SECTION 02100
CLEARING AND GRUBBING

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Removing surface debris and rubbish.
- B. Clearing site of plant life and grass.
- C. Removing trees and shrubs.
- D. Removing root system of trees and shrubs.
- E. Fence removal.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for clearing and grubbing shall be on a per acre basis.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for work in this Section shall be included in Total Stipulated Price.

1.3 REGULATORY REQUIREMENTS
- A. Conform to applicable codes for disposal of debris.
- B. Coordinate clearing work with utility companies.

1.4 REFERENCES
- A. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS – Not Used

PART III: EXECUTION

3.1 PREPARATION
- A. Verify that existing plant life and features designated to remain are identified and tagged.

3.2 PROTECTION
- A. Protect following from damage or displacement:
  1. Living trees located three feet (3 Ft) or more outside of intersection of side slopes and original ground line.
  2. Plants and landscape features designated to remain.
  3. Utilities designated to remain.
  4. Benchmarks, monuments, and existing structures designated to remain.

3.3 CLEARING

A. Remove stumps, main root ball and root system to:
   1. Depth of twenty-four inches (24 In) below finished subgrade elevation in area bounded by lines two feet (2 Ft) behind back of curbs.
   2. Depth of twenty-four inches (24 In) below finished surface of required cross section for other areas.

B. Clear undergrowth and deadwood without disturbing subsoil.

C. Remove vegetation from top soil scheduled for reuse.

3.4 REMOVAL

A. Remove debris, rubbish and extracted plant material from site in accordance with requirements of Section 01580 – Waste Material Disposal.

B. Remove on-site fences: Materials generated from removal of fences shall become property of the Contractor. Properly dispose of materials in accordance with applicable local, state and federal laws, or as otherwise directed by the Project Manager.

END OF SECTION

SECTION 02105
REMOVING EXISTING PAVEMENTS AND STRUCTURES

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Removing concrete paving, asphaltic concrete pavement, brick pavement and base courses.
B. Removing concrete curbs, concrete curbs and gutters, sidewalks and driveways.
C. Removing pipe culverts, sewers and sewer leads.
D. Removing existing inlets and manholes.
E. Removing and disposing of concrete beams, including pre-stressed beams, and drill shafts.
F. Removing miscellaneous structures constructed of concrete or masonry.
G. Removing existing bridges.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:
1. Payment for removing and disposing of asphaltic surfacing with or without base, regardless of thickness encountered, shall be on a square yard basis measured between lips of gutters.
2. Payment for removing and disposing of reinforced concrete pavement, with or without asphalt overlay, regardless of thickness encountered, shall be on a square yard basis measured from back-to-back of curbs. Payment includes concrete pavement, esplanade curbs, curbs and gutters and paving headers.
3. Payment for removing and disposing of cement stabilized shell base course, with or without asphaltic surfacing, regardless of thickness encountered, shall be on a square yard basis.
4. Payment for removing and disposing of concrete sidewalks and driveways, regardless of thickness encountered, shall be on a square yard basis.
5. Payment for removing asphaltic surface course, regardless of thickness encountered, shall be on a square yard basis paid under item description "Asphalt Surface Mill." This includes removal of existing surface to pavement base.
6. Payment for removing and disposing of miscellaneous concrete and masonry items shall be on a cubic yard basis of structure in place.
7. Payment for removing and disposing of pipes, culverts, sewers and sewer leads shall be on a linear foot basis for each diameter and each material type of pipe removed.
8. Payment for removing and disposing of existing inlets shall be

on unit a price basis for each inlet removed.

