safety issues:

- At minimum, hard hats, safety vests, and eye protection must be worn at all times when working in and near an open trench.
- If the trench is deeper than four feet or is an oxygen-deprived environment, atmosphere monitors must be used and proper respiration PPE or ventilation provided, when necessary.
- Trenches and excavations should not be left in an open, unprotected condition after working hours.
- Steel trench plates should be used to cover trenches in paved areas that cannot be backfilled before stopping work.
- When trench boxes are used, workers shall remain inside the trench box at all times.

Proper use of trench boxes

- Temporary fencing should be placed around excavations and trenches when the Contractor will not be present, including lunch breaks.

- If sloping and benching methods are used, soil classification must be accomplished to determine slopes. The Contractor must have a competent person on site that is trained in soil classification.
- Excavated materials should be placed a reasonable distance away from the edge of an excavated area to avoid collapse or cave-in.
- All water should be removed from a trench before any workers enter the trench.
- Care should be exercised to avoid trench collapse due to equipment vibrations too close to the trench.
- Machinery should never be operated directly overhead or on a slope above workers in a trench.

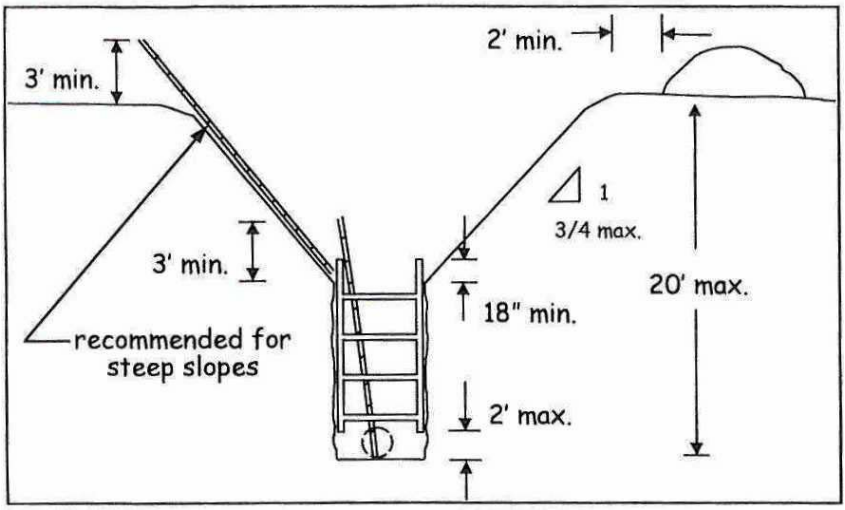


Figure 5.1. Trench Safety Diagram

5.4.5 Confined Spaces

Entering a manhole, whether during new construction or on an existing system, is considered to be confined space entry and may require a confined entry permit. The Inspector should not enter a confined space unless they have proper training, equipment, and permission. The proper safety precautions should be followed:

- Workers entering should be thoroughly trained in confined space entry.
- Per City policy, a Confined Space Entry Permit may be required before entering any confined space on a jobsite.
- Each worker entering should be properly equipped.
- Smoking is not allowed within 20 feet of the entrance to a live wastewater pipe connection.
- Atmospheric monitoring equipment should be utilized and sound an alarm when there is a lack of oxygen or if flammable gas or hydrogen sulfide exist.
- Removing manhole or vault covers requires special tools to prevent injury. To avoid explosions from trapped gases, blow torches or open flames should never be used to loosen a stuck or frozen cover.
- Fall protection is required when entering a manhole or vault greater than six feet deep.
- Open manholes or vaults require proper safety barricades and should never be left open when not attended. At the end of the day, all open confined spaces should be securely covered.

5.4.6 Tunnel Construction

Tunnel construction is considered to be confined space work, therefore, the precautions noted in Section 5.4.4 should be observed. The Inspector should make sure the additional following safety precautions are also followed during tunnel construction:

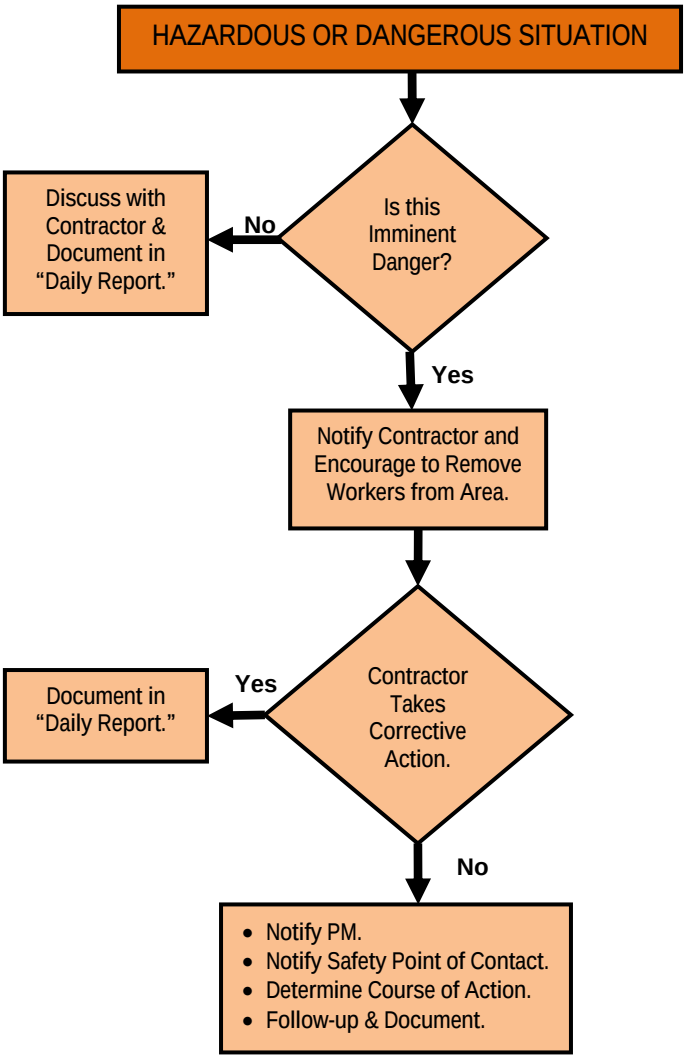
- Sturdy, well-secured ladders should be used to provide access into the shaft.
- The shaft should be fenced or otherwise protected with barriers to keep the public away from the excavation.
- The tunnel should be well-lit throughout its entire length.
- An adequate flow of safe, fresh air should be provided at the tunnel face.
- Workers should not smoke in or within 20 feet of the tunnel.

5.4.7 Imminent Danger

Imminent danger results when a threat of immediate physical harm exists for anyone on a site. When this situation arises, the Inspector should promptly notify the Contractor and contact the PM**.** It is best to work with the Contractor and assist in imminent

danger situations, since they will have a safety plan in place and have authority to immediately stop work. If the Contractor does not take corrective action or disagrees that there is imminent danger, the Inspector should stay clear of the area and ask the PM for direction. A procedure should be in place for the Inspector to handle these types of situations.

An example procedure for an imminent danger situation is shown below:



5.4.8 Hazardous Materials

The Inspector shall be aware of special precautions that are necessary for projects. These may include demolition, storage, or disposal of hazardous materials. Any spills that have the potential to impact water quality shall be reported to the Lincoln Lancaster County Health Department (LLCHD). Asbestos, PCB's, petroleum, lead based paint, hazardous waste, or radioactive material uncovered or revealed at the site not shown on the plans or identified in the Contract Documents shall be documented and the PM notified.

The Inspector should check that a proper survey of the hazardous materials has been performed and that these materials are stored, handled, and disposed of properly. Any questions about a hazardous material encountered on site should be directed to the PM.

Hazardous materials can pose safety issues if handled improperly

5.5 TRAFFIC CONTROL

As outlined in the Contract Documents, the Contractor is required to provide adequate traffic control which may include signs, barricades, lights, flaggers with vests, and other City-approved devices. In addition, the contract documents may require special traffic control requirements. Street closures require weekly notification to the PM. This is particularly important when significant street rehab projects are planned or underway as the street planned for closure could be a detour route for another roadway.

Traffic control is important for good flow and safety

5.5.1 Pre-Construction

Before construction, the Inspector should review all items concerning traffic control for the project. A Traffic Control Plan

(TCP) should be submitted by the Contractor's Traffic Control Supervisor (TCS) to the PM so that it can be reviewed and approved at least 1 week prior to construction. The Inspector should obtain a copy of the approved plan. Prior to working in any public street or right-of-way, the Contractor is required to notify all appropriate government agencies. Signs should be covered until the message on the sign is applicable.

5.5.2 During Construction

On some projects, the Contractor may be required to notify the local fire department, police, EMS, and schools of roadway construction. The Inspector should get a copy of this notice. On PCA projects, the Inspector should remind the Contractor to notify these agencies of construction in public right-of-way. The Contractor shall make sure the signs and other traffic control devices accurately notify drivers and pedestrians of the conditions. The signs and other devices should be clean, in good working condition, and installed correctly.

5.5.3 Post-Construction

After construction is completed where traffic control is required, the Inspector should ensure that any traffic control devices are removed and traffic flow is restored. Some traffic control devices may be required for phases of the construction project and should be removed when no longer necessary rather than leaving in place for the duration of the entire project.

CHAPTER 6: OPEN TRENCH CONSTRUCTION

6.1 OVERVIEW

Most underground utilities are constructed within open trenches. This chapter discusses the proper installation, construction testing methods, and pipe foundation and backfilling for water mains, wastewater, force mains, and stormwater installed in open trenches.

6.2 SITE PREPARATION

The amount and type of site preparation work varies with the locations of the project, surrounding topography, and existing utilities. This phase of the project is generally more complicated in developed areas. Site preparation usually includes:

- Marking existing underground utilities.
- Creating and executing a Stormwater Prevention Pollution Plan (SWPPP).
- Protecting, pruning, or removing trees and shrubs located in construction limits (clearing and grubbing).
- Installing systems to handle/divert surface drainage.
- Saw cutting pavement and sidewalks.
- Implementing a traffic control plan.
- Constructing access roads.

6.2.1 Marking Existing Underground Utilities

Underground utility markings

It is the Contractor's responsibility to contact the Nebraska Diggers Hotline (One Call) at 1-800-331-5666 to request the marking of underground utilities at least 48 hours before excavating. The Inspector should look for stakes, flags, or paint markings that denote underground utilities. If they are not present in an area where the Contractor is beginning to excavate, the Inspector should ask the Contractor whether all utility companies have been notified. Underground

utilities are typically marked according to the following color codes:

Utility	Color Code
Electrical	Red
Gas/Steam	Yellow
Telecommunications	Orange
Water	Blue
Wastewater, stormwater	Green

6.2.2 Stormwater Prevention Pollution Plan (SWPPP)

Initial components of the SWPPP must be in place prior to any site work. The Inspector should verify that the Contractor has installed all components (controls) according to the plan. For more information, see Chapter 10.

6.2.3 Clearing and Grubbing

Damage to trees should be avoided whenever possible, particularly when a tree is marked on the plans as "Do Not Disturb (DND)." The Inspector should meet on site with the Contractor prior to construction to discuss clearing and grubbing. The Inspector should monitor the Contractor's treatment of trees that must be trimmed or that are damaged. For more information, see Chapter 10.

Clearing and grubbing activity

6.2.4 Surface Drainage

Surface water should be diverted away from open trenches for the following reasons:

- Excess water in a trench can cause a cave-in from the additional load and reduced soil strength.
- Trench bottom can soften and contribute to excessive settlement of the installed pipeline.
- A muddy work environment is created.

- Water standing in the trench can float a pipe that is not backfilled.
- Contractor should be encouraged to backfill before leaving the job site if rain is likely. This will prevent damage to the trench.
- Standing trench water can contribute to contamination of a water main.

6.2.5 Saw Cutting Pavement and Sidewalks

When utilities are to be installed beneath pavement or sidewalks, the surfaces must be cut with a pavement saw. The Inspector should verify that the cuts:

- Are straight.
- Completely penetrate the pavement or sidewalk.
- Are 12 inches back from the top of the trench. The Inspector may need to consult with the PM if saw cutting is near an existing joint.

Depending on the location, several types of saw cutting can be used: Types A, B, C, D or wheel sawing.

Type A relates to asphaltic concrete. Pavement to be removed shall be isolated from the pavement to remain by cutting a joint with a wheel saw, through the full depth of the pavement. After the pavement base has been replaced, a 4 inch wide strip of the asphaltic concrete surface course shall be sawed and removed to provide a straight, smooth edge where the new asphaltic surfacing adjoins the existing surfacing.

Type B relates to PCC pavement. PCC pavement to be removed shall be isolated from the paving to remain by cutting a full depth saw cut, using either a wheel saw or diamond blade. If a wheel saw is used, additional sawing shall be required to provide smooth, straight and true vertical faces.

Type C relates to PCC pavement for driveways and sidewalks. Pavement to be removed from concrete base shall be sawed and removed to pride a straight, smooth edge where the new asphaltic surfacing will adjoin the existing.

Type D relates to asphaltic concrete surface course. Asphaltic concrete surface course to be removed from concrete base shall be

sawed and removed to provide a straight, smooth edge where the new asphaltic surfacing will adjoin the existing.

Wheel sawing relates pavement in general. Pavement to be removed shall be isolated from the pavement to remain by cutting a joint with a wheel saw, through the full depth of the pavement.

6.2.6 Traffic Control Plan (TCP)

The Contractor shall maintain traffic during construction and provide, install, maintain and remove all traffic control devices. It is the Contractor's responsibility to submit a traffic control plan (TCP) one week prior to construction. The Inspector should verify the following:

- All signing, barricades, barrels, cones, safety fences, and dynamic message boards are in installed.
- Lane closures and detour routes are properly marked and displayed.

6.2.7 Access Roads

When work on the project is within public right-of-way (ROW) or easements, access roads or construction entrances may need to be installed. Use of the ROW or easement should be minimized to carry out the work. The Inspector should periodically verify that the Contractor maintains prudent use of the easement or ROW. If access roads or detours need corrective action or maintenance, the Contractor should be notified and concerns addressed as needed.

6.3 EXCAVATION

6.3.1 Trench Dimensions

In open trench construction, the most important excavation limits are the trench width and depth. The term "trench width" refers to the width of the trench as measured at the top of the pipe. Figure 6.1 below shows the common terminology associated with open trenches and the backfill

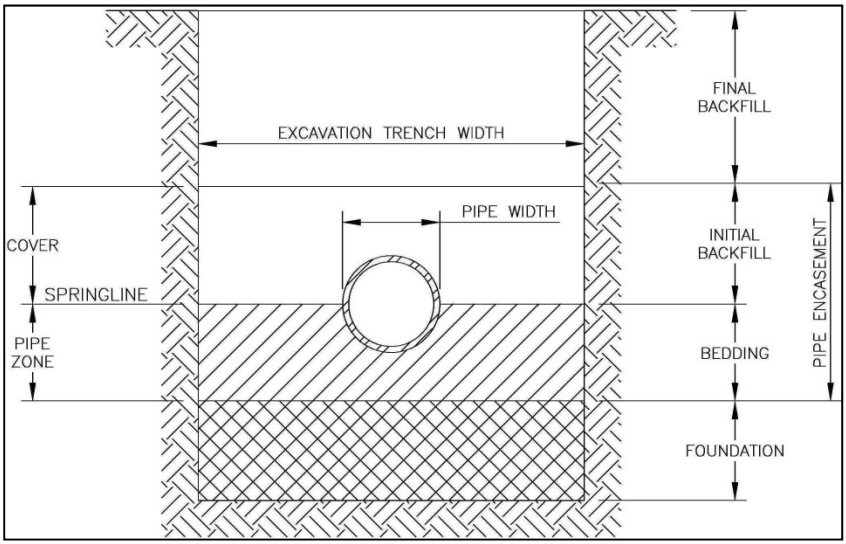


Figure 6.1. Common terminology of open trenches

In no case shall the excavation be less than 2 feet greater than the outside diameter of the pipe. The width of excavation for utility lines 6 inches or greater shall be a minimum of 3 feet. Excessive trench width or depth can increase the load on the pipe and may cause the pipe to deflect.

Since trench support systems can be costly, many Contractors prefer sloping or benching the sides of the trench, or a combination of sloping and benching with a shoring box in a deep excavation. If sloping or benching is used, the maximum trench width should be maintained to a height above the pipe required for proper bedding material placement. The maximum slopes allowed for sloping or benching, as determined by the soil evaluation completed by the Contractor's onsite competent person, are shown in the following table:

Soil Type	**Max slope allowed**
Stiff clay soils (Class A)	¾:1
Silty soils (Class B)	1:1
Sandy soils (Class C)	1 ½:1

6.3.2 Excavated Material

The Inspector should monitor the placement of excavated material, checking for the following:

- SWPPP Best Management Practices (BMPs) should be in place prior to excavation.
- Stockpiles should be placed a minimum of 2 feet from the edge of the trench to prevent caving of the trench wall and to permit safe access along the trench.
- Stockpiles should be covered with temporary plastic or seeded if construction is halted for longer than 14 days.
- Excavated material should not obstruct sidewalks or driveways for extended periods unless alternative access is provided for in the contract documents. Hydrants under pressure, valves boxes, curb-stop boxes, or other utility control shall remain unobstructed and accessible.

Surplus excavated material should be hauled off site as soon as it is excavated in order to prevent excessive erosion and siltation as approved by the Engineer or Project Manager (PM). In some areas, the Contractor is required to provide a permit regarding the offsite disposal location. A copy should be provided to the Inspector so that he or she will know that the excess material is being handled properly. The Inspector should immediately notify the Contractor and PM if no documentation is provided.

The Inspector should monitor excavated material that will be used for backfill. The material should:

- Be free of frozen soil, organics, highly plastic clay, or other unsuitable materials.
- Contain no stones larger than 4 inches in diameter, large clods, frozen earth, trash, or debris of any kind.
- Be suitable for densification or compaction.
- Meet the specifications.

If the Inspector is unsure about the suitability of a soil for trench backfill, the PM should be contacted.

6.3.3 Trench Support Systems

Trench support systems (sheeting and bracing, trench boxes, etc.) must be able to prevent cave-in of the trench walls or settling of areas adjacent to the trench. The Contractor is responsible for the structural adequacy of any required system. The contract documents may require an excavation support plan to be designed by a licensed professional engineer. Regardless of the method used to stabilize trench walls, the Contractor should periodically inspect trench walls especially after every rain event to determine if additional protection is needed.

6.3.3.1 Trench Box

A trench box consists of a rigid prefabricated steel unit. The box shall extend a maximum of 2 feet above the bottom of the excavation to a minimum of 18 inches above the trench. The box is typically pulled ahead as the pipe is installed inside, and continued until the box is either no longer needed, or piping is finished. This system is useful in loose granular or soft cohesive soils where the excavation depth does not exceed 20 feet. Special boxes have been used successfully to depths of 30 feet.

Example of a trench box

6.3.3.2 Sheeting and Bracing

Sheeting and bracing may consist of steel sheeting, timber shoring and bracing, or steel sheeting with timber or steel walers and struts. In relatively narrow trenches, trench jacks are often used to hold the sheeting in place. All structural components of these systems should safely withstand water pressure and lateral earth pressure. Typical steel sheeting segments have a nominal covering width of 18 inches and are supplied in standard lengths from 6 to 20 feet (in 2 foot multiples). The edges of each segment have an interlock that provides a joint to keep soil and water behind the sheeting wall.

Sheeting may be typically installed either by driving it with hammers or by pushing it into place in trenches with equipment. A hand maul or an air hammer is generally sufficient for pushing sheeting in a trench where the bottom can be excavated ahead of driving, and earth loads on the sheeting are minimal. When the sheeting is to be driven before excavation, or when the earth loads on the sheeting are large, equipment such as a drop hammer, vibratory hammer, or a pile driver should be used. The driving equipment must be capable of supplying enough energy to move the sheeting easily. A driver that strikes a heavy blow at low velocity will do the most work with the least damage to the sheeting.

6.3.3.3 Dewatering

Sometimes a well-point or a deep well dewatering system may be necessary to lower the groundwater level near the trench. Any dewatering requires a permit from the Nebraska Department of Natural Resources. This method should be avoided when buildings are near the work area since lowering the groundwater level may cause settling in the surrounding area. The Inspector should ensure that any sediment laden water is not pumped into the storm drain system.

6.3.4 Safety

All necessary bracing and sheeting must be provided to maintain a safe trench condition in unstable soils. The Contractor has the responsibility for complying with all OSHA requirements. The Inspector should confirm that the setback of excavated soil material is adequate to prevent surcharging the trench wall and be cautious near excess moisture or wet soil conditions near trench walls. See Chapter 5 for more information.

6.3.5 Sequence

Excavation, pipe installation, and backfill operations should follow in sequence as closely as possible. No more than 100 feet of trench shall be open unless directed by the PM. Avoiding long stretches of open trench will:

- Maintain good relations with property owners and the public.

- Reduce the potential for trench flooding and displacement of installed pipe.
- Reduce the need to control groundwater and surface runoff over a long distance at any one time.
- Reduce erosion and siltation.

6.3.6 Equipment

The Contractor shall select the method and type of equipment to be used for excavation. The selection of equipment takes into account the type of material being excavated, the depth of the excavation, and the amount of space available. Different types of equipment have limitations in regard to minimum trench widths, maximum depths, and casting capabilities.

Typical construction equipment

The Inspector should be aware that the equipment used by the Contractor is in good working order. Signals to look for include:

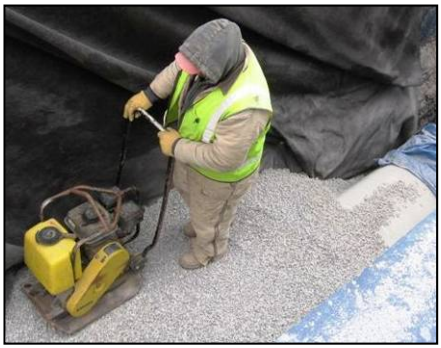
- Leaking hydraulic fluid, diesel oil, and gasoline, which can damage pavement, driveways, and environment.
- Engine noise loud enough to disturb local residents.
- Lack of backup alarm on any equipment.

If any of the above symptoms are noticed, the Inspector should inform the Contractor and note the item in the Daily Activity Report.

6.4 PIPE INSTALLATION

6.4.1 Pipe Foundation

The Inspector should check for suitable subgrade conditions before the pipe bedding material is placed. Foundation materials generally will be required where



Compaction of bedding material

unstable soil conditions exist at the bottom of the trench. The subgrade is generally too soft to support normal pipe installation if workers are sinking into the bottom of the trench. Typically, a soft subgrade can be adequately stabilized by undercutting the trench bottom an additional 6 inches to 2 feet and backfilling with foundation material. Foundation material consists of crushed stone or crushed concrete and may vary in size. Some cases may require special treatment for extremely poor foundation conditions. Geo-textile fabric along with 4 to 9 inch diameter rock may be required for additional support in extreme wet areas. When geo-textile fabric is used, it must be wrapped fully around the pipe bedding material and pipe and overlap per manufacturer's recommendations. In any situation where special treatment is required, the Inspector should consult with the PM. For utilities that cross ditches or streams, steel sheeting and concrete embedment may be required.

6.4.2 Pipe Bedding

Correct preparation of the trench is essential for a satisfactory utility pipe installation. Materials used for pipe bedding material in open trench projects typically consist of well graded crushed rock or crushed concrete. The bedding material shall be well-graded coarse aggregate and should generally be free from sharp, sliver-shaped pieces. The majority of the bedding material is typically between 1 inch and 1/4 inch, unless otherwise designated in the plans and specifications. All bedding material shall be placed in 6-inch lifts and thoroughly settled by mechanical compaction to fill all voids below, around, and above the top of the pipe.

Pipe bedding consists of several components. Figure 6.2 shows LSP 185 pipe bedding detail for a PVC water pipe including geo-textile. All PVC pipe is generally encased in bedding material. This includes 4 inches below, a minimum of 1 foot wide on both sides, and covering at least 6 inches above the pipe. DIP and RCP pipe, 15 inches diameter and greater, require 4 inches below and a minimum of 1 foot wide on each side going up to the spring line of the pipe. The spring line refers to the maximum horizontal dimension, or middle of a

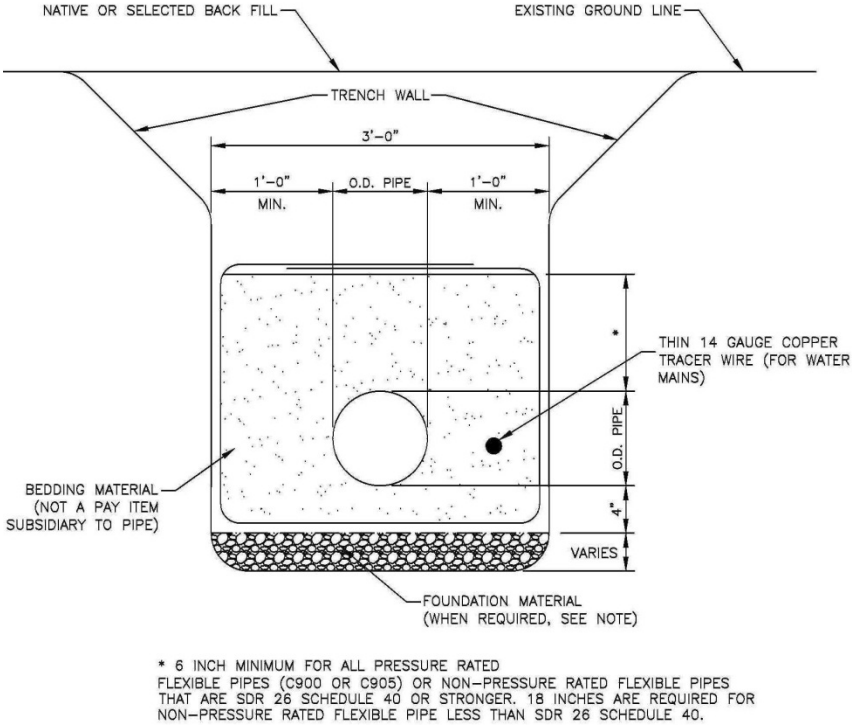


Figure 6.2. LSP 185 PVC bedding material detail

circular pipe. In all cases, the bedding material should be placed across the entire width of the trench. The Inspector should periodically verify that the Contractor is providing enough granular cover above the pipe. Placement of the bedding material should proceed as follows:

1. The bedding material is placed in the trench and graded until a relatively uniform surface is achieved on a straight grade paralleling that required for the utility.
2. The pipe segment is then placed in the trench, jointed, and the final grade position of the bell or groove end is checked.
3. Bedding material is added or removed from beneath the pipe to provide uniform support at final grade without any bends or bowing in the pipe. The Inspector should ensure that the Contractor excavates the bedding material beneath the bell end so that the pipe is uniformly supported throughout its length.