9. Payment for removing and disposing of concrete piles, including pre-stressed piles, and drill shafts shall be on a linear foot basis.
10. Payment for removing and disposing of existing bridges, including piles and abutments to minimum of four feet (4 Ft) below ground level, shall be on a lump sum basis.
11. Payment for removing and disposing of existing manholes shall be on a unit price basis for each manhole removed.
12. No payment for saw cutting of pavement, curbs or curbs and gutters will be made under this section. Include cost of such work in unit prices for items requiring saw cutting which are listed on the Unit Price Form.
13. No payment will be made for work outside maximum payment limits indicated on the Drawings or for pavements, structures or other items removed for the Contractor's convenience.
    a. For utility installations: Actual pavement replaced should match but not be greater than maximum pavement replacement limits shown on the Drawings. Limits of measurement will be as shown on Street Cut Pavement Replacement Rules.
14. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):
    1. If Contract shall be Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REGULATORY REQUIREMENTS
A. Conform to applicable codes for disposal of debris.
B. Coordinate removal work with utility companies.

1.4 REFERENCES
A. CTFS – City of Friendswood Technical Specifications.

PART II: PRODUCTS – Not Used

PART III: EXECUTION

3.1 PREPARATION
A. Obtain advance approval from the Project Manager for dimensions and limits of pavement, structures and other items to be removed.
B. Identify known utilities below grade. Stake and flag locations.

3.2 PROTECTION
A. Protect the following from damage or displacement:
    1. Adjacent public and private property.

2. Trees, plants and other landscape features designated to remain.
3. Utilities designated to remain.
4. Pavement, structures and other items designated to remain.
5. Bench marks, monuments and other items designated to remain.

3.3 REMOVALS

A. Remove pavements, structures and other items by methods that will not damage underground utilities. Do not use drop hammer near existing underground utilities.
B. Minimize amount of earth loaded during removal operations.
C. Where existing pavement is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut to minimum depth of two inches (2 In).
D. When street and driveway saw cut location is greater than one-half (1/2) of pavement lane width, remove pavement for full lane width or to nearest longitudinal joint as directed by the Project Manager.
E. Remove sidewalks and curbs to nearest existing dummy, expansion or construction joint.
F. Where existing end of pipe culvert or end of sewer is to remain, install eight inch (8 In) thick masonry plug in pipe end prior to backfill in accordance with requirements of Section 02120 – Excavation and Backfill for Structures.

3.4 BACKFILL

A. Backfill of areas excavated during removal operations shall be in accordance with requirements of Section 02120 – Excavation and Backfill for Structures.

3.5 DISPOSAL

A. Inlet frames, grates and plates; and manhole frames and covers may, as directed, remain City property. Disposal shall be in accordance with requirements of Section 01580 – Waste Material Disposal.
B. Remove from site any debris resulting from work under this section in accordance with requirements of Section 01580 – Waste Material Disposal.

END OF SECTION

SECTION 02110
BORROW

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Soil materials for embankment.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for borrow shall be on a cubic yard basis calculated by theoretical quantities using average end area method based on the Drawings.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for work in this Section shall be included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials
  1. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil Aggregate Mixtures.
  2. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- B. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit location and description of proposed borrow area for approval.
- C. Submit material samples for testing.

PART II: PRODUCTS

2.1 SOIL MATERIAL
- A. Borrow material to be used for embankment shall be free of lumps greater than six inches (6 In), rocks larger than three inches (3 In), organic material, chemical waste or other contamination and debris. Take borrow material from sources approved by the Project Manager.

B. Material shall have a plasticity index not less than twelve (12), nor more than twenty (20) when tested in accordance with ASTM D4318. Maximum liquid limit shall be forty-five (45), unless approved by the Project Manager. Blending of cohesive and granular soils to achieve required plasticity index is not allowed.

PART III: EXECUTION

3.1 PREPARATION

A. Notify the Project Manager and testing laboratory five days (5 D) in advance of opening borrow source to permit obtaining samples for qualification testing. If material does not meet specification requirements, locate another source of borrow.

B. Clear approved source area of trees, stumps, brush, roots, vegetation organic matter and other unacceptable material before excavation.

3.2 TESTS

A. Test and analyze soil materials in accordance with ASTM D4318 and ASTM D2216 under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.

3.3 EXCAVATION

A. Provide adequate drainage of surface water so that surface water run off does not enter borrow pit excavation.

3.4 HAULING

A. Use covered trucks to transport material to site of embankment construction. Conform to requirements of Section 01555 – Traffic Control and Regulation.

END OF SECTION

SECTION 02115
EMBANKMENT

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Construction of embankments with qualified excess excavated material and borrow material.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No separate payment will be made for borrow material and handling under this section. Include payment in unit price for excavation or borrow.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for work in this Section shall be included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft_3 (600 kN-m/m_3)).
  2. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  3. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- B. CFTS – City of Friendswood Technical Specifications.
- C. TCEQ – Texas Commission on Environmental Quality.
- D. TDSHS – Texas Department of State Health Services.
- E. TRRC – Texas Railroad Commission.

PART II: PRODUCTS

2.1 MATERIALS
- A. Refer to Section 02135 – Excavation For Roadway, for acceptable excess materials from roadway excavation.
- B. Refer to Section 02125 – Excavation and Backfill For Utilities, for acceptable excess materials from utility excavation and trenching.
- C. Refer to Section 02110 – Borrow, for acceptable borrow materials.

PART III: EXECUTION

3.1 EXAMINATION

A. Verify that borrow and excess excavated materials to be reused are approved.

B. Verify that removal and clearing and grubbing operations have been completed.

3.2 PREPARATION

A. Backfill test pits, stump holes, small swales and other surface irregularities. Backfill and compact in designated lift depths to requirements for embankment compaction.

B. Record location and plug and fill inactive water and oil wells. Conform to Texas Department of State Health Services (TDSHS), Texas Commission on Environmental Quality (TCEQ) and Texas Railroad Commission (TRRC) requirements. Notify the Project Manager prior to plugging wells.

C. Excavate and dispose of unsuitable soil and other unsuitable materials which will not consolidate. Backfill and compact to requirements for embankment. Unsuitable soil is defined in Section 02120 – Excavation and Backfill for Structures and Section 02140 – Utility Backfill Materials.

D. Backfill new utilities below future grade. Conform to requirements of Sections 02125 – Excavation and Backfill For Utilities, 02400 – Water Lines, 02500 – Gravity Sanitary Sewers and 02510 – Sanitary Sewer Force Mains.

3.3 PROTECTION

A. Protect trees, shrubs, lawns, existing structures and other features outside of embankment limits.

B. Protect utilities above and below grade, which are to remain.

C. Conform to protection requirements of Section 02135 – Excavation For Roadway.

3.4 PLACING EMBANKMENT

A. Do not conduct placement operations during inclement weather or when existing ground or fill materials exceed three percent (3%) above optimum moisture content. The Contractor may manipulate wet material to facilitate drying by disking or windrowing.

B. Do not place embankment fill until density and moisture content of previously placed material complies with specified requirements.

C. Scarify areas to be filled to minimum depth of four inches (4 In) to bond existing and new materials. Mix with first (1st) fill layer.

D. Spread fill material evenly, from dumped piles or windrows, into horizontal layers approximately parallel to finished grade. Place proper thickness to meet specified compacted thickness. Break clods and lumps and mix materials by blading, harrowing, disking or other approved method. Extend each layer across full width of fill.
E. Each layer shall be homogeneous and contain uniform moisture content before compaction. Mix dissimilar abutting materials to prevent abrupt changes in composition of fill.
F. Layers shall not exceed the following compacted thickness:
    1. Areas indicated to be under future paving or shoulders, to be constructed within six months (6 Mos): six inches (6 In) when compacted with pneumatic rollers or eight inches (8 In) when compacted with other rollers.
    2. Other areas: Twelve inches (12 In).
G. For steep slopes, cut benches into slope and scarify before placing fill. Place increasingly wider horizontal layers of specified depth to level of each bench.
H. Build embankment layers on back slopes, adjacent to existing roadbeds, to level of old roadbed. Scarify top of old roadbed to minimum depth of four inches (4 In) and recompact with next fill layer.
I. Construct to lines and grades shown on the Drawings.
J. Remove unsuitable material and excess soil not being used for embankment from site in accordance with requirements of Section 01580 – Waste Material Disposal.
K. Maintain moisture content of embankment materials to attain required density.
L. Compact to following minimum densities at moisture content of optimum to three percent (3%) above optimum as determined by ASTM D698, unless otherwise indicated on the Drawings:
    1. Areas under future paving and shoulders: Minimum density of ninety-five percent (95%) of maximum dry density.
    2. Other areas: Minimum density of ninety percent (90%) of maximum dry density.