4. After the pipe has been laid and properly bedded, additional bedding material is added to the trench and graded into final position up to the spring line.
5. If encasement is required, bedding material is added above the pipe and graded until it is at the required uniform thickness above the pipe.

Concrete encasement of the pipe may be required for ditch or stream crossings. The concrete encasement should be constructed at least 2 feet beyond the horizontal limits of the point where pipe protection is required. Encasement items may include ties, anchor bolts, inserts, brick, pipe sleeves, conduits, and conduit fittings. The Inspector should ensure that:

Preparing concrete encasement for stream crossing

- Encased items should be fixed and held in position.
- In-place fixtures should not affect the positions of steel reinforcement except as shown on the plans.
- Form ties and spreaders should be removed to a minimum depth of 1 inch from the face of the finished concrete.
- Holes left in the concrete from removing ties and spreaders should be cleaned and filled with mortar consisting of one part cement and two parts sand.

Concrete encasement is typically placed if:

- Additional pipe protection is required (stream crossings, ditch crossings, or poor soil conditions).
- Utility pipe has less than the required clearance between it and another utility conduit.
- The required separation from a water line is not maintained.
- There is less than the required amount of cover in a public ROW or easement.

For more information on stream crossings, see LSP 220.

6.4.3 Polyvinyl Chloride (PVC) Pipe

6.4.3.1 General Information

Stockpile of PVC pipe

Polyvinyl Chloride or PVC pipe is typically used for water, gravity wastewater, and force mains. PVC pipe is available in various pressure classes and wall thicknesses. PVC pipe can be installed using push-on joints, but some fittings require mechanical joints. The Inspector should examine all pipes delivered to the site. Examination of PVC pipe should include the following:

- The stenciled markings for the ASTM or AWWA number, SDR, Schedule, or pressure class should match that indicated in the contract documents. If technical data is not stenciled on, the Contractor should be asked to supply a certificate of compliance for all pipe delivered to the site.
- All PVC pipe should be free from cracks and other defects throughout the pipe lengths and in the bells.
- Any gouges or scratches that extend 10% or more into the pipe wall shall justify rejection of that pipe.
- All rejected pipe should be marked and removed from the site.
- Bell ends and integrated gaskets should be free from deformations.
- Water main and force mains are typically installed using PVC pressure class rated C900 pipe.
- Damage to PVC pipe is more likely to occur during the winter, when cold weather makes the plastic less flexible.

6.4.3.2 Installation

Installation of PVC pipe

All PVC pipe should be handled carefully with padded slings or pipe tongs so that they are not damaged in loading and unloading. Under no circumstances shall PVC pipe be dropped. Stored materials must be protected from damage and kept free from mud, dirt and stormwater at all times. PVC pipe should not be exposed to excessive heat sources or hot objects. Gaskets that are provided separately must be stored in a cool location and must not come in contact with petroleum products or solvents that could damage the gaskets. Special care shall be given to gaskets to prevent damage from UV exposure during long-term storage. Accessories used for mechanical joints should be properly stored and handled. Pipes should not be stacked higher than recommended by the Manufacturer.

PVC pipe should be lowered into the trench in such a manner to prevent damage to the pipe coating or lining. PVC pipe should not be dumped or dropped into the trench. All pipes should be examined for damage and defects immediately before installation. Defective materials should be marked and removed from the project site. The Contractor may use the undamaged portion of a pipe by cutting off the damaged section. Generally, all PVC pipe, whether for water mains, gravity wastewater, or force mains require bedding to encase the pipe. For more information on bedding, see Section 6.4.2 and refer to LSP 185.

Pipe should be laid with the bell ends of the pipe pointing upstream for gravity lines, and is typically laid in the direction of progress. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to required line and grade. The pipe and joint shall be uniformly supported and secured in place with the specified embedment material.

PVC pipe can be field cut to fit conditions. All cuts must be square and must have the ends of the pipe beveled to approximate the Manufacturer's finish. Any rough or jagged edges that could nick or cut gaskets must be reworked before jointing. During laying operations, no debris, hand tools, clothing or other materials shall be placed in the pipe. Pipe shall be kept clean during and after laying. When laying operations are interrupted or terminated at the end of a day, pipe ends shall be sealed temporarily to prevent the entry of water, debris, small animals, and similar types of contamination. Precautions shall be taken to prevent flotation of the sealed pipe during work stoppages. When groundwater is present, a watertight seal shall be temporarily placed in the leading end of each pipe section during installation to minimized infiltration. When connecting to an active wastewater manhole, the Contractor should install a mechanical plug in the new wastewater pipe to prevent stormwater flow into and wastewater flow out of the existing pipe.

6.4.3.3 Joints

PVC push-on joints are sealed using elastomeric gaskets. These gaskets may be supplied separately in cartons, or they may be installed into the pipe bell at the plant. If supplied separately, the gaskets must be seated as recommended by the Manufacturer. In all cases, the Contractor should clean the gasket, bell, or coupling interior, and the spigot area using a dry cloth, brush, or paper towel to remove any dirt or foreign material. Lubricant should be applied to the spigot end of the pipe and the gasket as recommended by the Manufacturer. This is commonly referred to as "soaping the pipe." Since some lubricants may cause bacterial growth and damage the gaskets or the pipe, the Contractor should use a lubricant recommended by the pipe Manufacturer. Application of a non-approved lubricant or too much lubricant can result in a pipeline that is difficult to disinfect and cause a temporary taste and odor problems. The lubricant container should be kept covered while in the trench to prevent contamination of the lubricant.

The spigot end of the pipe should be inserted into the bell and pushed into the "home" position. This position is a reference mark

on the spigot end to verify the pipe is flush with the end of the bell. This reference mark should be visible after insertion to confirm proper insertion. The pipe should not be pushed past this reference mark since this may produce a leaking joint.

Mechanical joints require the spigot to be centrally located in the bell. PVC-to-iron fittings must have the factory bevel removed or shortened to ensure that when assembled, the gasket will be in full contact with the non-beveled portion of the pipe outside diameter. The surface that the gasket comes in contact with must be thoroughly cleaned just prior to assembly. The clean surface should be brushed with a Manufacturer recommended lubricant and the gasket slipped into the bell. The lubricant must also be applied to the gasket prior to installation to clean it and to lubricate the gasket as it is forced into its retaining space. Gaskets for mechanical joints must be placed correctly in order to prevent leaks. Bolts in a mechanical joint should be brought up evenly around the pipe to maintain approximately the same distance between the gland and the face of the flange at all points when tightening. The bolts should generally be tightened in the following order: bottom bolt, top bolt, bolts at either side, and all remaining bolts. This process should be repeated until bolts are tightened with the proper amount of torque recommended by the Manufacturer.

6.4.3.4 Tracer Wire

All PVC pipe or other non-metallic water mains shall be installed with a tracer wire attached. This wire shall be 12-gauge AWG-THNN solid copper with an insulation thickness of 0.030 inches and used in minimum 500 foot rolls. It shall be installed with as few splices as possible. Any splices constructed shall utilize end to end 3M DBR connectors, sealed with silicone sealant, aqua seal or equal, and covered with Scotch #33 electrical tape. It shall be installed with as few splices as possible. The two ends of the wire shall be knotted to prevent strain on the splice, and no bare wire shall be exposed. Branch connections shall be made without cutting the main wire utilizing a connection clip and sealing the joint the same as splices.

This tracer wire shall be attached directly to the top of the pipe between the 10 o'clock and 2 o'clock positions. Attachment should be with small tape patches every 5 feet. Wire should be secured so that some slack can be taken out of the wire for valve and tap installations.

Tracer wire shall be terminated in hydrant branch valve box except when the branch is greater than 10 feet in length. Tracer wire shall be attached to the outside of the box and inserted through a ½ inch hole 8 inches from the top. A coil of excess wire at least 18 inches in length shall be used.

When the branch is less than 10 feet in length, the tracer wire shall be terminated in a Valvco Termination Box (or equal) and placed adjacent to the street side of the hydrant. A coil of excess wire at least 18 inches in length shall be used. Wires shall be attached to the termination screws. Wire shall be attached to the barrel with tape.

All tracer wire shall be tested by the Contractor for continuity after backfilling with a wire continuity tracing device. 1 inch of insulation shall be stripped at the access loops for contact with tracing equipment. All wires failing to provide positive continuity for signal transmission shall be repaired or replaced. After testing, all tracer wires shall be sealed with heat shrink tape.

6.4.4 Reinforced Concrete Pipe (RCP)

6.4.4.1 General Information

Reinforced Concrete Pipe, or RCP, is widely used for stormwater. RCP can be used for gravity wastewater, but is lined with PVC. Normally, circular pipe with tongue and grove joints are specified, however, elliptical RCP can be used. RCP has five strength classifications. All five classifications refer to the strength of concrete and amount of reinforcement used to cast the pipe. The most commonly used class is Class III. RCP pipes are typically installed using push-on joints with rubber gaskets.

The Inspector should examine all pipes delivered to the site. Examination of RCP should include the following:

Stockpile of RCP pipe

- If the RCP has stenciled markings, the Inspector should note the manufacture date and class of pipe. If technical data is not stenciled on RCP segments, the Contractor should be asked to supply a certificate of compliance for all pipe delivered to the site.
- RCP should be free from damage from transport, cracks, factory defects and other surface imperfections. Each pipe segment should be examined with specific emphasis on the tongue and bell ends. Any cracked or defective pipe must be identified and removed from the site. Repairs should not be made onsite. The Inspector should notify the PM if any pipe has been noticeably repaired from the factory.
- If elliptical RCP is used, the Inspector must look for special markings designating the method of reinforcement. The reinforcement will dictate the orientation of the in-place pipe.
- RCP with a PVC liner should be installed per the Manufacturer's recommendations.

Occasionally, the pipe manufacturer may be required to perform a Three Edge Bearing Test to verify the D-load and ultimate strength of the RCP. This test may also be required if the Contractor desires to use RCP less than 7 days after manufacturing. The A copy of the test results should be provided to the Inspector from the Contractor.

6.4.4.2 Installation

All RCP can be handled with typical construction equipment. However, the pipe must be handled carefully to prevent collision

with other pipe segments or fittings to prevent chipping and spalling especially on joint surfaces. Stormwater pipe is usually supplied with a lifting hole near the center of the length. A simple threaded bar with bearing plate and nut can be inserted in the lifting hole to handle the pipe without slings. Pipes should not be stacked higher than recommended by the Manufacturer.

All pipe should be examined for damage and defects immediately before installation. Defective materials should be marked and removed from the project site. Pipe laying should proceed with the bell of the pipe pointing upstream. Care should be taken in assembling and jointing the pipe to ensure leak-proof fits. Generally, all RCP, whether for water or gravity wastewater, requires the bedding to be installed up to the springline of the pipe. For more information on bedding, see Section 6.4.2 and refer to LSP 185.

Any cuts that are made in the field are typically for inlets or manholes, where concrete is usually poured around the cut end for additional support. Foreign material should be kept out of the pipe at all times. The pipe must be free of tools, rags, dirt, mud, or other materials that could enter the pipe. The Contractor should plug the open ends of all pipes if laying is stopped for any reason (if installed for wastewater). When connecting to an active wastewater pipe, the Contractor should install a mechanical plug in the new wastewater pipe to prevent stormwater flow into and wastewater flow out of the existing pipe.

6.4.4.3 Joints

Joints for wastewater and stormwater require the use of round, O-ring-type neoprene or other synthetic rubber gaskets. O-ring gaskets should be fitted into the groove on the tongue or spigot end of the pipe. A screwdriver, or similar type instrument, should be inserted under the gasket and run around the pipe several times to equalize the stretch in the gasket. The gasket should be well-lubricated with a lubricant recommended by the Manufacturer.

6.4.5 Ductile Iron Pipe (DIP)

6.4.5.1 General Information

Ductile Iron Pipe, or DIP, is used mostly for water projects. DIP is also commonly used for encasement in ditch or stream crossings as well as horizontal bores. DIP comes in many sizes and thickness. AWWA standards document the installation, handling and storage of many DIP materials, fitting and appurtenances, and are available on the internet. DIP can be installed using push-on joints as well as mechanical joints. The Inspector should examine all pipe delivered to the site. Examination of DIP should include the following:

- If the DIP has stenciled markings, the Inspector should note the Manufacturer information. If technical data is not stenciled on DIP segments, the Contractor should be asked to supply a certificate of compliance for all pipe delivered to the site.
- DIP should be free from cracks, bends and surface defects.

6.4.5.2 Installation

All DIP should be handled carefully so that they are not damaged in loading and unloading. Stored materials must be protected from damage and kept free from mud, dirt, and stormwater at all times. Pipe should not be stacked higher than allowed in Table 6.1:

Pipe Size (inches)	Maximum Number of Tiers
6	13
8	11
12	9
16	7
24	5
30	4
36	4

Table 6.1. Maximum stacking heights for DIP

All pipes should be examined for damage and defects immediately before installation. Defective materials should be marked and removed from the project site. Pipe laying should proceed with the bell or groove ends of the pipe pointing upstream, however this is not necessary for pressure pipes. Generally, all

DIP requires the bedding to be installed up to the spring line of the pipe. For more information on bedding, see Section 6.4.2 and refer to LSP 185.

6.4.5.3 Joints

Water pipe is typically installed with push-on joints. DIP push-on joint gaskets are typically provided in a bag so that the Contractor must install them as specifically approved for potable water service (NSF certified). A joint lubricant provided by the Manufacturer is required for DIP jointing. Restrained joints are utilized for special applications including hydrant setting and for pipe placed in bores or in stream crossings where a thrust restraint is required. Push-on joints for DIP are similar to PVC. For more information on joints, see Section 6.4.3.3.

DIP can be field cut to fit conditions. The Contractor shall cut the pipe using an abrasive wheel, milling type cutter, or other approved mechanical cutter. Torch cutting shall be used only with specific permission of the PM and then only in strict conformance with the Manufacture's recommendations. All cuts must be square and the Contractor shall bevel the ends of the pipe to approximate the manufactured bevel. Pipe which is not cut square or which has rough and jagged edges that might nick or cut gaskets shall be reworked. Foreign material should be kept out of the pipe at all times. The pipe must be free of tools, rags, dirt, mud, or other materials that could contaminate the pipe. The Contractor should plug the open ends of all pipes if laying is stopped for any reason (if installed for water or wastewater).

6.4.5.4 Polyethylene (Polywrap) Encasement for DIP

Polyethylene, or polywrap, is applied as an encasement to the metallic pipe and fittings to prevent exterior corrosion when the pipe is installed in corrosive soils. The Inspector should check to ensure all polywrap is Class C, black pigmented, 8 mils thick and has linear low density. All DIP and all metallic connections and fittings must be double wrapped with polywrap encasement and sealed.

When PVC or other non-metallic pipe is used, only the metallic fittings and appurtenances need to be wrapped. The material is usually provided in tube form. However, sheet materials are available, when required. The polywrap must be installed to prevent contact between backfill and bedding but is not intended to be airtight or watertight. Overlaps between pieces of material must be sealed with tape which holds the polywrap in place until backfilling is completed. It is essential that there are no tears or openings in the material that expose the pipe to soil. These "tears" or "holes" in the polyethylene encasement become points of concentration for corrosion of the pipe and will accelerate the rate of corrosion resulting in early failure of the pipe. Tape used to repair or patch the encasement shall be manufactured from synthetic materials. Duct tape shall not be used.

Concentrated failure of DIP

Polywrap is typically installed by one of two AWWA/ANSI specific methods referred to as Method A or Method B:

Method A

- Cut a polywrap tube about 2 feet longer than the pipe and slip over the pipe segment.
- Bunch the material in accordion fashion until it clears the pipe ends.
- Lay pipe in trench and assemble the joint.
- Pull back the ends of the polywrap over the proceeding pipe and tape into place. The loose end of the polywrap from the preceding length of pipe must be pulled over the joint and secured in place before completing the new segment of pipe.

Method B

- Cut a polywrap tube one-foot shorter than the pipe barrel.
- Slip tube over the pipe prior to laying into trench.
- Cut another 3 foot segment of polywrap.
- Lay pipe in trench and assemble the joint.
- Pull this 3 foot segment up to overlap the joint and tape securely to each segment of pipe.

Any rips, punctures, or other damage to the polywrap must be repaired with adhesive tape and pieces of polywrap taped to the original wrap before backfilling. This procedure is repeated twice throughout the length of the project to meet the double wrap requirement.

Proper installation of polywrap on hydrant

Backfill of polywrap encased pipe must be completed with care to prevent damage to the wrap. The Inspector must ensure that the initial backfill material does not contain any cinders, rocks, sharp stones, or other material that could damage the polywrap. The Inspector must also ensure that bedding material and backfill is not dropped onto the polywrap encased pipe from heights that may puncture the polywrap. A chute or other means shall be used for large drops.

6.4.6 High-Density Polyethylene (HDPE) Pipe

6.4.6.1 General information

High-Density Polyethylene Pipe, or HDPE pipe, is limited to special stormwater applications, such as temporary drainage, rain gardens or private stormwater jobs. HDPE pipe is also used for special circumstances in wastewater applications.

The Inspector should examine all pipe when delivered to the site. Examination of HDPE pipe should include the following:

- The stenciled markings for the ASTM or other pipe properties should meet the requirements of the plans and City specifications.
- All HDPE pipe should be free from cracks and other defects throughout the pipe.
- Bell ends and integrated gaskets should be free from deformations.
- Damage to HDPE pipe is more likely to occur during the winter when cold weather makes the plastic less flexible.

Stockpile of HDPE pipe

6.4.6.2 Installation

All HDPE pipe should be handled carefully with padded slings or pipe tongs so that they are not damaged in loading and unloading. Stored materials must be protected from damage and kept free from mud, dirt and stormwater at all times. HDPE pipe should not be stored outside subject to UV light for extended periods. HDPE pipe should be stored per the Manufacturer's recommendations. Pipes should not be stacked higher than recommended by the Manufacturer. Installation of HDPE pipe is similar to that of PVC pipe. For more information, see Section 6.4.3.2.

6.4.6.3 Joints

HDPE pipes are typically installed using push-on joints sealed using elastomeric gaskets, much like the ones used for PVC pipe. For more information on joints, see Section 6.4.3.3.

6.4.7 Other Materials

Other materials such as Pre-Stressed Concrete Cylinder Pipe (PCCP), Vitrified Clay Pipe (VCP), steel reinforced HDPE, Corrugated Metal Pipe (CMP), and Centrifugally Cast Fiberglass Mortar Pipe (CCFMP) can be used in certain situations. These pipe materials shall be unloaded and installed according to the

Manufacturer. These materials must have the correct joints according to the plans and Manufacturer.

6.5 BACKFILL

Backfilling refers to filling the open trench above the bedding material to the pavement subgrade level or to the final ground level. The Inspector should see that the backfilling begins as soon as possible after installation of the utility. Backfilling shall not be completed in freezing weather except by permission of the PM.

6.5.1 Materials

Open trenches are normally backfilled using selected materials that have been removed during trench excavation or approved borrow material. The Inspector should ensure that the initial backfill contains no stones larger than 4 inches in diameter, large clods, frozen earth, or debris of any kind. The Contractor may encounter old miscellaneous building materials, old pipe or chunks of concrete. The Contractor is required to bring in material that is free of debris. The Inspector should contact the PM if this instance occurs.

6.5.2 Flowable Fill

Flowable fill is essentially identical to standard concrete mixes without the gravel or rock. Flowable fill is typically used to fill voids when trenchless technologies are used. The Inspector should verify with the PM that flowable fill may be used in any other circumstance. The mix shall follow that identified in Table 6.2 from the specifications. Typical compressive strengths range from 85 to 175 psi.

Flowable Fill Composition (per cubic yard)	
Cement (Type I or II)	60 pounds
Class C Fly Ash	200 pounds
Fine Sand (ssd)	2,700 pounds
Water (approx.)	420 pounds
Air Content (approx.)	10%

Table 6.2. Flowable Fill Composition

6.5.3 Mechanical Compaction

Jetting or hydro-flushing of backfill is not permitted. The Contractor must compact backfill within 3 feet of all structures and appurtenances by hand methods. The Inspector should ensure that no compacting or spreading equipment is permitted to travel over the pipe until a minimum thickness of 3 feet of cover soil has been placed over the pipe and properly compacted. Only approved compaction equipment suitable for the project shall be used. Compaction by pushing or pounding a bucket onto undisturbed material or "wheel rolling" are not acceptable methods of trench compaction.

Compacting backfill material with a sheepsfoot

The earth backfill is typically compacted in 6 inch lifts (12 inch maximum lifts) to a minimum density equal to 95 percent standard Proctor. The moisture content of the backfill soils must be between 2% below and 4% above the optimum moisture content. Field density tests will need to be performed at scheduled intervals to document that the specified density is achieved. Before mechanical compaction is started, the Inspector should receive enough notice from the Contractor so that the testing agency can be contacted for testing.

The backfill should be compacted using specified lift heights determined by the aggregate size and compaction equipment used. Each lift should be compacted using an approved compaction device such as a vibratory plate compactor or smooth drum vibratory roller.

6.6 ACCEPTANCE REQUIREMENTS

After the pipe has been backfilled, each segment must be checked for damage and improperly sealed joints by performing either one or a combination of the following tests. Prior to final acceptance, water mains are flushed and wastewater lines are inspected via television. After each test is completed, the Inspector

should document all results. It is recommended that the Inspector be onsite for all acceptance tests required by the Contractor.

6.6.1 Chlorination

All water projects 24 inches and smaller are required to be flushed and disinfected by chlorination. This is to be completed by LWS and requires that the Contractor give at least 24 hours advance notification of the time that these services are needed.

For water pipes 30 inches and larger, the Contractor shall provide and complete a flushing and disinfection plan to the PM. This plan shall include the method and disinfectant to be used in disinfection process, the concentration of disinfectant to be used, and the method of neutralization of the disinfectant prior to discharge into open channels or stormwater systems. The Inspector shall become familiar with this plan to ensure it was followed. The documented results of the bacteriological tests shall be provided to the Inspector with a copy to the LWS.

6.6.2 Deflection Test

All wastewater and any other non-pressure pipes require a deflection test. Deflection testing shall not be completed sooner than 30 days after backfill has been compacted, unless waived by the PM. The maximum percent deflection (reduction of inside diameter) after the trench has been backfilled is typically 5%. The majority of Contractors use go/no-go mandrels that have been calibrated for each pipe size. The mandrels are designed so that they can be pulled through minor obstructions such as gravel. During the test, the mandrel is pulled through the pipe in a smooth motion. If it becomes jammed because of excessive pipe deflection, the mandrel is removed and the Contractor must repair the deflected portion of the pipe and retest the pipe. In no case shall excessive force be applied in pulling the mandrel that may damage the pipe or erroneously indicate that deflection was within acceptable limits.

The City typically performs the mandrel test on pipes 8 to 15 inches in diameter on wastewater pipes. Wastewater pipes larger than 15 inches shall be mandrel tested by the Contractor with the Inspector present.

6.6.3 Infiltration/Exfiltration Tests

Infiltration and exfiltration tests determine the amount of leakage into and out of pipes and appurtenances using hydrostatic water pressure. These tests are typically completed on wastewater pipes. The maximum acceptable leakage rate shall be 0.0016 gallons per hour per lineal foot per inch in diameter. The groundwater level shall be ascertained prior to testing. The minimum head at the upper manhole or structure shall be 5 feet more than the groundwater level surrounding the pipe for infiltration tests. The Contractor may combine the infiltration test with the exfiltration test for the connection of manholes or other structures as long as the maximum head and test time are met.

Performing low pressure air test

6.6.4 Low-Pressure Air Test

This test is most commonly used for gravity wastewater. The equipment used to pressurize the line shall have a pressure of no more than 9 psig. The pressure gauge shall have a range of 0 to 10 psig, with 0.1 psig divisions and an accuracy of 0.05 psig. The pressure gauge shall have been calibrated and certified as to accuracy within the past year. Prior to testing, all backfill shall have been placed and compacted to the required density, and all equipment should be checked.

To perform this test, each segment of pipe to be tested is plugged at each end with inflatable stoppers. Air lines are extended to the top of the manholes and the segments are carefully pressurized. Low pressure air shall be introduced into the sealed segment until the internal pressure reaches 4 psig. The Contractor shall allow at least two minutes for the air pressure to stabilize. Once stabilized, the pressure shall be reduced to 3.5 psig. The air supply should be disconnected from the control panel and the testing can begin. The portion of segment being tested shall be termed acceptable if the time required in minutes for the pressure to decrease 1 psig is not less than the time shown in Table 6.3:

Diameter (inches)	Minimum Time (Minutes)
6	2.8
8	3.8
10	4.7
12	5.7
15	7.1
18	8.5
21	9.9
24	11.3
27	12.7
30	14.2
36	17.0
42	19.8

Table 6.3. Minimum time for passing low-pressure air test

When groundwater is evident above the invert of the segment being tested, a pressure correction will be added to the normal 3.5 psig. The air pressure shall be increased by 0.433 psig for each foot the groundwater level is above the invert of the segment being tested. Internal pressure should never exceed 5.0 psig. If this is encountered, an infiltration or exfiltration test may be required.

In most cases, a cracked pipe or a leaking joint will not allow the initial test pressure to build up. If a leak is detected, the stoppers should be checked first to ensure that air is not escaping due to poor sealing. No one should enter either manhole when the segment is being pressurized since stoppers occasionally blow out from the pipes they are sealing.

If other underground utilities are installed for the project after the air test is performed, a second low-pressure air test must be conducted. This test is necessary to detect leaks caused by the other construction.