3.6 TOLERANCES
A. Top of compacted surface: Plus or minus one-half inch (±1/2 In) in cross section or in sixteen feet (16 Ft) longitudinally.

3.7 FIELD QUALITY CONTROL
A. Compaction Testing shall be performed in accordance with ASTM D698 or ASTM D2922 and ASTM D3017 under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.

B. A minimum of three (3) tests shall be taken for each one thousand linear feet (1000 Lf) per lane of roadway or five hundred square yards (500 Sy) of embankment per lift at random locations determined by the Project Manager.

C. If tests indicate work does not meet specified compaction requirements, recondition, recompact and retest at no cost to the City.

END OF SECTION

SECTION 02120
EXCAVATION AND BACKFILL FOR STRUCTURES

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Excavation, backfilling and compaction of backfill for structures

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No separate payment will be made for structural excavation and backfill under this Section. Include payment in unit price or lump sum for construction of structures.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for work in this Section shall be included in Total Stipulated Price.

1.3 DEFINITIONS
- A. Unsuitable Material
  1. Unsuitable soil materials are the following:
    a. Materials that are classified as ML, CL-ML, MH, PT, OH and OL according to ASTM D2487.
    b. Materials that cannot be compacted to required density due to gradation, plasticity or moisture content.
    c. Materials that contain large clods, aggregates, stones greater than four inches (4 In) in any dimension, debris, vegetation, waste or any other deleterious materials.
    d. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- B. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement shall be considered suitable, unless otherwise indicated.
- C. Select Material: Material as defined in Section 02140 – Utility Backfill Materials.
- D. Backfill: Select material meeting specified quality requirements, placed and compacted under controlled conditions around structures.
- E. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.

F. Foundation Base: For foundation base material, use crushed stone aggregate with filter fabric as required, cement-stabilized sand or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.

G. Foundation Subgrade: Foundation subgrade is surface of natural soil which has been excavated and prepared to support foundation base or foundation backfill, where needed.

H. Ground Water Control Systems: Installations external to excavation such as well points, eductors or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of excavation and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01585 – Control of Ground and Surface Water.

I. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from excavation. Remove rain water and surface water which accidentally enters excavation as part of excavation drainage.

J. Excavation Drainage: Removal of surface and seepage water in excavation by sump pumping and using French drains surrounding foundation to intercept water.

K. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below foundation as shown on the Drawings and backfilled with foundation backfill material.

L. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins.

1.4 REFERENCES

A. ASTM – American Society for Testing and Materials.
   1. ASTM D698 – Standard Test Methods for Laboratory Compaction of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600kN-m/m3)).
   2. ASTM D1556 – Standard Test Method for Density of Soil in Place by Sand-Cone Method.
   3. ASTM D2922 – Standard Test Methods for Density of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
   4. ASTM D3017 – Standard Test Method for Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths).
   5. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

B. CFTS – City of Friendswood Technical Specifications.

C. TxDOT – Texas Department of Transportation.
   1. TxDOT Tex-101-E – Preparing Soil and Flexible Base Materials for Testing.
   2. TxDOT Tex-110-E – Particle Size Analysis of Soils.

D. OSHA – Occupational Safety and Health Administration.
   1. Federal Regulations, 29 CFR, Part 1926, Standards – Excavation, Occupational Safety and Health Administration (OSHA).