6.6.5 Hydrostatic Pressure Test

Hydrostatic pressure tests are completed for water and pressure pipe projects. All restraining appurtenances and backfill shall be in place prior to initiating a pressure test. The Contractor shall pump water into the system to raise the pressure to the level indicated in Table 6.3 at the lowest elevation in the segment being

tested. The Contractor shall maintain the test pressure for a minimum of two hours, carefully measuring all water added to the system during that period. The rate of water added per 1,000 feet of pipeline shall not exceed Table 6.4:

Nominal pipe size (inches)	Maximum Allowable Rate (gallons/hour)	Test pressure (psi)
6	0.64	200
8	0.85	200
12	1.28	200
16	1.47	150
24	2.21	150
30	2.76	150
36	3.31	150
48	4.41	150
54	4.97	150

Table 6.4. Maximum allowable leakage rat and test pressures for water lines

When the pipeline being tested contains segments of various diameters, the allowable losses shall be the sum of the computed allowable losses for each size. Where segments are isolated for testing, the allowable losses will be computed for the length of segments being isolated.

During the test period, the Inspector should check the ground surface along the length of the segment being tested for leakage. All detected leaks and settlement shall be repaired regardless of the test results. In the event that the test requirements are not met, the Contractor shall locate and repair all defects. Following the repairs, the tests shall be repeated until the test results requirements are met.

6.6.6 TV Inspection

Internal television (TV) inspection is commonly used on all gravity underground utilities, with the exception of stormwater. In most cases, TV inspection is carried out by wastewater and should be scheduled no earlier than 30 days after final installation and passing compaction tests. TV inspection shall be completed at the same time and in conjunction with final deflection testing, and after all line leakage and manhole exfiltration testing has been completed and accepted. Lines shall be termed “acceptable” if no

defects are found, such as open joints, breaks, cracks, excessive pipe deformation, intrusions, depositions, and debris in line, and excessive vertical or horizontal misalignment.

6.7 OPEN TRENCH CONSTRUCTION CHECKLIST

6.7.1 Site Preparation

- Do the markings for existing utilities create any conflicts with the planned utilities as designed?
- Has the Contractor completed tree pruning in accordance with required methods? Are operations being conducted so as to avoid damage to trees marked "Do Not Disturb (DND)" on the Drawings and to minimize damage to other trees?
- Are necessary access roads and detours in place? Have local residents, EMS, the fire department, police or other required agencies been notified of detours or road closures?
- Have provisions been made to prevent surface drainage from entering the trench?
- Have pavement cuts been made? Are saw cuts straight and do they extend the full depth?
- Are site activities restricted to within limits of construction or easements?
- Are components of the SWPPP in place prior to any site work?

6.7.2 Excavation

- Is the Contractor excavating the trench within the allowable trench limits?
- Do excavated materials that will not be used for trench backfill, or unsuitable excavated materials, appear to be removed from the site promptly to prevent erosion and siltation?
- Have necessary permits for offsite disposal been obtained? Does excess material hauled off site appear to be disposed of properly as approved by the Engineer?
- Are excavated materials that will be used for backfill stockpiled properly away from the trench wall?

- Is the Contractor allowing traffic to flow and providing proper access to residents?
- Does sheeting and bracing appear to conform to the plans?
- Are trench walls inspected by the Contractor after every rain event to determine if additional protection against slides and cave-ins is necessary?
- Is the trench bottom smooth, firm, and free of clods of earth, stones, and frozen materials?
- Is the trench free from loose rock and stone projections or ledges that extend into the trench?
- Have soft or yielding foundation conditions been corrected by adding foundation material?

6.7.3 Pipe Installation

- Have the correct type, rating, and class of pipe been supplied for the project?
- Does the pipe appear free from cracks and other defects?
- Does bedding material proposed for use as bedding or encasement appear to be of the correct gradation? Is it relatively free from sharp, sliver-shaped pieces?
- Is the Contractor using the proper thickness of bedding material beneath and around the pipe?
- Is the pipe being laid with the bell or groove end pointing upstream?
- Is the Contractor excavating beneath the bells so that the pipe will be uniformly supported throughout its entire length?
- Are all pipe bend fittings installed according to the Plans? Has Contractor replaced any pipe bends by joint deflections of pipes within allowable manufacturer's limits?
- Is grade being checked for every segment of pipe being laid?
- Are pipe joints being properly lubricated? Have gaskets been installed properly? Are joints being pushed "home" for the correct distance?
- Is bedding material being placed to provide the correct cover thickness over the pipe?

- Are concrete encasements installed at the locations shown on the plans?
- Is the pipe properly braced against floating prior to placement of concrete in cradles and encasements?
- Is a mechanical plug installed in the new wastewater pipe when tying into an existing pipe?
- Was any concrete encasement poured? Did it extend at least 2 feet beyond the horizontal limits of the point where pipe protection is required? Was the pipe properly supported to prevent it from floating off grade as the concrete was placed?
- In rock-bottom streams, the concrete encasement typically extends from 6 inches below the pipe up to the original rock level.
- Was a bore pit used? Was it of sufficient dimensions to accommodate entry of pipe? Was the bore depth logged by the Contractor at 25 feet intervals?
- Was the tracer wire installed by the Contractor? Was the tracer wire terminated correctly and tested by the Contractor?
- Was all DIP double wrapped with polywrap and taped?
- Were all fittings the correct size, type and configuration called out in the plans?
- Were all fittings properly tightened?
- Were all fittings fully encased with polywrap and taped?

6.7.4 Backfill

- Do selected excavated materials contain any rock? If so, has the Contractor been reminded not to place excavated materials containing rock?
- If mechanical compaction is used, have soil samples been submitted to a testing laboratory for standard Proctor tests and have arrangements been made to have field density tests performed?
- Were hand methods used within 3 feet of all structures and appurtenances? Was the appropriate equipment for compaction used?

6.7.5 Acceptance Requirements

- Have all utility pipes been visually examined to ensure the absence of debris or blockages prior to running acceptance tests?
- Have all required acceptance tests been performed? Did the tests pass? If not, did the Contractor determine where the problem occurred, complete the necessary repairs and complete any additional acceptance tests?
- Have all detected leaks and settlement been reported to the Contractor and addressed?
- Did the proper City agency do a final inspection, and either accept the work or provide a punch list?

CHAPTER 7: APPURTENANCES

7.1 OVERVIEW

Appurtenances are supplementary structures or devices that enhance the operation of and facilitate maintenance of utilities. This chapter describes common appurtenances used for water, wastewater, and stormwater projects and discusses the construction and installation of these items.

7.2 WATER PROJECTS

7.2.1 Types of Appurtenances

Appurtenances commonly installed on water projects include hydrants, valves and valve boxes, and thrust restraints. The Contractor is required to purchase the following materials from the LWS for water projects:

- Valves.
- Valve boxes, rings, and lids.
- Fire hydrants (ensures correct model and configuration for proper nozzle orientation).
- Hydrant extensions, when required.
- Pressure taps, tapping sleeves and valves, and all equipment for installation or abandonment.

These materials are located at the LWS Shop and must be transported to the site by the Contractor. The Inspector shall ensure that all appurtenances installed match the size, type, location, and configuration specified in the plans.

7.2.2 Installation

All appurtenances shall be kept clean and free from rags, dirt, mud, non-potable water, and other foreign materials and objects at all times during installation. If pipe laying is stopped or delayed for any reason, the Contractor shall plug the open ends of all pipes. Plugs shall be capable of preventing the entry of water and other foreign material with the excavation completely full of water.

Whenever PVC or other non-metallic pipe is used, all cast iron or other metallic fittings and appurtenances shall be double wrapped in polyethylene. Seams must be folded over twice and taped together to hold them down. Openings in the polywrap for

service taps and similar appurtenances can be made by making an "X" cut in the polywrap and temporarily folding back the polywrap. After the appurtenance is installed, tape the slack securely to the appurtenance and repair the cut. Service lines or connections to unwrapped pipe should have the polywrap extended 5 feet from the main and taped to secure the ends of the encasement. For more information on polywrap, see Section 6.4.5.3. The following sections present brief descriptions of the installation of common water appurtenances.

7.2.2.1 Valves and Valve Boxes

Immediately prior to installation, the Contractor shall inspect all valves to ensure they are in good operating condition and free from defects. All valves shall be installed in such a manner that the operating nut and key will be in a vertical position with the use of a level in both directions. When the operator is located on the side of the valve, the Contractor shall install the valve with the operator located on the curb side of the valve. Valves 12 inches in diameter and larger shall be installed resting on one or more precast concrete support blocks 18 inches square and 4 inches thick, which rest against undisturbed earth. The Contractor shall check the installation of all butterfly valves to be certain that the valves can be operated throughout the entire range of operation, and that they do not contact the inside edges of the pipe when operating. For more information on butterfly valves, see LSP 340.

Air relief and blow off valves shall be constructed as indicated in the plans. The Inspector shall ensure that all items essential to the operation and maintenance of the valves are correctly installed, in the correct locations, and of the correct type, size, and configuration. For more information on relief and blow off valves, see LSP 310.

Where tapping sleeves and valves are to be installed, the Contractor shall make all excavations to the dimensions required and provide all necessary trench protection. The Contractor shall provide precast concrete pads and other stabilizing materials under the tapping valves necessary to prevent rotation of the tapping sleeve on the main. For more information on water tapping, see LSP 340.

The Contractor shall install a valve box over every valve operator. All valve boxes are provided by LWS. The valve box shall be installed plumb and centered over the operating nut and with the bottom of the box sufficiently lower than the operating nut to prevent the entry of soil. The top of the box shall be set flush with the final grade or paved surface. Valve box adjusting rings shall not be used to adjust valve boxes to grade. Backfilling within 3 feet of all valves and valve boxes shall be accomplished by hand methods using the appropriate equipment for the soil type.

7.2.2.2 Hydrants

Properly installed fire hydrant

Hydrants shall be set plumb, resting on a precast concrete pad 4 inches thick and 18 inches square. The support pad shall rest against undisturbed earth. The top of the flange on the hydrant shall be set to the grade within 6 inches as shown on the plans. A hydrant of the length shown on the plans shall be used to attain this elevation. The Contractor shall make appropriate deflections or rotations in the tee and anchoring elbow, or use an anchoring offset to meet this grade. Where a hydrant extension is necessary to meet the required grade, the hydrant extension shall be installed only by LWS. Only one extension will be permitted on a hydrant. The Contractor shall remove and reset all hydrants which cannot be adjusted to grade with one extension. The Contractor shall notify the Inspector or the PM when hydrant extensions are required. When obtaining hydrants from LWS, the Contractor shall determine and select the hydrant shoe configuration that best suits proper orientation of the steamer (large) nozzle. The Contractor shall orient the large steamer nozzle of the hydrant perpendicular to the curb line. When required, adjustments to the final hydrant nozzle orientation shall be made by LWS. Backfilling within 3 feet of the hydrant shall be accomplished by hand methods using the appropriate equipment for the soil type.

The Contractor shall place a minimum of 0.75 cubic yard of drainage gravel around the base of the hydrant to allow drainage of

the barrel. Contractors shall not use crushed concrete in place of drainage gravel around the base of hydrants. Hydrant drainage gravel shall be clean, washed, hard, durable, uncoated and uniformly graded road gravel. Polywrap shall be placed on top of the drainage gravel prior to backfilling. The Contractor shall ensure that hydrant drain holes are not blocked or covered by polywrap. No poured in place concrete shall be used around hydrant assemblies. For more information on hydrants, see LSP 330.

7.2.2.3 Thrust Restraints

The Contractor shall construct reinforced concrete thrust blocks at all locations shown on the plans or indicated by the PM. All thrust blocks shall be placed so that pipe and fitting joints will be accessible for repairs. The bearing face of all thrust blocks shall rest against undisturbed soil. All hydrant drain holes and valve operators shall be protected from concrete during construction of the thrust blocks. It is important to protect the moving parts of the joints from concrete in the event that a future repair is needed. Only dry-blocking shall be used against all hydrant assemblies. When the existing water mains must be reconstructed or looped, the Contractor shall restrain all fittings with ductile iron retainer glands installed in accordance with the manufacturer's recommendations in addition to concrete thrust blocks and/or anchorages. For more information on reinforced concrete thrust blocks, see LSP 320.

Mechanical restraints by flanges or anchoring fittings intended to replace reinforced concrete thrust blocks must be installed in accordance with the manufacturer’s recommendations.

7.2.3 Appurtenances Construction Checklist for Water Projects

- Were all appurtenances the correct size, type, configuration, and were they installed at the correct elevation and location as shown on the plans?
- Was the subgrade verified to be free of roots, stones, or other undesirable material prior to setting pre-cast or cast-in-place appurtenances? Was the subgrade firm for thrust blocks?

- Was the strength of concrete used appropriate for cast-in-place appurtenances?
- Are all valve boxes properly installed and plumb?
- Are all hydrants plumb? Was 2 cubic feet of pea gravel used for drain material?
- Was the tracer wire box correctly installed near the hydrant?
- Were all metallic appurtenances double poly wrapped at least 1 foot past glands?
- Where the proper facing shoes installed on all hydrants? Were all fittings restrained?
- Were all valves and hydrants purchased from LWS?
- Were all 12 inch PVC pipes properly beveled when connected to butterfly valves?
- Were all bolts properly tightened on all appurtenances?
- Do all butterfly valves open and close all the way?
- Has polywrap been installed 1 foot past joints and up to operating nut with all ends properly taped?
- Have any valves or valve boxes been buried with appropriate backfill material?
- Are all valve boxes centered over the valves?
- Have any taps been completed? Were they at least 18 inches from any pipe joints, and at least 3 feet from any other taps?
- Were hydrant drain holes, valve operators, and all moving parts of joints protected from concrete during thrust block pours? Was dry-blocking used against all hydrant assemblies?

7.3 WASTEWATER PROJECTS

7.3.1 Types of Appurtenances

Appurtenances commonly installed on wastewater projects include manholes, drop manholes and services, and junction chambers. The Inspector shall ensure that all appurtenances installed match the size, type, location, and configuration specified in the plans. The following sections present brief descriptions of the installation of common wastewater appurtenances.

7.3.2 Installation

All appurtenances shall be kept clean and free from rags, dirt, mud, and other foreign materials and objects at all times during installation. If pipe laying is stopped or delayed for any reason, the Contractor shall plug the open ends of all pipes. Plugs shall be capable of preventing the entry of water and other foreign material with the excavation completely full of water.

7.3.2.1 Manholes

Manhole sections and rings

The bottom of each manhole shall be constructed of concrete or precast concrete manhole base sections. When constructing a precast section, double ring mastic type gaskets shall be placed between the bottom and first ring section. When constructing a poured concrete manhole bottom, manhole water stops shall be installed on all plastic pipes entering manhole walls. The water stop gasket shall be placed within 1 inch of the center of the manhole wall.

The manhole base consists of a channel and a wash section. The channel is constructed to carry the same volume of water as the incoming pipe. The bench section, also known as the wash, is constructed up to the pipe spring line with a slight slope towards the pipe. This provides a working surface for maintenance operations. It is crucial that the inverts in and out of manholes are properly constructed. Inverts shall be shaped to create even laminar flow through the manhole. Inverts shall also be no larger than the pipe diameter. Poorly constructed inverts create turbulence, which in turn create an unnecessary increase in odors and gasses that can reduce the life expectancy of the pipe and manhole. A common practice for straight runs is to lay the pipe through the manhole base and pour the manhole base mid way up the pipe. After the base has set, the top portion of the pipe is cut away to achieve an ideal flow path in and out of a manhole.

Typically, manholes are installed using precast sections. Care shall be exercised during the assembly of wall section to correctly

place gaskets to ensure watertight joints. Joints shall be mortar plastered inside and outside a minimum of 1/2 inch thick, 6 inches above and below. When installing cast-in-place sections, concrete shall be carefully placed and thoroughly consolidated to the greatest density possible. If cast-in-place, the Inspector should verify the strength of concrete and the size and spacing of rebar used. The Inspector shall also verify that no steps inside the manhole were installed. All holes, joints, or honeycombed sections shall be carefully filled and sealed with mortar. The Contractor shall take precautions to protect all parts from damage due to freezing. The Contractor shall cover and protect all brick and concrete masonry from temperatures below 45 degrees F for a period of at least 72 hours after the structure has been constructed. For more information on manholes, see LSPs 200 and 201.

Precast concrete grade rings may be used to adjust the manhole ring and cover to the required grade when the vertical adjustment is greater than 4 inches. At least one 4 inch grade ring shall be used to allow for future adjustments, and no more than 2 feet of rings shall be used. Approved mastic-type gaskets shall be used to seal the joints between precast adjusting rings, the reducing section, and the cast iron manhole ring. The outside of the cast iron manhole ring, including any adjusting rings and bricks, shall be mortar plastered on the inside and outside a minimum of 1/2 inch thick. Brick adjusting rings are only to be used when the vertical adjustment of the ring and cover is less than what a standard precast adjusting ring can provide. The Inspector should check to ensure that no debris, wood, or other unwanted material was used to adjust the rings or cover to grade. For more information on cast iron manhole rings, see LSP 162.

Example drop inlet

7.3.2.2 Drop Manholes and Service Connections

Drop manholes are used to connect an incoming wastewater pipe at a higher elevation than the outgoing pipe. No pipe less than 8 inches in diameter shall be tapped into a manhole. Service connections shall be constructed at all locations indicated on the

plans. The Inspector should verify that all taps are properly constructed and in the correct locations, and ensure that a PVC stub marker has been placed prior to backfilling. For more information on service connections, see LSP 210.

7.3.2.3 Junction Chambers

Junction chambers are typically cast-in-place concrete structures built at the intersections of two or more large wastewater pipes to replace standard manholes. Manholes shall be provided above the structures for inspection and maintenance access. If cast-in-place, the Inspector should verify the strength of concrete, size and spacing of rebar used. It is crucial that the inverts in and out of the structure are properly constructed. Poorly constructed inverts create turbulence, which in turn creates an unnecessary increase in odors and gasses that can reduced the life expectancy of the pipe and manhole.

7.3.3 Appurtenances Construction Checklist for Wastewater Projects

- Is bedding material properly placed around and beneath all appurtenances?
- Were the manholes properly backfilled and tamped using hand methods within 3 feet from the manholes?
- Were the manholes properly sealed?
- Were the inverts and benches properly constructed?
- Does the entire bench slope to the invert?
- Are all manholes at the correct locations and the correct size, type, and configuration?
- Was the foundation for any precast or cast-in-place appurtenance suitable?
- Were the gaskets for all connections cleaned prior to installation?
- If the gaskets were provided separately, were they stored correctly?
- Were all plugs installed correctly?
- Were stubs installed up to the Right-of-Way?

- Were service connections and stubs connected to the main line matching crowns?
- Are the adjusting rings free of debris, and properly adjusted to final grade?
- Were all drop manholes constructed properly?
- Was the proper strength of concrete and rebar used for any cast-in-place appurtenances?
- Is proper care being exercised by the Contractor to ensure that the service connections are not pushed too far into the branch?

7.4 STORMWATER PROJECTS

7.4.1 Types of Appurtenances

Appurtenances commonly installed on stormwater projects include manholes, inlets, open ditches, junction boxes, reinforced concrete collars, elbows, and plugs, rip rap, and headwalls and flared end sections. The Inspector shall ensure that all appurtenances installed match the size, type, location, and configuration specified in the plans. The following sections present brief descriptions of the installation of common stormwater appurtenances.

7.4.2 Installation

All appurtenances shall be kept clean and free from rags, dirt, mud, and other foreign materials and objects at all times during installation. If pipe laying is stopped or delayed for any reason, the Contractor shall plug the open ends of all pipes. Plugs shall be capable of preventing the entry of water and other foreign material with the excavation completely full of water.

7.4.2.1 Manholes

Brick manholes can be built where specified in the plans. The brick in each course shall break course with those in the adjoining courses. Mortar shall be mixed in the proportions of one part of Portland or mortar cement and two parts of sand, by volume. Every brick shall have full mortared joints on the bottom, sides and ends which shall be formed in one operation by placing sufficient mortar on the bed and forcing the brick into it. All joints shall be carefully filled and struck as the manhole is built up. The entire

space between adjacent bricks shall be filled solidly with mortar. The entire inside and outside surface of the brick masonry shall be carefully plastered with mortar applied at a thickness of not less than 1/2 inch.

Cast-in-place and precast manholes are similar to those constructed for wastewater. For more information see Section 7.3.2.1, or LSP 141 and 142.

7.4.2.2 Inlets

Example of a typical stormwater inlet

Brick inlets can be built where specified in the plans, and shall be constructed in the same manner as brick manholes. The inside and outside of the walls shall be plastered with mortar 1/2 inch thick. Each inlet bottom shall be fully formed to slope to the outlet and all corners shall be filled with concrete. The Inspector should verify that all inlet rings, covers, grates, and dimensions of all inlets comply with the plans.

Reinforced concrete inlets shall have the inlet tops set to grade and sealed with mortar. The ring and cover shall be adjusted to grade with brick and mortar and shall be sealed inside and out with mortar. The inlet throats for both brick and reinforced concrete shall be approximately 5 inches. For more information on inlets, see LSPs 100, 101, 130, and 131.

7.4.2.3 Open Ditches

All open ditches shall be constructed with alignment and grades as indicated in the plans. Concrete liners for open ditches shall be of type, thickness, location and grade as indicated in the plans. The Inspector should verify the strength of concrete, size and spacing of rebar used. For more information on concrete liners, see LSP 170.

7.4.2.4 Reinforced Concrete Collars, Elbows, and Plugs

Reinforced concrete collars, elbows, and plugs shall be built where specified in the plans, and in a manner required to attain the

correct rim elevation. The Inspector should verify the strength of concrete, size and spacing of rebar used. For more information on reinforced concrete collars, elbows, and plugs, see LSP 150.

7.4.2.5 Rip-Rap

Example pile of rip rap

Concrete or stone rip-rap shall be placed on prepared slopes and channel bottoms at locations shown on the plans. The materials used shall be hard stone, broken concrete, or prepackaged material, free from earth, clay, asphalt, or refuse and of such quality that it will not disintegrate from action of water or wind. The rip-rap shall be placed at the locations, size, and thicknesses indicated on the plans. Geotextile fabric shall be placed on the prepared slopes prior to placement of the rip-rap. Concrete or other masonry produced as a result of removal of such items at the job site may be used only with prior approval of the Inspector. For more information on rip-rap, see LSP 177.

7.4.2.6 Headwalls and Flared End Sections

Headwalls and flared end sections shall be installed where specified in the plans. The Inspector should verify that all headwalls are the proper size, type, location, and configuration as shown in the plans, and that the materials follow the required mix and strength, rebar location and size set out in the specifications and LSPs. For more information on headwalls and flared end sections, see LSPs 160 and 161.

7.4.3 Appurtenances Construction Checklist for Stormwater Projects

- Do the locations and dimensions of all appurtenances comply with the plans?
- Was the foundation for any precast or cast-in-place appurtenance suitable?
- Is bedding material properly placed around and beneath all appurtenances?
- Were the manholes and inlets properly backfilled?

- Were the manholes and inlets properly sealed?
- Were the inverts and fillets properly constructed?
- Does the entire fillet slope to the invert?
- Are all manholes and inlets at the correct locations and the correct size, type, and configuration?
- Do all storm inlet throats have adequate openings?
- Was the foundation for any precast or cast-in-place appurtenance suitable?
- Were the gaskets for all connections cleaned prior to installation?
- If gaskets provided separately, were they stored correctly?
- Were the proper types of grates and curb inlets (single or double) provided?
- Was the proper strength of concrete and rebar used for any cast-in-place appurtenances?
- Are all connections between the inlets and stormwater pipes grouted and watertight?
- Is backfill carefully placed around the stormwater pipe and headwalls to avoid cracking of the concrete? Were hand methods used within 3 feet of all structures and appurtenances? Was the appropriate equipment for compaction used?
- Was any rip-rap placed? Was geotextile fabric placed on the slope prior to placing the rip-rap? Was it the correct size, shape, and thickness?
- Did the proper City agency do a final inspection, and either accept the work or provide a punch list?

CHAPTER 8: TRENCHLESS CONSTRUCTION

8.1 OVERVIEW

The open trench method of installing underground conduits is the most commonly used construction process on PW&U projects. Interference with traffic and the resulting disruption of business and industry are undesirable consequences of the open trench method. In these cases, trenchless methods such as directional drilling are a safe and practical alternative.

"Trenchless" refers to any construction method that permits the construction of an underground utility without requiring continuous disturbance of the ground surface. The use of trenchless construction of underground utilities is widely accepted and many Contractors specialize in this area. Improper or unsafe trenchless construction can be costly and dangerous and therefore requires careful oversight.

8.2 TYPES & CONSIDERATIONS

The Contractor generally determines the trenchless method to be used, but must have the City's approval prior to construction. The Contractor is required to submit all necessary information concerning construction methods, the schedule of operations, and the working hours prior to construction. In addition, any horizontal bore construction beneath railroad tracks or other railroad property must be approved by the railroad prior to construction. Certain rehab methods such as slip lining, cured in place pipe (CIPP), and pipe bursting are trenchless methods that are also used and approved. Trenchless methods usually used on PW&U projects are:

- Boring and jacking.
- Conventional Mining (or tunneling).
- Directional drilling.
- Microtunneling.

Each of these methods is discussed in more detail in the following sections.

8.2.1 Boring and Jacking

Boring and jacking is the most common method of trenchless technology and is usually used in only soil or only rock. This method involves installing a steel casing pipe underground from a boring pit to a receiving pit. The casing pipe is advanced along the alignment using a boring machine that rotates an auger through the casing. The rotating auger cuts into the earth at the boring face and conveys the cuttings back to the access pit, where they are removed. The boring machine is pushed forward by hydraulic jacks, and this, in turn, pushes the casing pipe into the boring. After a section of casing is installed (casing is typically supplied in 20 foot lengths), the boring machine is retracted and additional auger and casing sections are set in place on the machine. The new casing is welded to the previously installed section and the process is repeated.

Jack and bore project

When visiting boring and jacking operations, the Inspector should check for the following:

- The direction and orientation of the boring machine should be carefully established before the work begins.
- Guide rails must be installed in the bottom of the access pit, and crushed stone or rock should be placed to maintain a stable base for the guide rails. In the case of a large pipe, rails should be carefully set in a concrete slab.
- The number and capacity of the jacks to be used should be appropriate for the size and length of the pipe to be placed and the type of soil encountered.
- Backstops must be strong enough and large enough to distribute the maximum capacity of the jacks against the soil behind them.
- The boring pit should be established on the downstream end unless the Contractor has justification to do otherwise. This maintains drainage away from the boring face and allows

easier correction of the grade when the boring is on a positive (uphill) slope.

- The Contractor should pump any water from the pit and remove sediment before discharging.
- The diameter of casing pipe must comply with the plans. In general, a 12 inch clearance must be provided between the carrier pipe bell and the inside of the casing. Less clearance may be allowed for water mains and pressure pipes because the grade is not as critical.
- When the casing pipe is specified to be 30 inch diameter or greater, the outside of the casing must be pressure-grouted after it is in final position. The grout should be pumped through nipples in the casing at 10 foot intervals. The carrier pipe should be installed after the voids outside the casing have been filled. To maintain proper clearance, casing chocks are usually secured to the carrier pipe with stainless steel bands. These chocks should be placed at a maximum of 6 feet apart for each section of pipe.
- When the pipe is pushed into position, the pipe sections should stay joined.
- After the carrier pipe is in final position, it should be properly blocked at both ends with a standard brick or concrete plug and checked. Then the remaining space inside the casing pipe should be filled with grout.

8.2.2 Conventional Mining (Tunneling)

Conventional mining methods are used for tunnels with interior dimensions of 4 feet or larger, for smaller tunnels that cannot be effectively installed by boring and jacking, or when finished grades are critical. With this mining method, material is removed from the tunnel face and is transported back to the tunnel heading or entry shaft, where it is removed. Steel liner plates or a rib-and-lagging system is installed to support the roof and sides of the tunnel as the excavation proceeds. Periodically, excavation operations are stopped and the voids behind the tunnel liner are filled by injecting a sand-cement grout into preset grout holes in the liner.

When the tunnel is completed, a concrete floor, steel rails, or other approved supports are placed in the bottom of the tunnel at the correct grade and the pipe is pulled into the tunnel in sections and joined. The space between the pipe and the tunnel lining should be completely filled with grout, pea gravel, or 3/8 inch crushed stone by pneumatic backstowing.

Excavation should be closely monitored to ensure that there is no loss of earth outside the tunnel lining. To prevent such loss and to ensure uniform loading of the liner plates, all voids between the tunnel lining and the soil must be filled with grout. Grout is generally pressure-injected through grout holes in the steel liner plates. Grouting must be performed daily during advancement of the tunnel. If soil loss and/or settling occur, grouting should be completed more frequently.

If excessive infiltration of groundwater occurs through the liner plates, wood excelsior and wood wedges are used to plug the leaks. The wood excelsior is packed behind the liner plates and the wedges are driven into joints where leakage occurs.

8.2.3 Directional Drilling

Directional drilling is one method of installing underground utility lines without causing significant disturbance to the ground surface. This method involves pushing rods into the ground at a downward angle until the pipe grade is reached. The rods are then pushed along the pipe alignment and angled upward to the ground surface at the end of the alignment. A back reamer and the HDPE pipe or PVC carrier pipe are then pulled back through the hole.

Pipe bursting can be utilized with directional drilling to allow upsizing wastewater pipes, installing force mains, and potentially replacing waterlines. However, maintaining water service and disinfection can present challenges. This technique has also been used by some municipalities to install service connections. Directional drilling offers improved safety because of less excavation and equipment at the surface and creates fewer traffic disturbances than many other methods.

8.2.4 Microtunneling

Microtunneling involves pushing a pilot tube and a carrier pipe through undisturbed soils. The 4-inch diameter pilot tube is first

pushed through the soil by displacement from a 6-1/2- to 8-foot diameter drive shaft toward a receiving shaft or existing manhole. The clay carrier pipe is then pushed along the alignment of the tunnel created by the pilot tube. Soil cuttings are carried back to the drive shaft during installation of the carrier pipe.

This method offers similar advantages as directional drilling such as a safer work environment and less ground disturbance. Additional benefits of microtunneling include more accurate grade control during installation and a lower installation cost.

8.2.5 Rehabilitation Methods

When extensive problems develop in existing pipelines, it is often more cost effective to perform cleaning and rehabilitation (rehab) than to remove and replace. Use of trenchless technology will cause less disturbance and can be a much faster solution. Some of the methods for cleaning and restoring existing systems are as follows:

Improper installation can lead to large root growth plugging pipes

- Maintenance of an existing line by using water pressure and mechanical cleaning tools (commonly referred to as pigging).
- Root control in wastewater lines.
- High velocity jetting.
- Rodding machines.
- Hydraulic machines.

Once cleaned, pipelines often undergo repair or rehab to extend their life and provide more reliability with better flow characteristics. A variety of methods have been introduced to provide maintenance and make repairs to existing systems. These include:

- Mechanical seals for joints (inside pipe) which can be used for potable water mains.

- MH wall and chimney seals.
- Coatings and linings that can be applied internally.
- Cured in Place Pipe (CIPP) or slip lining methods that can be used to rehab pipe by insertion into the existing pipe.

Prior to the start of construction, the Inspector must spend extra time to become familiar with the contract documents and proposed rehab methods. It is highly recommended that if unfamiliar with what is to be done, there be some interaction with the PM, designer, or the design team. Also, it is important to obtain Manufacturer installation guides and applicable ASTM standards in order to become knowledgeable of best construction practices.

8.3 TRENCHLESS CONSTRUCTION

The majority of PW&U underground utilities are constructed by the open trench method described above. Therefore, oversight of trenchless construction is not required very often. This section discusses the items to be checked on trenchless projects.

8.3.1 Pre-Construction Activities

Prior to construction, the Inspector should:

- Get a copy of the tunneling plan and submittals from the Contractor.
- Line and grade should be submitted based on utility locations, once call and any subsurface investigations conducted.
- Review and understand all items in the plan and submittals.
- Verify that all necessary permits and approvals have been obtained.
- Notify the PM at least 2 weeks prior to construction so that contact may be made with representatives of the owner division and companies that control the facility under where the trenchless method will be installed.
- Verify that all pre-construction surveying appears to be accurate and complete, including the following:
    1) Offset stakes should be set at shaft locations in order to accurately locate the alignment end to end.
    2) A benchmark should be set near the shaft to provide vertical control.

3) The surface elevations of structures, streets, highways, railroads, etc. located above the horizontal should be surveyed in order to monitor possible settling.

8.3.2 Construction Responsibilities

The Inspector should frequently check all phases of the construction project. The Inspector should pay particular attention to the following:

- All materials and methods used during construction should be checked to ensure that they conform to the records submitted by the Contractor.
- An adequate air supply must be provided to the workers at all times. The Contractor should monitor air in tunnels for toxic or flammable gases.
- The Contractor's surveyor should check line and grade of the tunnel generally once every day. This may change depending on the rate of construction. The Inspector should review the line and grade and notify the Contractor and PM if problem is suspected.
- Grouting should be performed at least daily for a tunnel. Grout should be injected into the lower grout holes first and then move to the higher holes as the voids are filled. The grout should consist of two parts sand to one part cement with enough water added to permit pumping.
- Loss of materials is an indication of voids that need filling by grouting. Over-excavation should be avoided because excessive voids between the tunnel lining and the soil above may cause settling at the ground surface. If over-excavation occurs, grouting should be done immediately.

The Inspector should be wearing the proper safety equipment prior to entering a tunnel including at a minimum a hard hat and air monitoring equipment. The Inspector should also be aware of the correct procedures to follow and have the proper training prior to entering a confined space.

All phases of trenchless construction should be adequately documented in the Daily Activity Report. In particular, the Inspector should document the rate of tunnel advancement, grouting intervals, and the results of line and grade checks. Any

unusual occurrence, including over-excavation or evidence of settling, should also be noted.

8.3.3 Carrier Pipe

After the trenchless installation is constructed, the carrier pipe is then placed within the casing or tunnel liner. The Inspector should check the following during pipe placement:

- An adequate concrete pad is typically constructed prior to placement of large diameter pipe.
- Line and grade of the casing pipe should be checked regularly. Casing chocks should be used to maintain spacing and should be placed at a maximum of 6 foot spaces.
- The space between the tunnel and the pipe must be grouted in lifts.
- During grouting, the carrier pipe must be braced within a tunnel to prevent flotation.
- An excessive amount of grout should be pumped into the tunnel to allow the release of trapped pockets of air.
- The calculated volume of grout required to fill all voids in a tunnel or slip lining pipe should be checked against the volume of grout delivered as noted on truck tickets.
- A vent pipe should be installed to purge any displaced air.
- The carrier should be able to handle the high temperatures that will occur during grout curing.

8.4 TRENCHLESS CONSTRUCTION CHECKLIST

8.4.1 Pre-Construction

- Has the Contractor submitted a plan for construction methods? Was a copy received?
- Have reference points and benchmarks been established so that the trenchless installation can be correctly positioned and line and grade can be checked?
- Have surface elevations on structures, streets, highways, or railroads that are above the horizontal bore or tunnel been obtained prior to construction?
- Has the PM been notified 2 weeks in advance of the beginning of a horizontal bore or tunneling operation?

8.4.2 Construction

- Do all materials and procedures comply with the trenchless construction plan submitted by the Contractor?
- Is an adequate air supply provided for the workers, if entry is required?
- Are line and grade being checked daily by the Contractor during tunnel construction?
- Are liner plates being installed properly? Are the liner plates securely fastened and adequately sealed, when necessary, to stop leaks?
- Is grouting being performed in accordance with the approved plan?
- Is the Contractor working cautiously to prevent over-excavation and loss of materials? If over-excavation occurs, are the voids being grouted immediately?
- Are bulkheads or breast boards installed at the end of each workday or whenever work is halted for an extended period?
- Have daily advancement, grouting intervals, and the results of line and grade checks been documented?

8.4.3 Pipe-Laying

- Is a suitable pad provided beneath the pipe if required by the plans?
- Are proper line and grade being maintained during carrier pipe placement?
- Were casing chocks installed at proper intervals?

8.4.4 Backfill

- Was the bore pit properly backfilled using the appropriate equipment?
- Are all voids between the tunnel lining or casing pipe and the carrier pipe grouted with the appropriate material? Is the carrier pipe adequately braced during grouting?
- Were the blocks at both ends of the bore installed correctly? Was the space in between completely filled with grout?
- Was a vent pipe installed to release trapped air?

CHAPTER 9: PAVEMENT RESTORATION

9.1 OVERVIEW

All pavement and ground surfaces on public right-of-way (ROW), easements, and private properties that are disturbed during construction of underground utilities must be restored to conditions that are as good as or better than those that existed before construction. The importance of this phase of construction cannot be overemphasized. The Inspector should ensure that proper pavement, sidewalk, and ground restoration are provided since the surface conditions will remain visible to the customer long after construction. The Inspector must also ensure that any pavement restoration is properly integrated into the existing pavement, allowing a smooth and rideable interface. For more information on pavement restoration, see LSP 670. In general, the Inspector will encounter two types of pavement repair:

- Portland Cement Concrete (PCC).
- Asphaltic Concrete.

9.2 PORTLAND CEMENT CONCRETE (PCC)

Concrete is commonly used as a construction material on construction utility projects because it provides high compressive strength, water tightness, durability, flexibility in non-standard applications, and abrasion resistance. In addition, concrete can be readily formed in a just-poured state to fit construction needs and requirements. The quality of finished concrete largely depends on proper batching, mixing, placement, and finishing.

PCC pavement restoration

Concrete is produced by mixing cement, water, sand, and gravel. As soon as the cement and water are combined, hydration begins and in a few hours the mixture begins to harden. The concrete's strength, weight, color, and porosity are a function of:

- Cement type.
- Water/cement ratio.
- Air content.
- Mix proportions of sand and gravel.
- Mixing method.
- Placement method.
- Curing conditions.

Concrete has relatively high compressive strength but is relatively weak in tension. Tensile forces may result from external loads on the concrete or from shrinkage and temperature changes. Steel reinforcing bars (rebar) or wire mesh is commonly used to increase the tensile strength of concrete. Reinforcement is typically added at places where bending or vertical shear may occur. Many different strengths of concrete can be made. However, the Inspector should ensure that the strength provided matches that indicated in the plans. L-3500 or 3,500 psi is used unless otherwise specified in the plans.

Sand and gravel make up about 60 to 80 percent of the volume of hardened concrete. The sand and gravel should have the following properties:

- Good strength, durability, and weather resistance.
- No loam, silt, or organic matter (all of which may weaken the bond with the cement paste).
- No unfavorable chemical reactions when mixed with the cement.

Admixtures are substances that are added to concrete to improve its workability, accelerate its set, harden its surface, and increase its waterproofing qualities. The common types are:

- Accelerating admixtures – reduce the time of setting and accelerate strength development.
- Air-entraining admixtures – increase the workability and the free-thaw resistance of the concrete.
- Finely divided mineral admixtures – reduce the permeability of the concrete and correct deficiencies in the concrete mix by providing more fine material.

- Super plasticizers and water-reducing admixtures – temporarily increase the workability of concrete without adding water.

9.2.1 Prior to PCC Placement

Prior to PCC placement, the Inspector should verify that the excavation, forms, and steel are as indicated in the plans.

9.2.1.1 Excavation

The Inspector should verify the following:

Subgrade prior to PCC pouring

- The excavation should be level and on firm soil.
- Soft soils should be undercut to firm material and backfilled with suitable material.
- Excavated surfaces against which concrete is to be placed should be clean and moist to prevent concrete from drying faster than anticipated, and any apparent roots (organic material) shall be removed.
- The surfaces should be free of frost, ice, and mud.
- The excavation should not be under water.
- Cutbacks must be at least 12 inches from the undisturbed subgrade on each side of the trench.
- Cuts in the pavement should be straight lines so that joints between existing and new pavement will be smooth and continuous.
- When a single set of saw cuts is required, the recommended distance to the saw cut lines should be at least 12 inches from the undisturbed subgrade on each side of the trench. Any broken edges must be cut a second time.
- If the saw cuts in concrete pavement are within 4 feet of a formed joint, it is recommended that the existing slab should be broken and removed to the joint.
- All pavement cutting should extend to the subgrade and the affected area should be completely excavated.
- All manholes, valve boxes, and stormwater inlets must be adjusted to the proper elevations.

- All survey center line monuments must be preserved and adjusted to grade.

9.2.1.2 Forms

Forms should be checked for the following:

- Forms should be made of steel with a minimum base width of 6 inches, a minimum length of 10 feet, and shall have adequate locking devices. Wood forms may be used only on curves of less than 150 feet radius the depth of all forms shall be equal to at least the depth of the concrete being placed. No built up form will be permitted.
- Forms used for permanently exposed concrete surfaces should be checked to ensure that they are smooth and free from irregularities, dents, sags, and holes.
- Sawdust, chips, blocks, dried mortar, ice, and water should be removed from forms.
- All forms should be at the correct locations, be mortar-tight, have the correct dimensions and have adequate support to withstand the weight of the concrete during pouring.
- Slip form equipment shall have traveling side forms of suitable dimensions, shapes, and strength to support the concrete. Equipment shall spread, consolidate and screed the concrete properly. Equipment shall have the line and grade automatically controlled.

Prior to placing concrete or reinforcing steel, the inside faces of the forms are typically coated with a light non-staining form of oil or lacquer. Coatings should not be so thick as to stain or soften the concrete surface. Excess oil or lacquer should be wiped off. Oil should not be placed on construction joint surfaces or on steel reinforcement. Before forms are reused, they should be cleaned by wire brushing and, if necessary, be reconditioned. Metal forms should not be sandblasted or abraded to a bright surface. The Inspector should check each of the mentioned items prior to placing concrete or reinforcing steel.

9.2.1.3 Steel Reinforcement (Rebar)

The sizes of steel reinforcing bars (rebar) are designated by numbers ranging from 2 through 18. For rebar #2 through #9, the

numbers designate the diameters of the bars in 1/8 inch multiples. For example, a #3 rebar has a 3/8 inch nominal diameter. For rebar sizes larger than #9, the multiple is slightly higher. Nominal dimensions for rebar sizes are shown in Table 9.1:

Rebar Size	Nominal Diameter (Inches)
#3	0.375
#4	0.500
#5	0.625
#6	0.750
#7	0.875
#8	1.000
#9	1.128
#10	1.270
#11	1.410
#14	1.693
#18	2.257

Table 9.1. ASTM standard rebar sizes

Steel reinforcement should be checked for the following:

- Grade 60 bars (60,000 psi minimum yield strength).
- Correct size.
- Bending (bars should be cold bent).
- Correct spacing within a 1/2 inch tolerance.
- Correct location within a 1/4 inch tolerance.
- Proper support with wire, chairs, or concrete blocks.
- Surface free of loose rust or scale.
- Proper splices as shown on the plans.
- Wire mesh used only in driveways.

Installation of rebar for manhole base

9.2.2 During PCC Placement

A batch ticket showing the date, time, plant designation, mix designation, batch size, material quantities per batch, and aggregate moisture values used to calculate aggregate quantities

shall accompany each load and be made available to the Inspector. The Inspector should ensure the following:

- The total time between batching and final placement should not exceed 30 minutes with continuous mixing in the truck agitator. On continuous concrete pours, the elapsed time between the placement of subsequent batches of concrete should not exceed 20 minutes.
- The concrete should be conveyed from the mixer to the forms or subgrade as fast as possible by methods that prevent segregation or loss of the ingredients. Concrete free fall distance shall not exceed 5 feet. This includes free fall in a discharge pipe when using a conveyor system for placement. Pumped concrete is not considered in free fall until the concrete exits the pumper hose.
- Concrete placement should be restricted to the amount that can be properly consolidated and finished at one time.
- The concrete should be deposited as closely as possible to its final position. The concrete should not be moved laterally by vibrators and re-handling should be minimized.
- Vibration should be supplemented by hand spading on the exposed faces along the forms. Too much vibration may cause segregation and bleeding. Too little vibration may cause poor consolidation and honeycombing.
- Vibrators should not distort the forms. Forms should be checked regularly during concrete placement to be sure that they have not moved and that wedges, ties, and bracings have not loosened or failed.
- Concrete should be placed in continuous horizontal layers of 12 inches or less.
- If placement is interrupted long enough for initial hardening to take place, a construction joint must be formed.
- All concrete should be placed so that the top surface is level with the forms.
- Finishing should be done after the concrete has slightly hardened so that fines and water will not work to the surface. Finishing too early can result in fine surface cracks and reduced surface durability. Finishing may not be possible if the concrete is allowed to harden too much.

- Overworking the concrete before initial set tends to concentrate water and fines at the surface and cause fine hairline cracking, dusting, and poor surface durability. Cracking also can result from rapid drying or cooling of the concrete surface.
- It is illegal to wash concrete into the storm drain system. If the Inspector observes this practice, it must be stopped immediately and any concrete that is deposited into the storm drain must be removed. Inspector shall report any instances of this to the PM.

9.2.2.1 Concrete Sampling and Testing

The Inspector or lab technician should record the following information on the Daily Activity Report. This information may be obtained from the supplier's batch ticket:

- Time of arrival.
- Time of placement.
- Location of placement.
- Contact number.
- Test results (if taken).

Testing normally consists of the following:

- **Slump tests** – determines the consistency of the concrete and indicates the amount of water used in the mix. High slumps indicate a high water/cement ratio and generally result in low strength. Typical slumps range from 3 to 6 inches.
- **Air content tests** – determines the amount of entrained air in a concrete mix. Too much air in the concrete reduces the strength. Too little air means the concrete will be susceptible to free/thaw damage. Typical air content ranges from 4 to 7%.

Typical concrete testing equipment

- **Concrete test cylinders** – are cast in order to determine the strength of the concrete. Cylinders are typically made in molds 6 inches in diameter and 12 inches in height. The cylinders should be moved to the testing lab after 24 hours of proper curing.

9.2.2.2 Concrete Placement in Hot Weather

When the weather is hot and the temperature of the concrete mixture approaches 90 degrees, special measures are needed to obtain high-quality concrete. Wind and low humidity increase the problem. High temperatures can cause the following:

- Rapid evaporation of the mixing water.
- Reduction in slump and workability.
- Shrinkage cracks.
- Excessive volume change.
- Rapid hydration.
- Early setting.

These problems will reduce the strength of the concrete and cause difficulty in finishing. During placement of concrete in hot weather, the Inspector should check for the following:

- Subgrade should be sprayed with water to prevent shrinkage cracks since the subgrade will draw water out of the concrete as it sets up.
- The work area should be limited to the necessary labor force.
- If possible, concrete should be placed in early morning or late evening.
- Placement should be avoided on extremely hot, dry, or windy days.
- Windbreaks, shade, and application of water through a fog nozzle or blanket should be used.
- Curing compound should be applied immediately after finishing.
- When curing with wet burlap, make sure concrete remains covered and burlap kept wet.

9.2.2.3 Concrete Placement in Cold Weather

Concrete shall not be placed in inclement weather except with permission of the PM. The air temperature for placing concrete shall be 35°F and rising. No concrete shall be placed on frozen sub-grade. When air temperatures can be anticipated below 35°F, the concrete shall be preheated such that the temperature of the fresh concrete in place is a minimum 55°F and be maintained for 72 hours at a minimum of 50°F with adequate layers of burlap, plastic, insulated blankets, or other approved materials. Concrete construction during cold weather shall be continued only with the specific authorization of the PM, who may require special construction methods.

The Inspector should ensure that the following points are observed during placement in cold weather:

- Concrete should not be placed on frozen subgrade.
- All snow and ice must be removed from forms, subgrade, and reinforcing steel.
- Concrete temperature must be 55°F or above during placement.
- Concrete must be covered with curing blankets or other approved materials.

9.2.3 After PCC Placement

9.2.3.1 Construction Joints

Joints are installed in concrete structures to control the locations of cracking, to permit movements between sections of the structure (expansion joints), to help in the building of forms and the placing of concrete and reinforcing steel, and to provide breaks in concrete placement operations. The length between joints typically does not exceed 20 feet. Construction joints should be installed whenever pouring is stopped for 30 minutes or more.

Freshly poured concrete

Joints should be checked for the following:

- The joints should be at the correct location.

- The concrete should be well consolidated at the joint.
- Construction keys should be the correct size.
- If required, waterstops and dowels should be in the correct place.
- All joints should be installed within their required time after pavement completion.

For more information on concrete pavement joints, see LSP 620, 630, 660, 662 and 670.

9.2.3.2 Form Removal

The structure location, anticipated loads, weather, and other factors affecting the hardening of the concrete should be considered when determining the time to remove forms. Forms shall be removed no earlier than 12 hours after pouring.

9.2.3.3 Surface Repairs

Surface repairs should be made using a mortar or grout made of one part cement and two parts sand. When repairing defects or applying special finishes, concrete surfaces should be clean and thoroughly wetted. After the voids are filled, excess mortar on the concrete should be removed. The repaired areas should be kept moist for a few hours to allow the mortar to set before applying a curing compound. The Inspector should verify that the additional PCC is not too high for traffic to cross safely and will not cause damage to vehicles.

9.2.3.4 Curing

Curing prevents loss of moisture from concrete during the "rapid" stage of hydration. General methods for curing concrete are:

- Applying curing compounds to the surface. All curing compounds shall be NDOR approved.
- Covering the surface with wet burlaps.

Under most conditions, a curing compound will seal the surface and allow the concrete to retain enough moisture for hydration. A white-pigmented compound works well because it reflects sunlight and can be easily checked for uniform coverage. The Inspector should check for the following:

- Curing compound should be applied to exposed, unformed surfaces as soon as the finish is completed and the surface water has disappeared.
- Formed surfaces must be coated immediately after the forms are removed and surface repairs are completed.
- Areas to be repaired must be kept continuously moist until the repair is completed and extended curing is applied.

9.2.3.5 Curb and Gutter

Any curb and gutter removed shall be replaced as shown in the plans. For more information on curb and gutter, see LSP 651.

9.3 ASPHALTIC CONCRETE

Asphaltic concrete, or asphalt, is used as an alternative to PCC, and is typically used for larger pavement restoration projects. Asphalt consists of a base material, binder course, surface course, and tack coats when necessary. There are two main types of asphalt: Class 1 and Class 2. Class 1 consists of a 2-1/2 inch thick asphalt surface course on top of a PCC base. Class 2 consists of an asphaltic concrete base and surface course.

9.3.1 Prior to Asphalt Placement

Prior to asphalt placement, the Inspector should verify the following:

- All asphalt mixes must conform to Chapter 5 and 12 of the specifications. It is important these be reviewed by the Inspector prior to asphalt placement to gain general knowledge about the required properties of the mixes.
- The excavation should be level within 1/4 inch when checked with a 10 foot straightedge.
- Soft soils should be undercut to firm material and backfilled with suitable material.
- Excavated surfaces against which concrete is to be placed should be clean and moist to prevent concrete from drying faster than anticipated.
- The surfaces should be free of frost, ice, and mud.
- The excavation should not be under water.
- Cutbacks must be at least 12 inches from the undisturbed subgrade on each side of the trench.

- Cuts in the pavement should be straight lines so that joints between existing and new pavement will be smooth and continuous.
- When a single set of saw cuts is required, the recommended distance to the saw cut lines should be at least 12 inches from the undisturbed subgrade on each side of the trench. Any broken edges must be cut a second time.
- If the saw cuts in concrete pavement are within 4 feet of a formed joint, it is recommended that the existing slab should be broken and removed to the joint.
- All pavement cutting should extend to the subgrade and the affected area should be completely excavated.
- All manholes, valve boxes, and stormwater inlets must be adjusted to the proper elevations.
- All survey center line monuments must be preserved and adjusted to grade.

9.3.2 During Asphalt Placement

All asphalt mixes should be checked prior to placement. Most projects are small and require only observing the asphalt mix before placement. On larger jobs, a testing agency typically provides paving verification that may include field density tests, extraction tests, and sieve analyses. This section will discuss only the small projects that require observation prior to placement. The following may indicate a poor quality asphalt mix:

Asphalt placement

- Stiff appearance or improper coating of the larger aggregate particles - a mixture that is too cold.
- Mix slumped in truck – mix may contain too much asphalt.
- Lean, brown, or dull appearance – mix may contain too little asphalt.
- Unsatisfactory compaction under the roller – mix may contain too little asphalt.

- Rising steam – excess moisture.
- Blue smoke rising from mix – overheated mix.
- Bubbling and popping – overheated mix.
- Segregation of aggregates – mix may have been handled improperly. To avoid segregation, the asphalt mix should be spread uniformly with a paver or carefully shoveled if hand spreading.
- Raveling at the edges – mix too cold.

The Inspector should inform the Contractor immediately if the Inspector determines that an asphalt mix is inadequate. If the Contractor does not take steps to correct the mix, the Inspector may reject the mix as a last alternative. Asphalt should not be placed when the ambient temperature is expected to fall below 35°F. Asphalt should not be placed on a wet, frosted, or frozen surface. The minimum temperatures are shown below:

Lift Thickness	Minimum Surface Temp (°F)
Less than 2 inches	45
2 to 3 inches	37
Greater than 3 inches	35

9.3.2.1 Asphalt Compaction

When checking compaction of asphalt, the Inspector should verify the following:

- The initial pass should be made as soon as possible to roll the mixture without cracking the mat or having the mix picked up on the roller wheels.
- The initial pass should include rolling longitudinal joints.
- The second, or intermediate, rolling should follow the initial rolling as closely as possible and should be done while the paving mix is still at a temperature that will result in maximum density.
- The finish rolling should be done while the material is still workable enough for removal of roller marks.

- Any asphalt displaced by the roller should be loosened with a rake and restored to original grade with loose material before re-rolling.
- Rolling should be done carefully to avoid roughening the pavement surface.
- Roller wheels should be kept moist during compaction with only enough water to prevent the wheels from picking up the asphalt mixture.
- Rollers should move at a slow, uniform speed generally with the drive roller or wheels nearest the paver.
- A test sample and a core sample have been taken to ensure compaction has been achieved. Contractor should also take samples.
- The line of rolling should not be suddenly changed and the direction of the roller should not be suddenly reversed.

9.3.2.2 Placement of Base Material (Class 2 Asphalt)

The base course should consist of compacted, dense-graded aggregate as indicated in the plans. The Inspector should verify the following:

- Base material should be mixed with water in a pug mill prior to arrival on site.
- Moisture content should be between 5% and 7% for ideal compaction.
- Lifts should be 3 to 6 inches thick.
- Base material should be compacted using a vibratory roller or plate compactor.
- Base material should be placed level and at the correct thickness as indicated in the plans.

9.3.2.3 Placement of Binder Course

A binder course is an intermediate asphalt course placed between a base course and an asphalt surface course. Binder courses generally consist of coarse-graded aggregate and asphalt. The Inspector shall verify the type and thickness of the mix used for binder material to ensure it matches that indicated in the plans. Generally, a 2 to 4 inch thick binder course is required.

Prior to construction of the bituminous concrete binder, the Contractor must submit a job-mix formula for both the bituminous concrete binder and surface courses unless a pre-approved source is being used. Although a Contractor may use a pre-approved source, a submittal or notification is still required. A submittal should be required for each project. The Inspector should ensure that the procedure below is followed when the binder course is placed:

- Pavement repair by patching-
  - The base course should be removed to a sufficient depth to allow the placement of both the binder and the surface course.
  - The binder course should be placed and compacted to the required thickness, allowing sufficient depth for the surface course to be placed level with the existing pavement.
- Pavement repair by resurfacing entire road-
  - The base should be removed to the depth of the binder course.
  - The binder course should be placed and compacted so that it is level with the existing pavement.

9.3.2.4 Placement of Surface Course

The surface course represents the top portion of the asphalt pavement. The Inspector shall verify the type and thickness of the surface course to ensure it matches that indicated in the plans. A job-mix formula or pre-approved source also needs to be submitted by the Contractor for the surface course. The Inspector should ensure that the following procedure is followed when a surface course is placed:

- Pavement repair by patching-
  - The area to receive asphalt should be cleaned and treated with a tack coat. For more information on tack coats, see Section 9.3.5.
  - The surface course should be placed and compacted to 2-1/2 inches thick so that the top of the surface course is level with the existing pavement. A smooth transition should occur between the existing pavement and the pavement patch.

  - After the surface course is placed, the perimeter of the patched area should be sealed with an approved sealer compound.
  - Surface course should be level to within 1/4 inch when checked with a 10 foot straightedge.
- Pavement repair by resurfacing entire road-
  - The area to be paved should be cleaned by sweeping and/or hosing with water.
  - The area to receive asphalt should be cleaned and treated with a tack coat. For more information on tack coats, see Section 9.3.5.
  - The surface course should be placed and compacted to 2-1/2 inches thick.
  - Surface course should be level to within 1/4 inch when checked with a 10 foot straightedge.

9.3.2.5 Tack Coats

The tack coats increase the bond between the old and new surfaces. The use of tack coat is important to the durability of pavement. The Inspector should look for the following:

- The tack coat should be applied well before the asphalt to allow all water to evaporate before the surface course is placed. This chemical process is termed “breaking” or “setting.” This can be detected when its color changes to dark brown within a short time after application. The exact length of time depends on the temperature of the air and pavement.
- No more tack coat than is necessary for the day’s operation should be placed. Traffic and weather conditions may limit the distance that tack can be placed ahead of the asphalt.
- The rate of application should generally be from 0.05 to 0.2 gallons per square yard.

9.3.3 After Asphalt Placement

The Inspector should verify the following:

- Temporary ramps are provided where necessary for traffic to use.

- The finished surface of the surface course should not deviate by more than 1/8 inch over a 10 foot length in the direction of paving.
- The cross slope of all courses should not deviate by more than 1/4 inch over a 5 foot length.
- If there is an abrupt drop-off at the shoulder after placing the surface course, additional asphalt should be placed to provide a smooth transition.
- The surface course should be tapered at driveways, sidewalks, and entrances to a feather-edge at the edge of the pavement.
- Grades should be checked for positive drainage. Any valley gutters in intersections must be replaced.
- Driveway aprons may need to be resurfaced as a transition to the new construction.

Finished asphalt

9.4 PAVEMENT RESTORATION CONSTRUCTION CHECKLIST

9.4.1 Prior to PCC Placement

- Are all areas that are to receive concrete cut back properly in straight lines so that all joints between existing and new pavement will be smooth and continuous? Are cuts at least 12 inches back from the trench edges?
- Are all areas that are to receive concrete excavated down to the subgrade soil?
- Have all manholes and stormwater inlets been adjusted to the proper elevations?
- Is the concrete subgrade free from frost, ice, mud, water, or loose material?
- Is the concrete subgrade firm? Have any soft areas encountered been removed and backfilled?
- Are form locations, alignments, and dimensions correct?
- Are forms mortar-tight and strong enough to withstand concrete placement?

- Are form surfaces clean, smooth, oiled, and free from holes and blemishes?
- Are embedded items properly placed?
- Is steel reinforcement the correct grade and size, firmly installed, and bent, spaced, and located properly?
- Is steel reinforcement free from coatings such as rust, paint, oil, grease, mud, and dried mortar?
- Are splices and laps properly constructed as indicated in the plans?
- Are all unapproved objects removed from the forms prior to placing concrete?
- If a testing agency is required, has it been notified at least 1 day in advance?
- Do the locations and types of joints conform to the plans?
- Are keys formed in all joints?
- Are concrete joint surfaces properly cleaned prior to placing new concrete?
- Are waterstops and dowel bars placed as indicated in the plans?

9.4.2 During PCC Placement

- Is the appropriate type of concrete being used for the project?
- If required, has the concrete been sampled and tested?
- Has a copy of the concrete delivery ticket been obtained when the ready-mix truck arrives at the job? The following items should be noted on the ticket:
  - Time batched (should already be on ticket).
  - Time of arrival on site.
  - Time of placement.
  - Location of pour.
  - Project number.
  - Test results (if taken).
- Is the concrete placed within 90 minutes of batching? For continuous pours, is the elapsed time between the placement of subsequent batches 20 minutes or less?
- If no testing is required, are the slump and temperature of the concrete within the appropriate ranges?

- Is the concrete being placed and vibrated properly?
- If the concrete is to be placed in hot or cold weather, has special protection been provided?

9.4.3 After PCC Placement

- Has the concrete gained sufficient strength prior to removing forms?
- Are defects such as small rock or air pockets, tie holes, ridges, bulges, and fins being treated properly?
- Is excess mortar being removed from the concrete after the repair of defects?
- Is an appropriate curing method being used? Is the curing method applied as soon as possible, after the finishing is complete and all surface water on the face of the concrete has disappeared?
- Are formed surfaces being cured after removal of the forms?
- Have all concrete test cylinders set for at least 24 hours prior to being delivered to the testing laboratory?

9.4.4 Prior to Asphalt Placement

- Are all areas that are to receive asphalt cut back properly in straight lines so that all joints between existing and new pavement will be smooth and continuous? Are cuts at least 12 inches back from the trench edges?
- Are all areas that are to receive asphalt excavated down to the subgrade soil?
- Have all manholes and stormwater inlets been adjusted to the proper elevations? Is inlet throat opening adequate?
- Is the concrete subgrade free from frost, ice, mud, water, or loose material?
- Is the concrete subgrade firm? Have any soft areas encountered been removed and backfilled?
- Is it warm enough to place asphalt?

9.4.5 During Asphalt Placement

- Is the base course being properly placed and compacted in required lift and total thickness? Is a vibratory roller or vibratory plate being used to compact the base?

- Is the base material at the proper moisture content during placement and compaction?
- Is the Contractor using approved base material and asphalt? If not, has the Contractor submitted the necessary data for approval?
- Prior to placing the surface course, have all areas to receive pavement been cleaned (by hosing and sweeping, if necessary) and treated with a tack coat?
- Is a sufficient tack coat layer applied?
- Is the binder course of the correct material, thickness, compaction, and level? Does all asphalt mix delivered to the site appear to be acceptable with respect to color, texture, asphalt content, temperature, etc.?
- Is the asphalt mix rolled properly, so that it is compacted to the required density and thickness?

9.4.6 After Asphalt Placement

- Is the finished surface level? Have smooth transition been incorporated near abrupt drop-offs on shoulders?

CHAPTER 10: ENVIRONMENTAL ISSUES & COOPERATION

10.1 CONTACTS & LINKS

- Soil Erosion and Sediment Control - General (PW&U Watershed Division):
  - Contact: Gary Lacy, Senior Engineering Specialist
  - Cell: (402) 430-9716
  - E-mail: glacy@lincoln.ne.gov
  - Website: http://lincoln.ne.gov/city/pworks/watrshed/require/erosion/index.htm
    - *Lincoln Design Standards – Erosion and Sediment Control Webpage*: http://lincoln.ne.gov/city/attorn/designs/ds205.pdf
    - *Design Criteria Manual – Erosion and Sediment Control Website*: http://lincoln.ne.gov/city/pworks/watrshed/require/drainage/pdf/chapt9.pdf
- Floodplains - General (PW&U Watershed Division):
  - Contacts: Devin Biesecker, Engineer / Edwin Kouma, Engineer
  - Phone: (402) 441-4955 / (402) 441-7018
  - E-mail: dbiesecker@lincoln.ne.gov / ekouma@lincoln.ne.gov
  - Website: http://lincoln.ne.gov/city/pworks/watrshed/require/standard/index.htm
    - *Lincoln Floods and Floodplain Webpage (Administered by Building & Safety Department)*: http://lincoln.ne.gov/city/build/flood/index.htm
    - *Lincoln Floodplain Standards Webpage*: http://lincoln.ne.gov/city/pworks/watrshed/require/standard/index.htm
    - *Lincoln Design Standards – Ch. 10-Flood Design Criteria Webpage*:

http://lincoln.ne.gov/city/pworks/watrshed/require/drainage/pdf/chap10.pdf

- Wetlands - General (PW&U Watershed Division):
  - Contact: Ben Higgins, Senior Engineer
  - Phone: (402) 441-7589
  - E-mail: bhiggins@lincoln.ne.gov
  - Website: http://lincoln.ne.gov/city/pworks/watrshed/require/erosion/index.htm
    - *Lincoln Stormwater Wetland BMP Guideline Webpage*: http://lincoln.ne.gov/city/pworks/watrshed/educate/bmpguide/pdf/3.19.pdf
    - *Guide to Nebraska Wetlands Webpage*: http://www.ngpc.state.ne.us/wildlife/programs/wetlands/wetlandsguide.pdf
    - *Saline Wetlands Information(Lincoln Area) Webpage*: http://www.lincoln.ne.gov/city/parks/parksfacilities/wetlands/wetlandspartnership.htm
- Environmental Issues & Illicit Discharges - General (Lincoln Lancaster County Health Dept.):
  - Phone: (402) 441-8000 (General number)
  - Phone: (402) 441-8040 (Spill response center)
  - Website: http://lincoln.ne.gov/city/health/index.htm
    - *City Illicit Discharge Summary Page Website*: http://lincoln.ne.gov/city/pworks/watrshed/require/discharg/index.htm

10.2 OVERVIEW

This chapter discusses appropriate ways to respond to non-compliance violations, which are violations of PW&U approved construction plans, sediment and erosion control requirements, floodplain ordinances, wetlands regulations, and other environmental requirements including illicit discharges. In general, the City is responsible for obtaining USACE 404 permits and NDEQ permits, while the Contractor (or Developer) is

responsible for all other permits. Each of these issues will be discussed in greater detail later in this chapter.

10.3 ROLES & RESPONSIBILITIES

10.3.1 Observation & Site Visits

A common theme throughout this guide is the role of the Inspector to serve as the onsite owner representative observing quality and quantity aspects of PW&U construction projects. Although most of the information presented speaks to onsite observations and activities for assigned projects, the Inspector also has the responsibility to be on the lookout for environmental issues on any City projects or property and report issues to the appropriate contact. Because the Inspector is often in the field or en route to/from a site, there is ample opportunity to serve as the eyes and ears of PW&U. This activity is not intended to add to the workload of the Inspector, but rather to take advantage of travel time to and from a site.

Inspector observing manhole installation

A preliminary site visit and subsequent frequent site visits provide the best opportunity to monitor quality, material quantities, and compliance with safety, traffic control, and accessibility as well as identify environmental issues. An Inspector should take photos and videos, create drawings and maps, and make any measurements necessary to document violations. Inspectors must coordinate schedules with Contractors to ensure he or she is onsite for important milestone activities. The Inspector must also allow some flexibility in his or her schedule and a willingness to change plans at a moment’s notice as construction schedules are dependent upon so many uncontrollable factors such as weather, availability, and contractual issues. A final site visit is also important to ensure all project components have been completed to required

specifications. Generally, the Inspector will conduct a final walkthrough with the PM, Consultant, or other stakeholders.

10.3.2 Reporting, Documentation

The Inspector plays a key part in reporting environmental issues and documenting corrective actions. Forms, report templates, and checklists are available to assist the Inspector in this process. If an environmental issue or problem is observed on a site or project not assigned to them, the Inspector should contact his/her PM/Supervisor. When an environmental issue or problem requiring action occurs on an assigned project, the following process should be followed:

Inspectors can assist by identifying issues

- **Discussion with Contractor** – The first step in the process is to bring the situation to the attention of the Contractor and have a discussion of corrective action steps. Unless it is an obvious egregious situation, the Contractor may not be aware of the problem or may be aware and already working to rectify the situation. Details of any conversations or other interactions should be recorded in the Inspector's Daily Activity Report.
- **Contact Watershed Management or Appropriate Division** – The Inspector should contact the appropriate PW&U Division to ensure everyone is notified of issues and to clarify whether or not the Contractor has already been notified or agreed to correct any problems.
- **Contractor Notification Form** –Following the discussion with the Contractor and after an appropriate period of time to make corrections, the Inspector would fill out this form if there has been no obvious effort to correct the situation. For more information on filling out this form, see Chapter 3.
- **Identification & Corrective Actions** – Specific corrective actions may be required if the Contractor does not respond to

requests to address issues or violations. In most instances, the Inspector would not be responsible for specific actions, but may have a role in making periodic site visits and documenting progress of corrective actions in the Daily Activity Report.

- **Development Code Violations** – Development code violations differ from environmental violations in the procedures to document and report. The Inspector may or may not be involved with these types of issues. If new construction or construction on an existing structure is found without an approved Plan or not according to the approved Plan, the Inspector should follow these steps:
  - Document the violation in the Daily Activity Report and contact the PM.
  - Try to negotiate compliance before proceeding with corrective action steps. Negotiated compliance may be used if:
    - If construction is occurring without an approved Plan, the Inspector should contact their PM or other designated party such as an EO.
    - The approved Plan has not been followed.
    - Site conditions have changed so that the approved Plan cannot be followed. Design modifications may be required. The responsible party is allowed 48 hours to begin making changes or to submit a new Plan.
  - If the responsible party does not respond to the negotiated compliance within 48 hours, the Inspector should complete and submit a Contractor Notification Form.
  - If the responsible party does not respond to the Contractor Notification Form within 48 hours of getting the notice, the Inspector should note this on the Contractor Notification Form and contact the EO or PM for corrective actions, if required.

Specific types of environmental issues may have additional reporting and regulatory requirements. Refer to Section 10.4 and specific subsections for more details.

10.4 SPECIFIC ISSUES

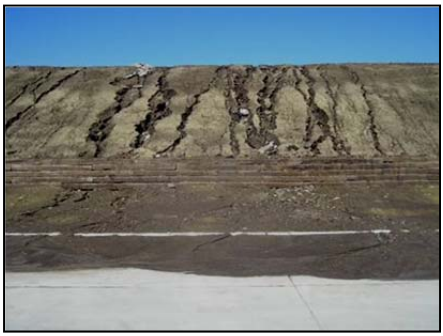
The following subsections describe four common environmental issues that the Inspector may be required to address when working on a PW&U project:

- Stormwater Pollution Prevention Plan (SWPPP).
- Floodplains.
- Wetlands.
- Illicit discharges.

10.4.1 Soil Erosion and Sediment Control

Stormwater runoff from construction sites represents a significant source of water pollution. Sediment in the runoff from construction sites may contain excessive amounts of harmful contaminants that can negatively impact aquatic habitats and cause other environmental problems. Environmental damage caused by construction-related erosion and sedimentation is often extensive and repairing the damage can be costly and time-consuming. By carefully monitoring a construction site, an Inspector can help prevent or minimize environmental damage by ensuring Contractors follow their approved Stormwater Pollution Prevention Plans (SWPPPs) and identifying problems.

10.4.1.1 Stormwater Pollution Prevention Plan (SWPPP)



Erosion and sedimentation due to poor controls and practices

The Federal Clean Water Act as administered by the Environmental Protection Agency (EPA) mandates that the City have a program in place to control erosion and sedimentation from construction sites. Teaming with the Lower Platte South Natural Resources District (LPSNRD), the City administers a program that requires a Notice of Intent (NOI) permit that includes a Stormwater Pollution Prevention Plan (SWPPP). A copy of the SWPPP along with updated plans must be kept onsite at all times. If not onsite, the location shall be posted on a notice

near the entrance or trailer stating the location of the SWPPP with a name and phone number. The SWPPP must be available within a reasonable amount of time.

Prior to construction on sites of 1 acre and greater, a permit application must be submitted to the LPSNRD (on behalf of the City) in the form of a NOI. Sites greater than 5 acres are also required to submit the NOI to the Nebraska Department of Environmental Quality (NDEQ) for approval. The NOI must include a SWPPP. The SWPPP must contain Best Management Practices (BMPs) that will be implemented to address erosion, sedimentation, and pollutants. The Inspector should review the SWPPP and all BMPs to ensure that they are installed and properly maintained during the project.

10.4.1.2 Best Management Practices (BMPs)

Construction projects generate large amounts of waste materials that can end up polluting stormwater and consequently streams and lakes, if not properly managed. The suite of BMPs used on a site must include pollution prevention measures for a wide array of materials and wastes. Selection of BMPs depends on conditions at the site and on regulations that must be met, but all BMPs to be used need to be approved and documented in the SWPPP prior to construction start.

Properly installed storm drain inlet snake

Per City ordinance, there are five guiding principles to assist the Consultant (or Developer for PCA projects) in creation of an effective pollution prevention plan that will include appropriate erosion and sediment control BMPs. It is important that an Inspector have an understanding of these to identify violations. The five principles include:

1. Providing for waste management.
2. Establishing proper building material handling and staging areas.
3. Designating washout areas.
4. Establishing proper equipment/vehicle fueling and maintenance practices.
5. Developing a spill prevention and response plan.

BMP specifics including descriptions, selection, design, and proper installation can be found in the City's Drainage Criteria Manual (Chapter 9, pp. 9-5 through 9-82). Examples of recommended BMPs include: silt fences on small sites; construction entrance rocking laid on top of erosion control fabric; inlet protection; concrete truck washout areas; slope protection; temporary seeding; and compost socks. The Inspector should be familiar with the installation and maintenance procedures for the approved BMPs. If the Inspector has questions about BMPs, the PM should be contacted or the Drainage Criteria Manual consulted.

Silt fence installed and operating correctly

Any major changes regarding the SWPPP made prior to or during construction must be approved by appropriate authorities through the NOI process. Major changes would include removing or modifying approved BMPs, or changing the project specifications. The Inspector may be allowed to make minor changes, with the approval of Watershed Management, to the SWPPP such as changing the location of BMP or adding additional pollution prevention controls already specified in the SWPPP or approved plan. The Inspector should consult with the PM to determine this authority prior to commencement of construction. In addition, if the controls are not working, the contractor should be required to make changes to the sediment control plan.

10.4.1.3 Identification & Corrective Actions

The Contractor will be responsible for designating "qualified personnel" to perform regular erosion and sediment control self-inspections. Qualified personnel are those persons who possess the necessary skills to assess conditions at the site and effectiveness of control measures. Often, this is delegated to a subcontractor. For this reason, serving as the PW&U representative (in Inspector role) is vital to ensuring erosion and sediment control measures are implemented and work effectively. All observations onsite or at other PW&U projects should be properly documented in the Daily Activity Report and discussed with the PM or appropriate contact. Local ordinances require that reports for inspections be kept onsite at all times along with a signed copy of the SWPPP.

PW&U wants to be a good steward of the environment and accountable to the public, many of whom watch what is happening particularly in their neighborhoods.

Sediment can end up in stormwater pipes

10.4.1.4 Roles & Responsibilities

The Inspector may be responsible for capital improvement projects (CIP) and private construction agreement (PCA) projects. The Inspector's erosion and sediment control role is the same for both types of projects. The frequency of observations may differ according to the type of project, site conditions, municipal ordinances, or external agency requirements. At a minimum, the Inspector should conduct a preliminary site visit, check all BMPs after a qualifying storm event, make periodic site visits as construction progresses (rule of thumb – every 14 days minimum), and make a final site visit following construction. An Inspector has the following specific responsibilities:

- Become familiar with the approved SWPPP, the BMPs to be used, and the sequence of construction activities necessary for

compliance with the approved plan. Discuss issues with the PM including any authorities explicitly granted to make changes.

- Make a preliminary site visit to note existing site conditions and areas adjacent to and downstream from the construction site including installed and proposed BMPs. This will help the Inspector identify any problems or violations that might occur because of inadequate control measures.
- Attend a pre-construction meeting with the Contractor to identify any areas of concern.
- Thoroughly check all land-disturbing activities for compliance with the approved SWPPP. Site visits should determine whether or not the Contractor:
  - Has copy of required permits, SWPPP, and self-inspection forms posted onsite as required.
  - Has installed BMPs in the proper location according to the SWPPP.
  - Has installed BMPs following the plans and specifications.
  - Is staying within the limits of soil disturbance specified in the SWPPP.
  - Is protecting trees, vegetation, and sensitive areas (green space, streams, wetlands, sinkholes, etc.) as shown on the plans.
  - Is stabilizing inactive construction areas.
  - Is maintaining stabilized construction entrances properly and is cleaning up soil, mud, debris, or dust that has been tracked onto public right-of-ways and public roadways from the construction site.
  - Has not damaged or infringed upon adjacent private property.
- Keep records of all site visits. Observations should be noted on the Daily Activity Report. Watershed Management should be notified of any non-compliance with the SWPPP. If action is required, a Contractor Notification Form may need to be filled out and submitted (For more information, see Chapter 3).
- Review records of all observations, repairs, and changes made by the Contractor during the project on a “Quality Assurance” (QA) basis.

- Make final site visit to ensure all residual erosion and sediment controls are still in place, unnecessary measures removed, site has been cleaned up, and no damage has occurred.
- Check for erosion and sediment control problems or violations on other PW&U project sites and City-owned properties while travelling to and from project sites. The Inspector should document any issues and contact the PM or other department contact.

The Inspector should pay particular special attention to these aspects of a project:

- BMPs must be installed correctly, work properly, and not be damaged. Damaged BMP components should be repaired or replaced immediately by the Contractor. The Inspector should fill out and submit a Contractor Notification Form to the Contractor following consultation with the PM. Maintenance requirements should be outlined for each BMP in the Design Criteria Manual and in the plans. The approved SWPPP may require additional maintenance procedures. As a general rule, sediment should never be allowed to exceed half the height of the structure.

Example of a poorly installed BMP

- The sequence of construction as described in the SWPPP must be followed. This is particularly important in regard to limiting the amount of time that the soil surface is exposed to erosion.
- The Inspector should look for siltation in areas down gradient or downstream from installed BMP. This includes checking ditches, streets, and streams for sedimentation obviously caused by the construction site. If the BMPs are not preventing erosion or sedimentation, the Inspector should check whether they were installed and maintained according to the approved SWPPP. If the BMPs were installed and maintained correctly, the Inspector should notify the PM and determine a course of action.

As mentioned, the Contractor will be responsible for designating qualified personnel to perform regular erosion and sediment control self-inspections. The Inspector should discuss the SWPPP responsibilities with the PM to ensure all responsibilities between the Contractor and Inspector are met. These self-inspections must be performed and comply with the following provisions:

- Minimum periodic inspection frequency of once every seven calendar days.
- Inspection required within 24 hours of any storm event that produces a half-inch or more of precipitation.
- All necessary repairs or cleanup to maintain effectiveness of the BMPs be made prior to the next storm event and documented in the SWPPP unless unusual conditions such as weather or complex repairs require a longer timeframe.
- Reasons for noncompliance or substitution of alternative BMPs must also be documented.
- A copy of the SWPPP and all records of inspections, repairs, and modifications should be kept onsite throughout the duration of construction or land-disturbing activities.

SWPPP information properly posted onsite

Even though self-inspections are allowed for PCA projects, the Inspector still has important responsibilities to check soil erosion and sediment control practices. This includes ensuring that the Contractor's (or Developer's) onsite designated representative for self-inspections understands provisions of the SWPPP. This designated representative then has the responsibility to meet all SWPPP inspection requirements including frequency of inspections, storm event inspection triggers and timelines, repair/maintenance schedules, and reporting requirements. The pre-construction is a great opportunity to meet with the onsite designated representative for self-inspections and review the approved SWPPP. The Inspector should also conduct a site visit

prior to construction to observe onsite and adjacent conditions, and review planned soil erosion and sediment control BMPs.

The Inspector should conduct quality assurance (QA) checks of the soil erosion and sediment control of private development projects at the following intervals:

- Minimum periodic site visits of once every 14 calendar days.
- Site visit within 24 hours of any storm event that produces a ½-inch or more of precipitation.
- Site visit within 48 hours of discovery of a control failure or violation.

10.4.1.5 Soil Erosion & Sediment Control Checklist

- Was a copy of the approved construction plans, permits, and notices acquired?
- Has a copy of the SWPPP been acquired and reviewed?
- Is a signed copy of the SWPPP onsite and reports available upon request?
- Have the BMPs been reviewed and are they used on the site in the proper sequence and configuration?
- Have the existing conditions down gradient and adjacent from the construction site been noted?
- Have photos of sensitive features identified in the SWPPP been taken?
- Are the BMPs correctly installed and in the right place? Are they working properly?
- Is the Contractor protecting trees, vegetation, and other sensitive areas?
- Are inactive construction areas properly stabilized?
- Is the construction entrance properly stabilized?
- Have all observations made during site visits on the Daily Activity Report been noted?
- Is the Contractor conducting self-inspections according to the minimum requirements? Is the SWPPP up to date with self-inspections?
- Is the Contractor properly maintaining each BMP structure such as removing sediment and fixing gaps?

- Have areas downstream or down gradient of the site such as in ditches, streets, streams, public ROW areas, adjacent properties been checked for siltation?
- Has a final site walkthrough been conducted to ensure all required BMPs are still in place, unnecessary structures/measures removed, site is cleaned up, and no obvious damage is observed?

10.4.2 Floodplain

Floodplains and floodways have special requirements

Any activity performed in the floodplain within the City jurisdictional boundary must have a Floodplain Development Permit prior to commencement. This includes grading, filling, residential construction, and commercial construction. The Lincoln Department of Building and Safety administers this program and reviews applications for a floodplain permit. Information regarding this program can be found at http://lincoln.ne.gov/city/build/flood/index.htm. Other required permits such as the NOI or 404 permits must also be submitted with the Floodplain Development Permit application for review.

Although the Lincoln Building and Safety Department has its own inspectors on staff, the Inspector may be asked to assist and help document site conditions, violations, or other important details. Because the Inspector is often onsite more frequently than other City representatives, it is important to have a basic understanding of floodplain requirements and be observant for violations or unusual circumstances.

10.4.2.1 Identification & Corrective Actions

Floodplain requirements and regulations can be complicated and require considerable technical expertise and knowledge in this particular area. Thus, the Inspector should coordinate with the Watershed Division of PW&U and the City Building and Safety Department to gain an understanding of what to look for in floodplain violations. The PM should inform the Inspector in discussions prior to construction if floodplain issues are

considerations in the project and whether a Floodplain Development Permit is required. The Inspector may also have an opportunity to discuss further with the Contractor at the pre-construction meeting and check to see if the permit has already been granted or the application has been submitted. The permit process can take up to several months to complete, so the process must begin much sooner than the pre-construction meeting to ensure timelines and schedules can be met.

The Inspector should be watchful for the following activities which may constitute a floodplain construction violation:

- Having no Floodplain Development Permit for known activities requiring a permit.
- Encroachment into a waterway, drainage channel, or a wetland.
- Pushing materials into the floodplain or floodway.
- Improper development of crossing over or through a stream, drainage channel, or wetland.
- Runoff or flooding of adjacent properties.
- Excessive sedimentation or erosion into body of water, channels, wetlands, or other offsite locations.
- Redirection of a stream or drainage channel.
- Ponded water not shown in the plans.
- Commencement of construction while permit is pending or under review.

If there is non-compliance with the City Floodplain Management Ordinances, the Inspector should take the following steps:

- Document the violation in the Daily Activity Report and contact the PM. The Inspector may be asked to consult with the PW&U Watershed Management Division and/or the Building and Safety Department. The Contractor will be contacted by the appropriate City representative.
- If the issue is not resolved after adequate time to correct, fill out and submit a Contractor Notification Form to notify the Contractor of the violation so the item may be corrected or the Contractor can obtain the necessary permits.

- If the responsible party does not respond to the Contractor Notification Form within 48 hours of getting the notice, the Inspector should note this on the Contractor Notification Form and contact the EO or PM for corrective actions, if required. Check with the PM to determine if there any additional enforcement reporting requirements such as an enforcement log.

10.4.2.2 Floodplain Checklist

- Is this construction project located in the 100-year floodplain as shown on the plans? If yes, does the Contractor have a Floodplain Permit or have the permit prior to of construction?
- Is the Contractor outside the limits of the 100-year floodplain if they are not allowed to work within it as shown on the plans?
- Has a copy of the approved construction plans, permits, and notices been acquired?
- Have the Floodplain Permit and its requirements been reviewed?
- Has a preliminary site visit been conducted, and has any floodplain-related issues been noted?
- Have existing conditions down gradient and adjacent from the construction site been noted?
- Have photos of floodplain features including any environmentally-sensitive features, waterways, wetlands, etc. been taken?
- Is the Contractor aware of requirements of the Floodplain Permit?
- Have follow-up visits been made to ensure Contractor is following all floodplain regulations?
- Have all observations made during site visits on the Daily Activity Report been noted?
- If violations are observed, has a Contractor Notification Form been completed? Did the Contractor comply? If not, has non-compliance been noted on the Contractor Notification Form and notified the PM or EO? Has the violation been addressed by the PM or EO?

- Has a final walkthrough been completed to ensure the site has been cleaned up and no adverse impacts are observed in waterways, wetlands, or on adjacent properties?

10.4.3 Wetlands

Wetlands

The U.S. Army Corps of Engineers (USACE) has primary regulatory responsibility for protection of wetlands through its 404 Permit process. This includes any encroachment into drainage channels or wetlands. When it is determined that a PW&U construction project may impact a wetland or other qualifying water body, the PW&U or Contractor may be required to apply for a 404 permit through the USACE. Because this process can take up to several months, applicants should begin the process well in advance of construction activities. Penalties and fines can be quite large for failure to apply for a permit or noncompliance with 404 Permit requirements.

The Inspector should have a general understanding of wetlands and how to identify when a wetland has been compromised or adversely impacted. The Inspector should also be familiar with any 404 Permits issued for a construction project site and requirements of that permit. Often states and municipalities have additional criteria and requirements related to wetlands. Check with the PM or the Watershed Division of PW&U for additional information.

There are three basic characteristics of wetlands. They include:

- **Vegetation** - The prevalence of hydric (water-loving) plants adapted to growing in inundated or saturated conditions.
- **Hydric soil** - The presence of soils that develop under inundated or saturated conditions that limit oxygen (anaerobic conditions).
- **Hydrology** - Inundation or saturation by water at some time during the growing season (the time when plants are actively growing).

Wetlands are highly dynamic and productive systems that can be impacted positively by natural process such as fire and wet/dry cycles and adversely by human-induced processes as permanent drainage, water diversion, sedimentation from erosion, and filling with soil, concrete, or trash. Many of these adverse impacts can result from poor construction site planning and management.

10.4.3.1 Identification & Corrective Actions

Because the Inspector must ensure that any required 404 Permits have been obtained prior to commencement of construction, he/she should become familiar with specific requirements outlined in the 404 Permit. Obvious violations would include filling in or relocation of a wetland area without permissions granted via the 404 Permit. Less obvious issues may concern diversion of drainage that feeds a bog or excessive sedimentation into a marshy area. Careful observation and documentation during a pre-construction site visit will provide an opportunity to observe site conditions, take baseline photos, and locate areas identified in the 404 Permit. Consultation with the PM and discussion with the Contractor at the pre-construction meeting are additional opportunities to review wetland issues before construction begins.

If there is a violation of the 404 Permit, the required permit has not been obtained prior to construction, or other wetland-related issues are observed, the Inspector should take the following steps:

- Document the issue in the Daily Activity Report and contact the PM immediately. Generally, the PM will handle contact with the USACE, if necessary. The Inspector may be asked to verbally notify the Contractor and discuss the issue.
- If the issue is not addressed in a timely manner following a verbal discussion, the Inspector may need to fill out and submit a Contractor Notification Form to the Contractor so the item can be corrected or the Contractor can obtain the necessary permits.
- If the responsible party does not respond to the Contractor Notification Form within 48 hours of getting the notice, the Inspector should note this on the Contractor Notification Form and contact the EO or PM for corrective actions, if required. Check with the PM to determine if there any additional

enforcement reporting requirements such as an enforcement log or federal requirements.

10.4.3.2 Wetland Checklist

- Are there wetlands at the construction project site? Will a 404 Permit be required?
- Does the project owner or Contractor have a 404 Permit or will they obtain one prior to commencement of construction?
- Has a copy of the approved construction plans, permits, and notices been acquired?
- Have the 404 Permit and its requirements been reviewed?
- Has a preliminary site visit been conducted, and have any wetlands or issues of concern been noted?
- Have photos of wetlands or made maps/diagrams of wetland areas been taken?
- Is the Contractor aware of requirements of the 404 Permit and are they being followed?
- Has a follow-up visit been conducted to ensure Contractor is following all wetland regulations and there is no encroachment into a wetland, drainage channel, or stream?
- Have any channel modifications or disturbances been noted?
- Have all observations made during site visits on the Daily Activity Report been noted?
- If violations are observed, has a Contractor Notification Form been completed? Did the Contractor comply? If not, has non-compliance been noted on the Contractor Notification Form and notified the PM or EO? Has the violation been addressed by the PM or EO?
- Has a final walkthrough been conducted to ensure the site has been cleaned up and no adverse impacts are observed, in waterways or wetlands, or on adjacent properties?

10.4.4 Illicit Discharges

Illicit discharge to stormwater

Federal regulations define an illicit discharge as "...any discharge to a Municipal Separate Stormwater Sewer System (MS4) that is not entirely comprised of storm water...." There are some exceptions to this definition including discharges from National Pollutant Discharge Elimination System (NPDES) permitted industrial sources and discharges from firefighting activities. The City is required to have a program to detect and remove "illicit discharges" (including the source of illegal pollutant discharges). Any suspected illicit discharges should be reported directly to the Lincoln-Lancaster County Health Department Environmental Response Call Center at (402) 441-8040.

If a pollutant source can be determined from a specific location, it is called "point source pollution." If the origin of a pollutant discharge cannot be directly located it is called "non-point source pollution." Non-point source pollution originates from a number of sources including erosion and sedimentation from construction sites.

The State of Nebraska, working on behalf of the Federal Government to implement an illicit discharge program, requires local ordinances to provide methodologies to restrict illicit discharges and locate pollutant sources such as the random monitoring of stormwater systems. The Lincoln-Lancaster County Health Department - Environmental Quality Unit administers the Illicit Discharge Program for the City. More information can be found online at: http://lincoln.ne.gov/city/health/environ/kllcb/storm.htm. Although not as common as other environmental issues, the Inspector may

be involved in observing, documenting, and reporting illicit discharges.

10.4.4.1 Identification & Corrective Actions

The Inspector is on construction sites and in the field more frequently than most other PW&U representatives and has the best opportunity to observe and address illicit discharges. A pre-construction site visit can provide excellent opportunities to identify and discuss any potential problems or activities that could lead to illicit discharges. While making a preliminary site visit, the Inspector should note drainage patterns, projected construction material and hazardous storage areas, waterways and wetlands, and any other unusual site conditions. Photographs, maps, and diagrams can help document baseline conditions for later reference and comparison. If an illicit discharge is identified, the Inspector should take the following steps:

- Document the violation in the Daily Activity Report and contact the PM immediately. Consultation with the Lincoln-Lancaster County Health Department may be required. Generally, the PM will handle contact with regulatory agencies such as NDEQ or EPA, if necessary. If the illicit discharge is determined to constitute an emergency, contact the PM immediately and the proper emergency response authorities.
- If after initial notification and adequate time to address the illicit discharge, the Inspector should fill out and submit a Contractor Notification Form to the Contractor so the item may be addressed. At this stage, the Inspector should consult the PM to ensure there are no additional federal or state reporting requirements.
- If the responsible party does not respond to the Contractor Notification Form within 48 hours of getting the notice, the Inspector should note this on the Contractor Notification Form and contact the EO or PM for corrective actions, if required. Check with the PM to determine if there any additional enforcement reporting requirements such as an enforcement log.

10.4.4.2 Illicit Discharge Checklist

- Has a preliminary site visit been completed, and have site conditions and location of construction been reviewed?
- Are there site conditions that could lead to offsite discharges such as steep slopes, drainage channels/patterns, or exposed land surfaces? Have these areas been documented and photographed?
- Has a copy of the approved construction plans, permits, and notices been acquired?
- Have site conditions or potential issues related to illicit discharges and related information been reviewed with the Contractor?
- Are there any materials or substances onsite that are considered dangerous or hazardous? Is there secondary containment?
- Does the Contractor have BMPs in place to reduce erosion, sedimentation, and runoff?
- Have follow-up visits been conducted to ensure Contractor is meeting all containment, conservation, and discharge requirements and maintaining all BMPs?
- Have any discharges into water bodies, channels, or wetlands been observed?
- Have there been any spills or leaks onsite? If so, have they been reported, cleaned up, and monitored?
- Have all observations made during site visits on the Daily Activity Report been noted?
- If violations are observed, has a Contractor Notification Form been completed? Did the Contractor comply? If not, has non-compliance been noted on the Contractor Notification Form and notified the PM or EO? Has the violation been addressed by the PM or EO?
- Has a final walkthrough been conducted to ensure the site has been cleaned up and no adverse impacts are observed, in waterways or wetlands, or on adjacent properties?

10.4.5 Other Environmental Issues

In addition to the specific environmental issues described above, there are a variety of other environmental issues that an Inspector may encounter while in the field or en route to a site. These should be properly documented and reported. Issues include, but are not limited to:

- Hazardous, Explosive, and Toxic Substances.
- Environmental Conditions – Fire, severe weather, swift and high water, ice, wind, extreme temperatures, and unstable slopes.
- Flora and Fauna – Wildlife, fish, plants, trees, insects, dangerous/biting/venomous animals, poisonous plants, nests or dens, and wildlife damage.
- Threatened, Endangered, or Sensitive Species and Habitats.
- Seasonal Issues – Hunting areas and potential for gunfire, construction and agricultural machinery traffic, pedestrian and bicycle traffic on trails.
- Logistics Issues – High crime areas, secluded areas, and other known hazards.
- Migratory Bird Act Issues – Protection of migratory birds during nesting season.
- Illegal Activities and Intimidating Circumstances – Criminal activity including meth labs, threats, and physical attacks.

If an observation is made regarding these activities, the Inspector should take the following steps:

- Alert anyone in apparent danger, if possible, and contact the appropriate authorities. Contact the PM immediately and inform them of the situation. The PM can be a guide as to appropriate action for resolving the activities listed above. The situation should be documented at the appropriate time in the Daily Activity Report.
- If the issue is related to actions of a Contractor, the Inspector should first verbally notify the Contractor of the issue, if it poses no imminent danger. The PM may request the Inspector to fill out a Contractor Notification Form to notify the Contractor of the violation so the item can be corrected. At this

stage, the Inspector must maintain contact with the PM to ensure there are no additional federal or state reporting requirements.

- If the responsible party does not respond within 48 hours of getting the notice, the Inspector should note this on the Contractor Notification Form and contact the EO or PM for corrective actions, if required. Check with the PM to determine if there any additional enforcement reporting requirements.

CHAPTER 11: PRIVATE CONSTRUCTION AGREEMENT (PCA) PROJECTS

11.1 CONTACTS & LINKS

- Public Works & Utilities (PW&U) Department – Engineering Services Division – PCA Projects.
  - Contacts: Dennis Bartels, Eng Services Mgr / Charles 'Buff' Baker, Sr. Eng Specialist.
  - Direct Phone Numbers: (402) 441-7595 / (402) 441-7838.
  - Website: http://lincoln.ne.gov/city/pworks/engine/index.htm
  - Construction Phase Services for PCA Projects Webpage:
    - http://lincoln.ne.gov/city/pworks/engine/devserv/eo/cps/index.htm
    - *PCA (EO) Project Process & Requirements*: http://www.lincoln.ne.gov/city/pworks/engine/devserv/eo/cps/pdf/process.pdf
    - *General Conditions for Private Construction of Public Facilities*: http://lincoln.ne.gov/city/pworks/engine/devserv/eo/cps/pdf/gencond.pdf
    - *GP&P Expectations Narrative*: http://lincoln.ne.gov/city/pworks/engine/devserv/eo/cps/pdf/expect.pdf
    - *GP&P Expectations Chart*: http://lincoln.ne.gov/city/pworks/engine/devserv/eo/cps/pdf/chart.pdf
    - *Inspection Request Form*: http://lincoln.ne.gov/city/pworks/engine/dconst/gpp/pdf/einspect.pdf
    - *Sampling Guide*: http://lincoln.ne.gov/city/pworks/engine/devserv/eo/cps/pdf/sampling.pdf
    - *Water Main Checklist*: http://lincoln.ne.gov/city/pworks/engine/dconst/gpp/pdf/watrmncl.pdf

- Development Design Standards Webpage (via City Attorney Webpage): http://lincoln.ne.gov/city/attorn/designs/contents.htm
- Building & Safety Department Webpage: http://lincoln.ne.gov/city/build/index.htm
  - *NOTE* – Under 'Highlights' section and 'Development Process' link is interactive flowchart for the development process including pertinent links.

11.2 OVERVIEW

11.2.1 Definitions & Requirements

Private Construction Agreement (PCA) projects describe construction projects that are funded by a private developer and not by the City. This type of project is generally associated with a residential subdivision and may include more construction than just underground utilities. This chapter will discuss only the underground utility aspects: wastewater, water (lines), and stormwater. Site visits are normally required by the City for PCA projects when underground utilities including wastewater, water, and stormwater will become a part of the City's system.

The developer will generally hire a consultant to perform design, but the Inspector will be required to conduct construction oversight on behalf of the City to verify proper installation, material quantities, and quality of construction. Since PCA projects are primarily coordinated by the developer, it is important that the Inspector be familiar with the site, know the construction schedule, and be onsite for important activities involving construction of underground utilities.

Prior to any construction, PCA projects require platting of the property in accordance with the City Land Subdivision Ordinance. This office issues an Executive Order (EO) by the Mayor, which is why PCA projects have often been referred to as EO projects. All aspects of the underground utilities constructed under PCA projects must adhere to City specifications and standard plans. This includes providing adequate land for roads and utilities, ensuring drainage and utilities are properly sized and designed, and constructing streets with necessary sidewalks, lighting, and other appurtenances. The Inspector should be familiar with this process.

11.2.2 PCA Project Approval Process

Subdivisions are usually approved through a two-step process involving a preliminary plat, which is approved by the Lancaster County Planning Commission, and a final plat approved by the City Planning Director. Approval authorizes the developer to construct the proposed improvements at his or her own expense and to City specifications. No utility or improvement shall be installed or constructed until the plans, profiles, specifications and any other required documents are prepared or submitted, and approval is granted. The Inspector may not have much involvement during this two-step process, but it is important to observe the project site to ensure unauthorized construction does not begin prior to approval. At times, the PW&U Director may approve grading, installation, and construction of project components in phases. The Inspector should be familiar with these provisions and ensure only authorized work takes place. Details regarding the subdivision process are available through the "Development Review" section of the Planning Department accessible online at http://lincoln.ne.gov/city/plan/index.htm.

PW&U will typically hold a "Field Check/Plan-in-Hand" review meeting with the consulting engineer, design and construction personnel, the Engineering Services Coordinator (ESC), and the appropriate PW&U operations division. Information regarding the location, capacity, design, and construction of public facilities for subdivisions is available through the PW&U's Development Service section, which can be accessed online at http://lincoln.ne.gov/city/pworks/engine/devserv/eo/cps/index.htm. No utility or improvement shall be installed or constructed until the area to be developed has soil erosion and sediment controls implemented and the developer has submitted a written statement and a copy of the Stormwater Pollution Prevention Plan or SWPPP (see Chapter 10 for more details on the SWPPP). The Inspector may assist with coordination of efforts and information distribution since so many departments, divisions, and agencies are involved. The developer must notify the ESC at least 48 hours prior to any work beginning.

11.3 ROLES & RESPONSIBILITIES

The Inspector often is the only onsite representative during installation of underground utilities. It is important that the Inspector understand the components of the PCA project and be onsite as often as possible to observe construction progress and report any problems. This requires communication with the Contractor or Developer and coordination regarding scheduling. Because PCA projects can be very complex and involve many stakeholders, the Inspector must work closely with the ESC and then address them directly with the Contractor/Consultant to find resolution.

11.3.1 Pre-Construction

The Inspector should acquire a copy of all plans and permits and walk the site before construction to become familiar with the planned locations of all underground utilities. Permits typically required for filling, hauling, working in a local or state right-of-way (ROW), and closing a roadway. The developer is responsible for obtaining all necessary permits for construction unless otherwise required by law. The Inspector should also develop a "job plan" prior to construction. The job plan may include noting areas that will require particular attention after heavy rain, marking particular aspects of construction that the Inspector wants to see, and marking the plans to highlight the various parts of construction. For more information on job plans, see Chapter 2.

A pre-construction meeting should include the Inspector and Contractor at a minimum. The Design Engineer would be important for larger or more complex developments. At the meeting, the Inspector should point out the important parts of the project identified when developing the job plan and get clarification on any questions or concerns. The Inspector will also want to coordinate initial schedules for construction components at this meeting, particularly those requiring observation, verification, or testing.

Construction may be staged over a long period, especially when multiple Contractors are involved. In some cases, construction may not begin until several months after the notice to proceed has been issued. In such cases, the Inspector should

periodically check the site to see if construction has begun and keep in contact with the Contractor.

11.3.2 During Construction

General clearing and site grading may be allowed after obtaining the required permits and work orders prior to approval of the Plans. This work should not include construction of stormwater structures and cannot significantly affect existing drainage in the area. Soil erosion and sediment control measures are typically required to be installed before any land-disturbing activities occur. This includes approval of a SWPPP by the Lower Platte South Natural Resources District (LPSNRD). In general, PCA projects begin with installation of soil erosion and sediment control structures, construction of wastewater and water lines, and lastly construction of the stormwater lines. This sequence may vary on a project-to-project basis and the Inspector should consult the ESC and project plans. For more information on SWPPPs and NOIs, see Chapter 10.

During construction, the Inspector should visit the site as often as possible within time and budget constraints. At a minimum, the Inspector should visit the site for the following:

Installation of a manhole

- During pipe installation.
- Construction/installation of appurtenances.
- At least once every week to check on the job progress.
- Oversight of the SWPPP as required.
- For all acceptance testing.
- During work on items identified in the Inspector's job plan.

During construction certain items continue to be problematic and should be watched carefully. These include:

- **Water components** – water mains, fittings, hydrant packing material and orientation, valves, loops, shutdowns, tapping sleeves and valves, and testing and disinfection.

- **Wastewater components** – manhole alignment, compaction, inverts, barrels, rings and lids, grade and slope, bedding, joint tightness, debris in system and backfill of wastewater pipes, service connection tie-ins, service marker pipes, siphons, junction structures, and drops.
- **Stormwater Components** – SWPPP in place, soil erosion and sediment control BMPs installed and maintained, sensitive and natural areas protected, and residual soil erosion and sediment control BMPS in place after construction.
- **General Issues** – Proper documentation and reports filled out/submitted, proper field order procedures followed, required notification made prior to construction, traffic control and street closures, safety issues (proper PPE), quantity verification, and use of correct materials required by specifications and Plans.

All activities reviewed by the Inspector during site visits shall be recorded using a Daily Activity Report or a field notebook. For more information on Daily Activity Reports, see Chapter 3. Throughout the construction process, the Inspector should develop an "Incomplete Items" list using the Incomplete Items Form. This list should be reviewed with the assigned ESC and given to the Contractor. For more information on Incomplete Items List, see Chapter 3.

Usually, the Contractor or Developer's engineer is responsible for recording depths, locations, quantities, and other parameters for underground utility components and updating these items on the "as-built plans." The Inspector should review this information with the Developer or Contractor. If the information appears to be correct, the Developer's engineer should deliver these reports and plans to the ESC for formal approval.

The Contractor is generally responsible for most acceptance tests including: low-pressure air for gravity wastewater; hydrostatic tests on pressure lines; infiltration/exfiltration tests on wastewater lines; and disinfection for water lines 30 inches and larger. The Inspector must be present during all testing and should complete the appropriate reports according to guidelines in Chapter 3. The Inspector should also note whether the pavement binder has been laid at the time of the second air test. If it has not, there is a

chance that the manhole casting can become misaligned during paving. The Inspector should also check problematic items such as orientation, true vertical position (plumbness), and height of hydrants. The Inspector should make sure the final bond release site visit includes opening manholes in paved areas and proper placement of hydrants.

11.3.3 Post-Construction

After construction, the Inspector must make sure that all aspects of the job have been completed and that all necessary records, reports, and other forms concerning the project have been completed and submitted. At this point, the Inspector will conduct a final walkthrough with the ESC, Developer, Contractor/Consultant, Developer's engineer, and/or the appropriate PW&U representative. A punch list should be developed by the Inspector during the final walkthrough to ensure all project components are completed and all corrections/omissions addressed including restoration, clean-up, and necessary soil erosion and sediment control practices. The following specific items have historically been a problem and should be checked carefully following construction:

- Compaction in and around manholes, valve boxes, and tap excavations particularly in the ROW and other areas where excavation took place.
- Hydrant orientation, plumbness, and height.
- Manhole alignment.

11.4 PRIVATE CONSTRUCTION AGREEMENT (PCA) CHECKLIST

- Has the project specifications and plans from the ESC been received and reviewed?
- Has the site been visited prior to construction? Has a job plan been developed?
- Was a pre-construction meeting held?
- Have all questions and concerns been addressed?
- Has communication been established with Contractor/consultant for notification of milestone activities that require site visits or schedule changes?

- Did the Contractor give proper notice prior to construction?
- Does the developer have an approved SWPPP? Are controls properly installed according to the plans?
- Have site visits been scheduled during pipe installation? Appurtenances?
- During construction, were the following water infrastructure items observed: water mains, fittings, hydrant and associated accessories, valves, loops, shutdowns, tapping of sleeves and valves, and testing and disinfection?
- During construction were the following wastewater infrastructure items observed: inverts, barrels, rings and lids, grade, slope, bedding, joint tightness, debris in system, and backfill of wastewater pipes, service connection tie-ins. Siphons, junction structures, and drop inlets?
- Have manholes been checked for alignment following final pavement restoration?
- Are all hydrants installed with correct orientation, height, plumbness, and in proper location?
- Are proper backfill materials being used for hydrants, manholes, and in other excavated areas? Have proper compaction procedures been used? Were any settlement issues observed?
- Was all acceptance testing witnessed? Have all necessary reports for testing been completed and submitted?
- Was there a final site walkthrough? Was a punch list developed?
- Have all punch list items been completed including restoration and clean-up? If required to remain in place after construction, are soil erosion and sediment control BMPs in place?
- Has all as-built information been reviewed? Have all the forms and final plans been approved and submitted?
- Have all the quantities been reviewed with the Contractor/consultant? Have all discrepancies been reviewed? Has the Contractor/consultant submitted final quantities?
- Have all reports, records, and other forms been properly filled out and submitted?

CHAPTER 12: CLOSEOUT

12.1 OVERVIEW

Final steps of pipe installation project

After construction, the Inspector must ensure that all aspects of the job have been completed, all requirements have been met, quality is to the level expected, contractual obligations are fulfilled, and final acceptance has been made. The official project file must also be updated and finalized including all required documentation such as records, reports, memos, forms, photos, and other information. Project closeout is the final step in the lifecycle of a project and it is also the most ignored and forgotten phase.

The Inspector plays a pivotal role due to the close involvement with the project, time spent in the field overseeing construction, and communication in the field with Contractors and other stakeholders. During closeout, there are several items or steps involved to ensure the project is completed. The sequence of these items and a general description is listed below and each will be discussed in greater detail in later sections. The steps described below are generally applicable to CIP projects, and will differ for federally funded and PCA projects:

1. **Coordination with PW&U** – Coordinating necessary PW&U divisions and other City Departments in the construction process and any subsequent activities.
2. **Incomplete Items** – Throughout the construction project, the Inspector should keep a running list of incomplete items and periodically present the list to the Contractor for completion.
3. **Substantial Completion** – Point in a project life cycle when most of the construction is finished. May include a walkthrough and development of a punch list of items to finish when put in operation.

4. **Punch List** – A punch list is developed that itemizes incomplete work and items for correction. Before final completion and formal acceptance, the Contractor must complete these items.
5. **Site Restoration** – Restoration of disturbed areas and clean-up is an important step to meeting final completion. Site restoration items should be listed on the punch list.
6. **Final Completion** – Point in time when all punch list items are completed by Contractor, final payment requests are submitted, and contractual obligations are met.
7. **Final Site Walkthrough** – Site walkthrough to verify project is complete.
8. **Formal Acceptance** – City formally accepts project as complete. On this date, all requirements are satisfied by the Contractor, and warranties and guarantees take effect.
9. **Warranty Checks** – Checks conducted within the warranty timeframe to identify integrity of constructed infrastructure and functionality.
10. **Closeout Documentation and Lessons Learned** – Complete and archive all project information and documents in official project file. As-built drawings completed, and lessons learned documented.

12.2 COORDINATION WITH PW&U

Throughout the project closeout processes, the Inspector must coordinate and maintain effective communication with all stakeholders including respective PW&U Divisions. There may be times when an Inspector needs information or assistance from another division or department, and times when these stakeholders should be informed of progress or major closeout milestones such as substantial completion, final site walkthrough, and formal acceptance. There may also be documents or information that is important or required for other divisions or departments, which must be given to them in a timely manner.

12.3 INCOMPLETE ITEMS

The Inspector should keep a list of incomplete items and share with the Contractor at a time prior to substantial completion of the

project. If this is done, the project will move towards completion quicker with fewer items for correction and completion on the punch list. The Inspector must stress to the Contractor that this is NOT a punch list, and completion of these tasks does not indicate completion of the project. The "Incomplete Work List" form was developed to assist the Inspector in tracking incomplete items, and is included at the end of Chapter 3.

12.4 SUBSTANTIAL COMPLETION

Substantial completion is the date at which the construction work is sufficiently (substantially) complete in accordance with the construction contract documents, so that PW&U may utilize the final deliverable(s) or designated portions for the intended use. This level of completion is generally agreed upon between the PM and the Contractor before the project begins to help establish milestones and timelines. Substantial completion can be based on a percentage of work complete or a judgment call that incorporates observations, discussions with the Contractor, and experience.

12.4.1 Walkthrough

Formal determination of "substantial completion" for many projects is made following a walkthrough with the Inspector, Contractor, PM, Project Engineer, and/or other stakeholders to observe the status of the project, determine corrections have been made, and confirm specifications have been met. A punch list can be developed during this walkthrough that lists items that are deficient or still need to be addressed. For more information on the punch list, see Section 12.5.

12.4.2 Certification of Substantial Completion

At substantial completion, all stakeholders have reviewed construction work under the contract and recommend issuance of substantial completion through a certificate or formal letter. Formal substantial completion requires signatures from specific stakeholder representatives including the owner (City), Contractor, and usually the Project Engineer. In some instances, a portion of held funds may be released to the Contractor based upon confirmation of "substantial completion."

12.4.3 Warranties

The certified completion date typically signifies the beginning of the warranty period, guaranties, and certain liabilities. The date of the final payment to the Contractor may also be used to begin the project's warranty period. Until the project is officially closed, the Contractor is responsible to maintain certain types of insurance and is not released from liabilities or other contractual obligations.

12.4.4 As-Built Plans

During construction, the Contractor is required to keep a close record of all deviations from the Plans with respect to location or elevation of any installation, known as the "as-built plans." Although construction should always proceed in close conformance with the Plans, slight deviations from the alignment and grade are sometimes allowed as long as the installed underground utility functions properly. After construction, the Contractor is required to submit to the City a complete set of as-built plans. The Inspector should keep track of all deviations from the original plans on a set of original as-built plans. The Inspector should ensure that all deviations submitted by the Contractor agree with those recorded on the original set of as-built plans.

When a Consultant is employed for construction phase services, as-built plans will be verified by them and the final as-built plans will be their responsibility. The Inspector should ensure the following:

- The Contractor gives plans with as-built revisions drawn in red to the Inspector when completed. The PM and/or Project Engineer may also need to review and comment.
- After review and verification of the drawings, the PM will then notify the Contractor of any changes or accept them.
- As-built plans are typically submitted prior to final payment.

An example as-built checklist form is available in Chapter 3.

12.4.5 Final Quantities, Claims, and Field Changes

Within one week after the project is certified "substantially complete," the Inspector should meet with the Contractor to determine the final quantities installed on the project and the status

of any remaining requests. After the final quantities are determined, the Inspector should discuss these numbers with the PM. If there is a difference between the number of units installed and the estimated number of units needed, the Inspector and PM should discuss with the Contractor resolve differences. The PM will process the final quantities, including any field changes, once the Contractor has submitted them.

When a Contractor informs the Inspector that there is a claim, the Inspector should follow the steps below:

1. Advise the Contractor to submit the claim in writing and document the conversation/discussion in the Daily Activity Report.
2. Inform the PM of the claim.
3. Continue keeping detailed documentation of the condition under claim throughout the life of the project. For example, if the plans indicate that saw cutting asphalt pavement is required and the Contractor has a claim because concrete saw cutting is required, then the Inspector should keep detailed records of the pavement material throughout the project.

12.5 PUNCH LIST

Applying mastic on outside of manhole

During the substantial completion walkthrough, a "punch list" of all items that are deficient or need addressed is developed. The "Incomplete Items" form can be used for the punch list, but this should be indicated somewhere on the form to differentiate from earlier incomplete lists. On larger projects, the PM, Contractor, and often the Project Engineer, and Inspector conduct the walkthrough and create the punch list. For smaller projects, the Inspector may be designated to conduct the walkthrough on behalf of PW&U and create the punch list along with the Contractor. In this case, the

Inspector should discuss the list with the PM before giving it to the Contractor.

The punch list should note any areas or items that need additional or corrective work along with restoration and clean-up items. The Inspector should check for areas that have not been seeded/sodded or paved correctly, and any structures or trees/landscaping damaged by the Contractor. The Inspector must discuss punch list items in detail with the Contractor to clarify issues and answer questions. After this discussion, the Inspector should retain a copy of the list and give the original to the Contractor. As the Contractor completes the tasks on the list, the Inspector should review the work. The Inspector should check off any item considered acceptable. A final additional site visit will be conducted later to verify completion of punch list items. If the Inspector considers the work unacceptable, the problems should be resolved directly with the Contractor. If this fails, the Inspector should notify the PM.

12.6 SITE RESTORATION

Site restoration is a standard part of all projects and includes restoration of disturbed areas and clean-up efforts. It should be included on the punch list as an item that must be completed before the project can be considered finished. Restoration would include activities such as slope protection, final grading, seeding, landscape restoration, plantings, tree/landscape replacement, construction access restoration, waste material clean-up and disposal verification, and general clean-up.

12.6.1 Landscape Restoration

The Contractor must restore any disturbed landscaping back to original condition as much as possible. Pictures taken prior to construction can greatly aid in the process to answer and confirm what the area resembled. Typical ground restoration efforts include

Stream bank restoration

application of seed, mulch, or straw mat installation. The type of mat protection is dictated by the slope. Sod is not a preferred method of ground restoration because it is costly and requires the future maintenance by the Contractor or property owner to become established. However, sod is excellent for controlling soil erosion and establishing vegetation if warranted. If landscaping creates an obstruction to public drainage, PW&U may require relocation that is to the satisfaction of the property owner so that it no longer obstructs drainage. On large jobs in which certain sections will be restored at different times, the limits of the individual restoration may be specified in the contract or by local ordinances.

12.6.1.1 Restoration of Grassed Area with Seed

Preparation of the seed bed should include the following:

- The seed bed should be loosened to a depth of 3/4 inch and graded to remove humps, depressions, and gullies that may collect water or make mowing difficult.
- Fertilizer should be applied to the area in accordance with contract specifications and seed supplier recommendations.

During application of grass seed, the Inspector should observe the following:

- Grass seed should typically be applied with a power seeder, rotary seeder, wheelbarrow seeder, or hydraulic equipment. The type of seed and application rate should comply with the contract documents and/or specifications.
- Permanent seeding is dictated by climate conditions and should take place during the intervals specified in the contract.
- Native seeding should be performed according to the schedule provided in the Specifications or on the Plans.
- Placing mulch or netting for protection of the seed should take place after seeding. The type and placement of mulch or netting should comply with the specifications and contract documents. Mulch is generally preferred for large areas. Netting is preferred for small areas and urban settings.
- All seeded areas should be thoroughly watered after seeding, with follow-up watering during dry periods.

- Straw mulch, netting, mats, blankets, or other specified erosion control methods should be used as determined by water velocities and/or side slopes.

12.6.1.2 Restoration of Grassed Areas with Sod

Preparation of the sod bed should include the following:

- The sod bed should be loosened to a minimum depth of 1 inch, graded to remove humps, depressions, and gullies and dampened with water.
- The area next to existing sod should be cut square for a smooth transition.
- If necessary, soil should be removed so the new sod will be level with existing sod.

During placement of sod, the Inspector should observe the following:

- Sod should be free of weeds, diseases, and pests.
- Sod that is brown should not be used.
- Sod should be cut with a uniform thickness of 1 to 2 inches (excluding top growth) depending upon the species and the season in which it is lifted.
- Sod should be lifted, delivered, and installed within 18 hours of being cut.
- Sod should be kept moist during delivery and placement.
- Sod should not be placed when the temperature is below 32˚F, or when the sod or sod bed is frozen.
- Sod should be placed in a staggered fashion (resembling a brick pattern) so that the joints are snug and that no holes exist.
- Sod should always be laid across a slope and never up and down a slope.
- Sod should be laid beginning at the bottom of the slope, working upward. On slopes steeper than 2:1 (horizontal to vertical) and 6 feet or more in height, sod should be secured with wood stakes or wire staples.
- Immediately after placement, sod should be rolled or tamped to make solid contact between the root mat and the soil surface.

After sod placement, the Inspector should observe that the Contractor maintains the sod as described in the specifications. The Inspector should discuss with the PM if there are no established provisions for maintaining the sod after installation.

12.6.2 Relocation and Replacement of Plants

Damage to existing plants and their roots in public rights-of-way (ROW) and on private property should be avoided, if possible. Some projects require the removal or relocation of plants including shrubs, small trees, and flowers. All plants must be replanted or replaced according to the Plans when the project is finished. The Contractor may be required to notify an arborist or other official before removing or cutting any trees within the public ROW and abide by certain requirements. Tree roots should be examined by a certified arborist before any large portion of root is removed to protect the health and stability of the tree. Prior to removing or relocating shrubs, flowers, or trees outside of easements on private property, the Contractor must obtain written permission from the property owner. The Inspector should ensure the Contractor meets these requirements and any special conditions of the contract. The Contractor is responsible for replacing any plants outside easements and public ROW or plants marked “Do Not Disturb” that are damaged during construction.

12.6.3 Tree Trimming

Trimming of trees or shrubs should be done only if absolutely necessary. The Contractor should have proper training in the correct method of trimming or consult with a certified arborist. The Contractor must be aware of proximity to overhead power lines when removing or trimming trees.

12.6.4 Natural Areas & Protected Species

During construction, all attempts should be made to limit disturbance of natural areas including wetlands and other bodies of water. Existing plants should only be disturbed as a last resort. Any plants marked “Do Not Remove” in the Plans or in the contract documents should not be disturbed in any way. The Inspector and Contractor must be aware of the location of threatened or endangered plants located on the plans. Plants that

should not be disturbed are usually marked with flags or stakes. In some cases, construction fencing may be required around natural areas, protected species, or at the drip line of trees to ensure that the trees are protected.

Wetlands

12.6.5 Clean-up

Some clean-up may be done as the project progresses, but a majority is generally completed following substantial completion. This includes all activities necessary to leave the site orderly and free of construction debris, leftover materials, obstructions, fencing, stockpiled soil/rock, and other trash. Clean-up should also extend to adjacent and other impacted offsite properties. Proper disposal of construction debris is the responsibility of the Contractor, but the Inspector should observe and document that proper disposal protocol has been followed. Traffic and pedestrian barriers and temporary signage must be removed once the project is complete unless there is a need to keep in place for future project-related activities. SWPPP BMPs must be removed once seeding is established including all silt fence, compost logs, gutter snakes, and triangular silt dikes. If any detours, road closings, or access restrictions are removed, notification should be made to the appropriate personnel or authorities (City public information services, NE Dept of Roads, etc.) so their records can be updated and the public notified.

12.7 FINAL COMPLETION DATE

This signifies the date when all punch list items have been completed by the Contractor. There may be a few minor clean-up items that remain for specific and allowable reasons. This is the stage when the Inspector would work with the Contractor and resolve any minor unresolved or lingering issues. However, there should not be any major problems, issues or unfinished items at this stage. Formal acceptance and final payment cannot be made until everything is complete and resolved.

12.8 FINAL WALKTHROUGH

Final site walkthrough

The final walkthrough is generally conducted with the Contractor, PM, and Inspector. For large, complex, or problem projects, the Developer, Developer's engineer, and other appropriate PW&U representatives may attend. At this stage, the project should be 99% complete and fully operational. Remaining items may include some minor restoration and clean-up items. The occasion of the final site walkthrough should be documented in the Inspector's Daily Activity Report.

The punch list developed earlier should be reviewed and revised accordingly by the Inspector during the final walkthrough to ensure all project components are completed and all corrections/omissions addressed including restoration, clean-up, and necessary sediment and erosion control practices. The following specific items have historically been a problem and should be checked carefully following construction:

- Compaction in and around manholes, valve boxes, tap excavations particularly in the ROW and other areas where excavation took place.
- Hydrant orientation, plumbness, and height.
- Manhole alignment.

12.8.1 Final Payment Estimates

Throughout the project, the Contractor receives payments from the City based on the progress of the work. The Contractor submits information regarding this progress as well as the official request on payment request forms. The Contractor typically receives a final payment request form following a successful final walkthrough. The Contractor must submit a formal, written statement indicating that the project is complete. The Inspector must ensure that all work listed on the final form has been

completed in a satisfactory manner and that any complaints have been resolved. Once confirmed by the Inspector, the PM should be notified in order to process the request for final payment.

12.9 FORMAL ACCEPTANCE

Formal acceptance is the official recognition by the City that the project is complete and the Contractor has met all requirements of the contracting documents including quantities, quality, and functionality. Formal acceptance is used as the legal acknowledgement that all project deliverables have been delivered as intended and the final product is operational. Formal acceptance is usually completed by the authorized procurement or contract administrator for the project on behalf of the City. Formal acceptance is typically documented as a form or letter that is signed by the City and usually provides specific details such as project commencement and completion dates, the project name, and legal provisions such as warranty or liability considerations. All documentation for this process should be placed in the official project file.

12.10 WARRANTY

Warranties or guarantees for PW&U projects generally extend two years, but may have certain components that are warranted for much longer periods of time. Contract documents should indicate provisions related to warranties. The Inspector may be involved in site visits during the warranty period due to their heavy involvement in the construction process. Site visits during the warranty period may be initiated for one of three reasons:

- To address existing, known problems.
- For routine observation.
- To uncover any unknown or emerging issues prior to the end of the warranty period.

Final acceptance typically involves the appropriate PW&U Division personnel.

12.11 DAILY ACTIVITY REPORT CLOSEOUT DOCUMENTATION

12.11.1 Filing Project Records and Related Forms

Proper documentation and filing of project information is vitally important to every project. Information that is not documented will be lost when personnel move to different positions, new organizations, or retire. With this in mind, the last task that an Inspector needs to complete on a project is to ensure that all records (including contract documents), reports, information, photos and video, and other forms pertaining to the project have been completed and filed in the official project file. The Inspector is the most valuable part of this process since they may have information that no one else has and can prove both informative and necessary in the case of litigation or warranty issues. This part of the project closeout process is often the most neglected since the bulk of activities are already completed. It is important to understand what information is required to be included in the official file and the format the information needs to be in (i.e. Paper, electronic, or both). Most written and physical information can be converted to an electronic form using a scanner. Some reports and information may be required to be entered into Daily Activity Report AURIGO such as Daily Activity Reports. Because there may be various storage locations for different components of the project documents (i.e. AURIGO, file cabinets, server, etc.), the Inspector should ensure all information is properly labeled, organized and made accessible. Some commonly overlooked information that the Inspector should file includes:

- Written correspondence between the Inspector and the Contractor.
- Communications between the Inspector and property owners or between the Contractor and property owners.
- Properly labeled and archived photos and video.
- As-Built Plans.
- Field notebook if used in place of, or in addition to, the Daily Activity Reports.

12.11.2 Lessons Learned

"Lessons Learned" are those items that the Inspector or other stakeholders discovered during the project lifecycle and would prove beneficial for similar future projects. These can be anticipated issues that materialized or new discoveries. Many PW&U projects will have similar components, parameters, and attributes as past projects. Unforeseen obstacles, design flaws, material defects or failures, supplier or Contractor issues, and other problematic issues are often cited in lessons learned. Items or processes that went well should also be documented such as new contacts, better approaches, alternative components or materials, or successful design changes. Although the exact nature of the project or location may not replicated entirely, the lessons learned may provide valuable insight for PW&U personnel in the future so mistakes are not repeated and problems are avoided.

12.12 CLOSEOUT CHECKLIST

- Have all pertinent PW&U divisions and departments been informed and/or received all necessary information?
- Has the Contractor submitted any claims? Has the PM and/or Project Engineer been contacted?
- Has a running incomplete work list been kept through the point of substantial completion? Have the items been discussed with the Contractor?
- Has a substantial completion walkthrough been completed and a punch list developed noting all work that still needs to be addressed? Has this list been discussed with the PM? Has a copy been provided to the Contractor?
- Have all punch list items been completed in an acceptable way, and have all complaints been resolved? Has the Contractor submitted a final payment request, as well as a statement saying the project is complete?
- Has formal acceptance been made and officially documented?
- Have all required PW&U closeout procedures been followed?
- Have all records, information, plans, and other paperwork been submitted to the PM? Is all of this information properly filed and archived?

- Were lessons learned documented and added to the project file?
- Have warranty items been discussed with the PM? Are site visits scheduled during the warranty period?
- Does the site have any threatened, endangered, or protected species or areas (i.e. wetlands)? Have they been properly protected according to the plans and specs?
- Are all disturbed grassed areas being replanted with seed or sod as stated in the contract documents? Are they properly graded, and have all humps, depressions and gullies been removed?
- Are proper amounts of fertilizer being placed? Has the soil been tilled to a depth of 3 inches after placement of fertilizer?
- Are the appropriate type and quality of seed being used? Is the seed being applied evenly using specified application rates?
- Are the appropriate types and quality of mulch being used?
- Are areas that are to receive sod cut square adjacent to existing grassed areas?
- Is sod of proper quality being used?
- Is the sod being placed in a staggered fashion without leaving gaps between pieces of sod or the existing grassed areas?
- Is sod being laid across slopes, starting at the bottom and working uphill?
- Is sod level with existing grassed areas? Has the sod been rolled?
- Has the sod been watered immediately after placement?
- Are plants being disturbed only when absolutely necessary?
- Within city limits, has the Contractor notified the forester or other required official prior to removing or cutting trees in public rights-of-way?
- Has the Contractor notified the property owner prior to removing or trimming any plants on private property? Has the Contractor received written approval from the property owner?
- Have any disturbed plants been replanted or replaced properly?
- Is all trimming and pruning of trees being performed properly?
- Are there any special conditions that affect site restoration?

- Are there future follow-up activities such as watering or material removal required after the Contractor demobilizes? Is this work assigned and scheduled?
- Has the Contractor properly and adequately cleaned up the site including construction debris, materials, trash, and equipment?
- Are all barriers and signage removed? If any access restricted, is it restored? Are detours removed? Have proper contacts been informed of street or access openings?
- Is it apparent that the Contractor is properly disposing of the clean-up materials and trash?

GLOSSARY OF TERMS

Access road: A traveled way designated for hauling equipment, materials, or machinery.

Addendum: Written alteration, clarification, or correction of the bidding documents or Contract Documents issued after the Notice to Bidders but before a bid opening; Outsourcing or Consultant Contract changes in scope of work or scope of services.

Admixture: Material other than water, aggregates, hydraulic cement, and fiber reinforcement used as an ingredient of concrete or mortar and added to the batch immediately before or during mixing.

Aggregate Base Course: The layer of material immediately beneath the pavement. It may be composed of crushed stone, crushed or uncrushed sand and gravel, or combinations of these materials. To provide the service intended, it must be uniform in strength to support the pavement.

Aggregate: Stone and gravel of various sizes, which compose the major portion of asphalt and concrete.

Alignment: The vertical and horizontal location of a project.

Asphaltic Cement: Brownish black, solid or semisolid mix of bitumens from native deposits or a petroleum by-product used in the manufacturing of asphaltic concrete.

Backfill: The operation involving the placement of materials in a trench, excavation, or adjacent to a structure. Also can refer to the material removed during construction.

Backslope: A downward-sloping surface toward a roadbed/street or other improvement. Also, the slope from the bottom of the ditch to natural ground on the opposite side of the foreslope.

Barrier: A device which provides a physical limitation through which a vehicle would not normally pass. It is intended to contain or redirect an errant vehicle. Ex: guardrail, crash cushions, and bridge railings.

Base Course: A layer or layers of designed material (gravel, sand, dirt, crushed concrete, and limestone) used to support the surfacing material.

Bitumen: A natural asphalt or substance found in a natural state or a residue

by-product from petroleum refinement.

Bituminous: Containing Bitumen.

Borrow Excavation: If there is insufficient earth along a project, the Contractor is required to obtain the needed additional material from a source. The material is called borrow excavation.

Borrow Pit: Excavation site providing material for use in another location.

Box Culvert: Cast-in-place or pre-cast reinforced concrete box shaped tube that is located under the embankment to drain water from one side of the street to the other.

Capital Improvement Program (CIP): A capital improvement program is a multi-year budgeting tool that programs capital facilities for construction or acquisition.

Cement: A powdered product made by grinding clinkers of limestone, clay, and other materials, and which reacts with water to form a rock like substance used to bond aggregates together in concrete.

Channel: Path in which water will or does flow; natural or artificial watercourse.

Channel Change: The change in direction of the natural path of water flow.

Channel Clean Out: The removal of debris, soil deposits, or heavy brush in an existing path of water flow.

Coarse Aggregate: Mineral aggregate or portion of a mineral aggregate that retains on a #4 (6.4 mm) screen.

Cofferdam: During the construction of a stream crossing, the Contractor may be required to drive sheet piling into the stream. This creates a cofferdam. The mud and additional stream bed material must be excavated prior to the construction of the crossing. This is called cofferdam excavation.

Cold Milling: When preparing a street pavement for resurfacing, the creation of a new street cross section and profile using a machine that has hardened steel bits in a revolving drum.

Concrete: A building material made of sand and gravel bonded together with Portland cement into a hard, compact substance.

Condemnation (Eminent Domain): The taking of private property for public use by a governmental agency, usually against the will of the owner, but with payment of just compensation. The legal process includes a resolution of public need, a purchase offer, and if a purchase cannot be negotiated, then court proceedings are initiated to determine the fair market value.

Contract: Binding written agreement between two parties detailing the obligations of each to perform the prescribed work.

Contract Price: The moneys payable by City to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement.

Construction Contract Documents: Invitation for Bids, Proposal, Contract, Contract Bond, Specifications, Supplemental Specifications, Special Provisions, Materials Testing Manual, General Conditions, Plans, Detailed Plans, Change Orders, Notice to Proceed, and any agreements required to satisfactorily complete the work, including authorized extensions thereof, all of which constitute one instrument.

Construction Plans: Show the details that are necessary to construct a specific project. Plans should be tailored to provide all the information necessary to accomplish the work in an orderly manner.

Contract Period: The period of time from the specified date to commence work to the date that the specified number of working days or calendar days has elapsed or to the specified completion date as indicated in the contract.

Contract Price: The moneys payable by the City to the Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement.

Contract Specifications: Requirements that are to be followed on City construction projects.

Contract Sum: Total monetary amount for all work contained within the Contract Documents. Contract Time: Date, number of working days, or calendar days allowed to complete the Contract. Contractor: An individual or legal entity contracted to perform the work

Control of Access (full): The authority to control access that allows access to select roads only and does not allow connections to driveways and grade crossings.

Control of Access (partial): Authority to control access that allows some access to select roads and may allow driveways and some grade crossing.

Controlled-access facility: A highway or street especially designed for through traffic and over, from, or to which owners or occupants of abutting land or other persons have no right or easement or only a controlled right or easement of access, light, air or view by reason of the fact that their property abuts upon such controlled-access facility or for any other reason; may be a parkway.

Controlling Operation: Operation that, if uncompleted, delays the completion of the work.

Dikes: A bank, usually of earth, constructed to control or confine water.

Dowel Bars: Steel bars placed at joints in concrete pavement used to facilitate the transfer of loads from one slab to another.

Drainage Structure: Structures used to promote or aid drainage other than drains, levees, and pumping plants.

Driveway Approach: Driveway approach shall mean the area of the public ROW between the roadway and the property adjacent to the public ROW, which is intended to provide access for vehicles from the roadway to the adjacent property.

Driveway Return Radius: Driveway return radius shall mean a circular transition or taper between the driveway approach and the roadway edge to facilitate the turning movement of vehicles.

Driveway Throat: Driveway throat shall mean the narrowest point of the driveway approach, usually at the property line, measured from edge to edge perpendicular to the centerline of the driveway approach.

Easement: The right to use property of another for designated purposes. These may include, but are not limited to, construction easements, drainage easements, sight line easements, or slope easements. These easements may be either temporary or permanent.

Egress: Access from a land parcel to a public roadway.

Embankment: A raised structure of soil, soil-aggregate, sand or rock. The top of which is higher than the surrounding surface or the original surface.

Eminent Domain: In property law, condemnation is identical to eminent domain. See Condemnation.

Emulsified Asphalt: A common construction materials used to prime, seal or resurface a highway. Consists of asphalt that is chemically mixed with water in an emulsion.

Excavation Limits: Vertical and horizontal boundaries established to control the excavation process.

Fine Aggregate: Mineral aggregate or portion of a mineral aggregate that passes through a #4 (6.4mm) screen and retains on a #200 (75um) sieve.

Foreslope: a Downward-sloping surface away from a roadbed or other improvement. Also, the edge of the shoulder to the bottom of the ditch or to the bottom of the roadway fill.

Frontage Road: A street located on the side of an arterial street that permits access to abutting properties and areas (residences and businesses) from the controlled intersection of the arterial street.

Grade: The vertical location of a street or utility (water main, gas, electric, fiber optic, wastewater line, etc)

Ground cover: Grasses or other plants grown to keep soil from being blown or washed away.

Ingress: Access from a public roadway to a land parcel.

Level of Service: The term used to indicate the quality of service provided by a facility under a given set of operating conditions.

Median: The portion of a divided roadway/highway separating the traveled ways for traffic in opposite directions. (2) A planted or paved section between two or more lanes in or near the center of the street not intended for vehicular travel.

Notice to Proceed: Written notice instructing the Contractor to proceed with the work.

Overlay: A method of street/road rehabilitation/repair consisting of milling off the top 1.5 to 2 inches and replacing it with fresh asphaltic concrete to seal and revitalize the street/road.

Pavement Marking: The lane lines or symbols painted on pavement surfaces.

Permanent Easement: A strip of land within a larger area to which the property owner grants permanent right-of-access by an individual or legal entity. Permanent Easements are acquired for a specific purpose. Any property ROW acquired in this manner remains the City's until it is sold or transferred by the City.

Pre-Cast Concrete: Conventionally reinforced (not pre-stressed) concrete products formed, cast, and cured in a casting yard and later incorporated into the work.

Pre-Stressed Concrete: Concrete subjected to compressive stresses, after hardening, using high strength tendons, for the purposes of eliminating or minimizing tensile like stresses in the concrete due to applied loads.

Profile Grade: A line that represents the roadway's vertical alignment as seen in the profile view.

Raised Median: That portion of the street that is raised above the travel-way by means of a curb and is used to separate opposing traffic. Also known as Raised Island or Traffic Island.

Reinforcement Bars (Rebar): Steel bars placed in concrete pavement or concrete structures to provide additional strength.

Right-of-Way (ROW): (1) Land, property or interest acquired for or devoted to storm drainage, wastewater, water, or transportation purposes. (2) This term can include acquisition of City property by deed, purchase of permanent easements, and/or temporary easements.

Riprap: Broken concrete or limestone rock placed to prevent erosion during construction of an embankment adjacent to a stream or lake.

Rutting: Permanent unrecoverable deformation to the surface of an asphaltic concrete pavement structure characterized by a surface cross section no longer in its design position.

Shoo-fly: A detour that is adjacent to construction.

Shop Drawing: A drawing furnished by the Contractor showing sufficient detailed information to build the object shown and described.

Shoulder: Portion of the roadway adjacent to the traveled way that can accommodate stopped vehicles for emergency use and for lateral support of base and surface courses. The shoulder can be made of turf, bituminous mixture, or concrete.

Soil Erosion: Wearing away of soil by the action of water, wind or glacial ice.

Soil Erosion and Sediment Control Measures: Standards used to retard deterioration or destruction of the land surface.

Stabilizing or Stabilization: The incorporation of materials into soils or aggregates to increase load-bearing capacity, firmness, and resistance to weathering or displacement.

Lincoln Standard Plan (LSP): A detailed drawing, approved for repetitive use showing details to be used where appropriate, used to reduce the number of required drawings to be supplied for each project. They provide uniformity of design and construction where the details are the same from project to project.

Subgrade: The top layer of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.

Surface Course: A pavement structure layer or layers constructed atop all other pavement layers and designed to accommodate the traffic load.

Surfacing: Material used to construct the upper layer (driving surface) of a pavement structure.

Temporary Easement: A strip of land within a larger area over which the property owner grants a temporary right-of-access to an individual or legal entity. Temporary Easements are acquired for a specific purpose, usually for construction purposes. Any property ROW acquired in this manner remains the City's until the construction of the project is complete.

Temporary Pavement: Pavement layers constructed to provide a temporary service to vehicular or pedestrian traffic.

Topography: Representation on maps or charts depicting natural and man-made features of an area or region.

Traffic Control Plan (TCP): A plan for handling traffic through a specific

highway or street work zone or project.

Traffic Marking: A traffic control device consisting of line, patterns, or colors on the pavement, curbs or other objects within or adjacent to the roadway; or words or symbols on the pavement.

Traffic Sign: A traffic control device mounted on a fixed or portable support that conveys a specific message by means of words or symbols. This is officially erected for the purpose of regulating, warning, or guiding traffic.

Trench Backfill: The materials used to backfill the excavation for utility construction

Watershed: The area contained within a divide above a specific point on a stream.

Waterway: A channel for the escape or passage of water.

Wetland: Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support (and that under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions.

REFERENCES, ABBREVIATIONS, AND ACRONYMS

AC	Asphaltic Cement
ADA	American Disabilities Act
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BMP	Best Management Practice
CCFMP	Centrifugally Cast Fiberglass Mortar Pipe
CITY	City of Lincoln
CIPP	Cured in Place Pipe
CMP	Corrugated Metal Pipe
DIP	Ductile Iron Pipe
DND	Do Not Disturb
EO	Executive Order
EPA	Environmental Protection Agency
ESC	Engineering Services Coordinator
GPS	Global Positioning System
HDPE	High Density Polyethylene
LPSNRD	Lower Platte South Natural Resource District
LSP	Lincoln Standard Plans
LWS	Lincoln Water System
NOI	Notice of Intent
NOV	Notice of Violation
INSPECTOR	City Engineering Inspector
PCA	Private Construction Agreement
PCC	Portland Cement Concrete
PCCP	Pre-stressed Concrete Cylinder Pipe
PM	Project Manager
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
PW&U	Public Works and Utilities
QA	Quality Assurance
RCP	Reinforced Concrete Pipe
ROW	Right-of-Way
SC	Service Connection
SWO	Stop Work Order
SWPPP	Stormwater Prevention Pollution Plan
TCP	Traffic Control Plan
VCP	Vitrified Clay Pipe

REFERENCE GUIDE

LWS: Water Main Pressure Testing

Nominal Pipe Size (inches)	Maximum Allowable Rate per 1,000 Feet (gallons/hour)	Test Pressure (psi)
6	0.64	200
8	0.85	200
12	1.28	200
16	1.47	150
24	2.21	150
30	2.76	150
36	3.31	150
48	4.41	150
54	4.97	150

Calculation Method:

Determine the allowable loss by using the table above. Add up the lineal feet of pipe, divide by 1000 then multiply by the maximum allowable rate (such as 0.64 for a 6" main). This calculation gives you the allowable loss in gallons for one hour, which should then be multiplied by 2 to get the allowable loss for the two hour test.

To determine the gallons per inch in the cylinder being used, multiply the square of the diameter by 0.7854 then multiply the depth of the cylinder by that factor which gives you the cubic feet of the cylinder, barrel, or bucket. Multiply the cubic feet of the cylinder by 7.48 to find the gallons the cylinder will hold. Divide the total gallons the cylinder will hold by the depth of the cylinder in inches to get the measurement needed to complete the test.

- When the pipeline being tested contains sections of various diameters, the allowable losses shall be the sum of the computed allowable losses for each size. Where sections are isolated for testing, the allowable losses will be computed for the length of sections being isolated.
- During the test period, the ground surface along the length of the section being tested shall be examined for leakage.

All detected leaks shall be repaired regardless of the test results.

Wastewater: Vacuum Testing Pipes

- Prior to testing, the backfill shall have been placed, compaction requirements fully met, and the line cleaned of all foreign matter.
- All equipment shall be checked for proper functioning prior to actual line testing. Use one (1) length of spare pipe laid on the ground; pressurize pneumatic plugs on each end to 25 psig; and internally pressurize the pipe to 5 psig. The plugs shall hold without bracing, and the line pressure gauge shall show no loss of air.
- Insert the pneumatic plugs at each end of the test segment; extend air lines to the top of the manhole; make sure no personnel remain in manholes; then carefully pressurize the plugs. Low pressure air shall be introduced into the sealed line until the internal pressure reaches 4 psig. Allow at least two (2) minutes for the air pressure to stabilize. Once the stabilization period has ended, reduce the internal pressure within the line segment to 3.5 psig. Disconnect the air supply to the control panel and begin testing. The portion of the line being tested passes if the time for the pressure to decrease 1 psig is greater than the time shown in the following table:

Pipe Diameter (inches)	Minimum Time (minutes)
6	2.8
8	3.8
10	4.7
12	5.7
15	7.1
18	8.5
21	9.9
24	11.3
27	12.7
30	14.2
36	17.0
42	19.8

Wastewater: Vacuum Testing Manholes

- All lift holes shall be plugged with an approved non-shrink grout.
- All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole.
- The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendation. Top of the manhole is considered to be the top of the casting forming the manhole lid.
- A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop 1 inch of mercury. The manhole shall pass if the time is greater than the time listed in the table below for the depth and diameter of the manhole being tested.
- If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained.

Manhole Depth (feet)	**Manhole Diameter (inches)**								
	30	33	36	42	48	54	60	66	72
	Time (seconds)								
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	56	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

Pavement

Asphalt cold weather placement

Lift thickness	Minimum surface Temperature
Less than 2 inches	45°F
2 to 3 inches	37°F
Greater than 3 inches	35°F

Type ‘A’ Sawing
Asphaltic Concrete pavement to be removed shall be isolated from the pavement to remain by cutting a joint with a wheel saw, through the full depth of the pavement. After the pavement base has been replaced, a 4 inch wide strip of the asphaltic concrete surface course shall be sawed and removed to provide a straight, smooth edge where the new asphaltic surfacing adjoins the existing surfacing.

Type ‘B’ Sawing
Portland Cement Concrete (PCC) pavement to be removed shall be isolated from the paving to remain by cutting a full depth saw cut, using either a wheel saw or diamond blade. If a wheel saw is used, additional sawing shall be required to provide smooth, straight and true vertical faces.

Type ‘C’ Sawing
Portland Cement Concrete (PCC) driveways and sidewalks to be removed shall be isolated from the driveway and sidewalk to remain by cutting a full depth saw cut.

Type ‘D’ Sawing
Asphaltic Concrete Surface Course to be removed from concrete base shall be sawed and removed to provide a straight, smooth edge where the new asphaltic surfacing will adjoin the existing.

Wheel Sawing

Pavement to be removed shall be isolated from the pavement to remain by cutting a joint with a wheel saw, through the full depth of the pavement.

Nominal Diameter inches	Tongue Length inches	Maximum Joint Opening inches	Minimum Radius in feet for Given Laying Length (LL) (using unbeveled round pipe)			
			4 ft. LL	6 ft. LL	7.5 ft LL	8 ft. LL
15	2	1 V2	52	78	98	
18	2 1/4	1 3/4	53	79	99	
21	3 V2	2 5/8	41	61	76	
24	2 3/4	2 1/16	59	88	110	
30	3 V2	2 5/8	57	85		108
36	3 V2	2 5/8	67	101		129
42	4	3	68	102		130
48	4 V2	3 3/16	73	110		140
54	5	3 3/4	70	104		131
60	5	3 3/4	77	115		146
66	5	3 3/4	85	127		161
72	5	3 3/4	92	138	170	174
78	5	3 3/4	100	149	184	188
84	4 V2	3 3/8	119	178	222	227

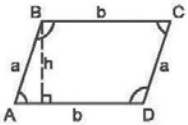
Common Equivalents

1 gallon of water weighs 8.34 lbs
1 cubic foot of water weighs 62.4 lbs
1 cubic foot of concrete weighs approximately 150 lbs
1 cubic foot of soil weighs approximately 100 to 120 lbs
1 cubic foot of steel weighs approximately 490 lbs

Conversion Factors

Multiply	By	To Obtain
°C	1.8 and then add 32	°F
°F	Subtract 32 then divide by 1.8	°C
acres	43,560	square feet (ft^2)
cm	0.394	inch (in)
cubic foot (ft^3)	7.481	gallon
cubic feet per second (cfs)	448	gallon per minute (gpm)
cubic meter (m^3)	1,000	liter (L)
feet	0.3048	meter (m)
gallon	3.785	liter (L)
hectare	42.4	Acres
horse power (hp)	745.7	Watt (W)
kilogram	2.205	pound (lbs)
kilometer per hour (km/hr)	0.621	miles per hour (mph)
mile	5,280	feet (ft)
miles per hour (mph)	1.609	kilometer per hour (km/hr)

PARALLELOGRAM

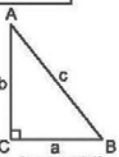


Area of ABCD = bh

RECTANGLE

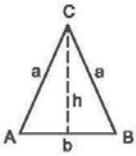
Perimeter = (l + h)
Area = l x h

RIGHT TRIANGLE



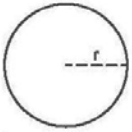
Area = ab/2
$c^2 = a^2 + b^2$
(Pythagorean Theorem)

ISOSCELES TRIANGLE



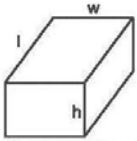
Area = bh/2

CIRCLE



Circumference of a circle = $2\pi r$
Area of a circle = πr^2

RECTANGULAR PRISM

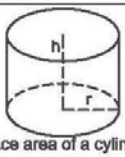


Surface area of a prism = 2(wl + lh + wh)
Volume of a prism = w x h

SPHERE

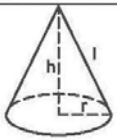
Surface area of a sphere = $4\pi r$
Volume of a sphere = $4\pi r^3/3$

CYLINDER



Surface area of a cylinder = $2\pi rh + 2\pi r^2$
Volume of a cylinder = $\pi r^2 h$

CONE



Surface area of a cone = $\pi rl + \pi r^2$ *(l=slant height)*
Volume of a cone = $\pi r^2 h/3$

PYRAMID

Surface area of a pyramid = B + Lateral area *(Lateral area = sum of triangular faces)*
Volume of a pyramid = Bh/3 *(B = area of base)*

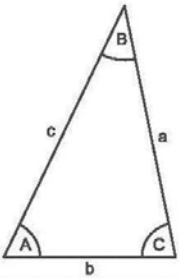
TRIGONOMETRIC RATIOS

$\sin(A+B) = \sin A \cos B + \text{con } A \sin B$
$\sin(A-B) = \sin A \cos B - \cos A \sin A$
$\cos(A+B) = \cos A \cos B - \sin A \sin B$
$\cos(A-B) = \cos A \cos B + \sin A \sin B$

$\tan(A+B) = \frac{\text{o (opposite)}}{\text{h (hypotenuse}}$

$\tan(A-B) = \frac{\text{a (adjecent)}}{\text{h (hypotenuse}}$

$\tan\theta = \frac{\sin\theta}{\cos\theta}$



Law of Sines

$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Law of Cosines

$a^2=b^2+c^2-2bc(\cos A)$
$b^2=a^2+c^2-2ac(\cos B)$
$c^2=a^2+b^2-2ab(\cos C)$

Law of Tangents

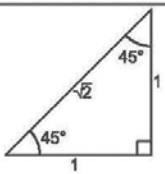
$\frac{a-b}{a+b} = \frac{\tan 1/2(A-B)}{\tan 1/2(A+B)}$

$\frac{b-c}{b+c} = \frac{\tan 1/2(B-C)}{\tan 1/2(B+C)}$

$\frac{c-a}{c+a} = \frac{\tan 1/2(C-A)}{\tan 1/2(C+A)}$

SLOPE

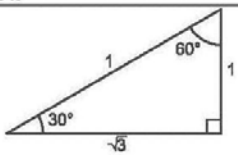
$\frac{\text{Rise}}{\text{Run}} = \frac{2 \text{ ft}}{200 \text{ ft}} = 0.01 \text{ ft/ft}$



$\sin 45° = \frac{1}{\sqrt{2}}$

$\cos 45° = \frac{1}{\sqrt{2}}$

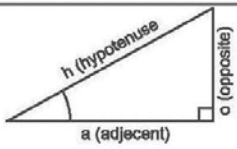
$\tan 45° = 1$



$\sin 30° = \frac{1}{\sqrt{2}}$ $\sin 60° = \frac{3}{\sqrt{2}}$

$\cos 30° = \frac{3}{\sqrt{2}}$ $\cos 60° = \frac{1}{\sqrt{2}}$

$\tan 30° = \frac{1}{\sqrt{3}}$ $\tan 60° = \sqrt{3}$



$\sin = \frac{\text{o (opposite)}}{\text{h (hypotenuse}}$

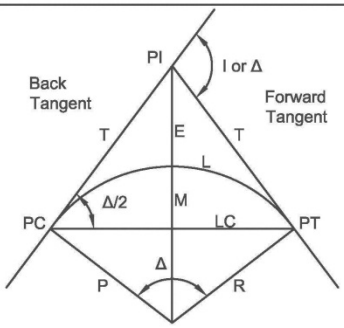
$\cos = \frac{\text{a (adjecent)}}{\text{h (hypotenuse}}$

$\tan = \frac{\text{o (opposite)}}{\text{a (adjecent)}}$

PC Sta. = PI Sta. - T
PT Sta. = PC Sta. + L

Deflection angle from tangent to chord is half the central angle of the subtended arc.

$$\text{Deflection Angle} = \frac{\text{Arc Length}}{100} \times \frac{D}{2}$$



Arc Definition...

$$R\ (ft) = \frac{5729.58}{D\ (\text{Degrees})}$$

$$T = R \tan \frac{\Delta}{2}$$

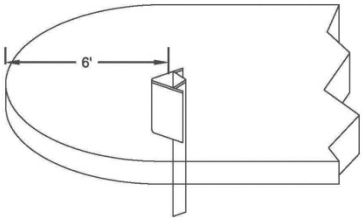
$$L = 100 \frac{\Delta}{D}$$

$$LC = 2 R \sin \frac{\Delta}{2}$$

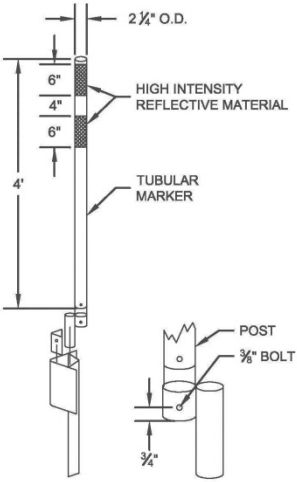
$$E = R \left[\frac{1}{\cos \frac{\Delta}{2}} - 1 \right]$$

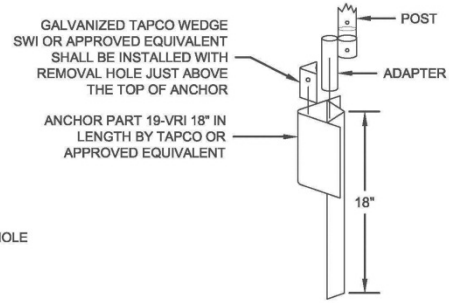
$$M = R (1 - \cos \frac{\Delta}{2})$$

GROUND SLEEVE SHALL BE PLACED PLUMB WITH THE TOP OF SLEEVE 1/4" TO 1/2" ABOVE SURFACE OF MEDIAN, CENTERED ON THE RADIUS AT THE END OF MEDIAN AND 6' BACK FROM TIP OF ISLAND. GROUND SLEEVE SHALL BE FREE OF DEBRIS OR CONCRETE. THE WEDGE SHALL BE POINTING TOWARDS MEDIAN NOSE.



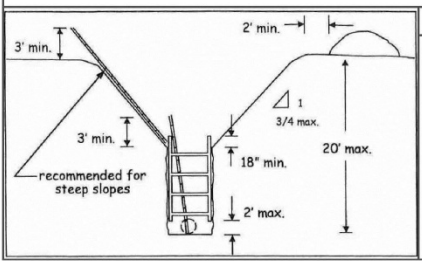
GROUND SLEEVE MEDIAN PLACEMENT DETAIL



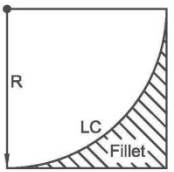


ADAPTER WILL CONSIST OF 2 PIECES OF PIPE WELDED TOGETHER, WITH TOPS EVEN AS SHOWN. THE SHORTER PIECE WILL BE 2" IN LENGTH AND 1 7/8" OUTSIDE DIAMETER. BOTH PIECES OF PIPE SHALL BE WELDED TOGETHER ON BOTH SIDES. TUBULAR MARKER SHALL BE SECURED TO ADAPTER USING A 3" X 5/16" HEX HEAD BOLT GRADE 2 AND NYLON LOCKING NUT.

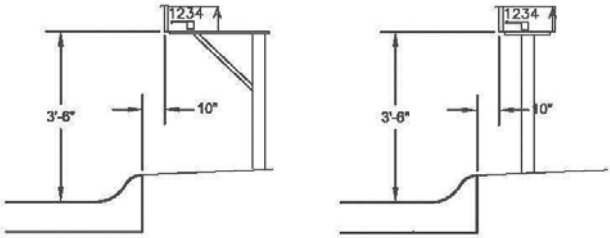
TUBULAR MARKER DETAIL



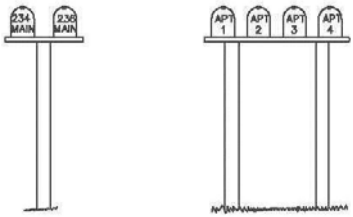
AREA OF A FILLET



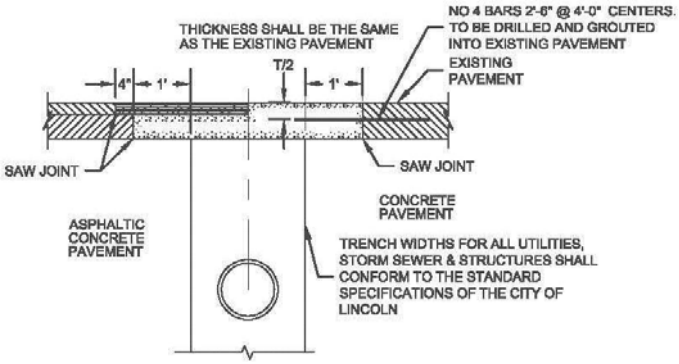
LC = 1.57 (R)
Fillet Area = 0.21 (R^3)
¼ Circle Area = 0.79 (R^2)



MAIL BOX INSTALLATIONS



MAILBOX GROUPING



NOTES:

1. THE EDGES OF ALL PAVING CUTS SHALL BE NEAT AND SQUARE. ALL CUTS IN EXISTING PAVEMENT SHALL BE MADE USING A CONCRETE SAW.
2. ALL CONCRETE SHALL CONFORM TO THE REQUIREMENTS OF THE CURRENT STANDARD SPECIFICATIONS OF THE CITY OF LINCOLN FOR L3500 CONCRETE OR BETTER.
3. GROUND EACH SIDE OF TRENCH SHALL BE UNDISTURBED FOR REPLACEMENT CONCRETE

PAVEMENT REPLACEMENT FOR UTILITY CONSTRUCTION