1.5 SUBMITTALS
A. Conform to requirements of Section 01330 – Submittal Procedures.
B. Submit work plan for excavation and backfill for each structure with complete written description which identifies details of proposed method of construction and sequence of operations for construction relative to excavation and backfill activities. Use descriptions, with supporting illustrations, sufficiently detailed to demonstrate to the Project Manager that procedures meet requirements of the Technical Specifications and the Drawings.
C. Submit excavation safety system plan.
   1. Submit excavation safety system plan in accordance with applicable OSHA requirements for excavations.
   2. Submit excavation safety system plan in accordance with requirements of Section 02280 – Trench Safety Systems, for excavations that fall under State and Federal trench safety laws.
D. Submit ground and surface water control plan in accordance with requirements in this Section and Section 01585 – Control of Ground and Surface Water.
E. Submit backfill material sources and product quality information in accordance with requirements of Section 02140 – Utility Backfill Materials.
F. Submit project record documents under provisions of Section 01785 – Project Record Documents. Record location of utilities, as installed, referenced to survey benchmarks. Include location of utilities encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.6 TESTS
A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by the City in accordance with requirements of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures and as specified in this Section.
B. Perform embedment and backfill material source qualification testing in accordance with requirements of Section 02140 – Utility Backfill Materials.

PART II: PRODUCTS

2.1 EQUIPMENT

A. Perform excavation with equipment suitable for achieving requirements of this Specification.

B. Use equipment which will produce degree of compaction specified. Compact backfill within three feet (3 Ft) of walls with hand operated equipment. Do not use equipment weighing more than ten thousand pounds (10000) closer to walls than a horizontal distance equal to depth of fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

2.2 MATERIAL CLASSIFICATIONS

A. Use backfill materials conforming to classifications and product descriptions of Section 02140 – Utility Backfill Materials. Use classification or product description for backfill applications as shown on the Drawings and as specified.

PART III: EXECUTION

3.1 PREPARATION

A. Conduct an inspection to determine condition of existing structures and other permanent installations.

B. Set up necessary street detours and barricades in preparation for excavation if construction will affect traffic. Conform to requirements of Section 01555 – Traffic Control and Regulation. Maintain barricades and warning devices at all times for streets and intersections where work is in progress or where affected by the Work and such is considered hazardous to traffic movements.

C. Perform work in accordance with OSHA standards. Employ an excavation safety system as specified in Section 02280 – Trench Safety Systems.

D. Remove existing pavements and structures, including sidewalks and driveways, in accordance with requirements of Section 02105 – Removing Existing Pavements and Structures.

E. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01585 – Control of Ground and Surface Water.

3.2 PROTECTION

A. Protect trees, shrubs, lawns, existing structures and other permanent objects outside of grading limits and within grading limits as designated on the Drawings and in accordance with requirements of Section 01560 – Tree and Plant Protection.

B. Protect and support above-grade and below-grade utilities which are to remain.
C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on the Drawings.
D. Prevent erosion of excavations and backfill. Do not allow water to pond in excavations.
E. Maintain excavation and backfill areas until start of subsequent work. Repair and recompact slides, washouts, settlements or areas with loss of density at no additional cost to the City.

3.3 EXCAVATION

A. Perform excavation work so that underground structures can be installed to depths and alignments shown on the Drawings. Use caution during excavation work to avoid disturbing surrounding ground and existing facilities and improvements. Keep excavation to the absolute minimum necessary. No additional payment will be made for excess excavation not authorized by the Project Manager.
B. Upon discovery of unknown utilities, badly deteriorated utilities, utilities not designated for removal or concealed conditions, discontinue work at that location. Notify the Project Manager and obtain instructions before proceeding in such areas.
C. Immediately notify agency or company owning any line which is damaged, broken or disturbed. Obtain approval from the Project Manager and agency for any repairs or relocations, whether temporary or permanent.
D. Avoid settlement of surrounding soil due to equipment operations, excavation procedures, vibration, dewatering or other construction methods.
E. Provide surface drainage during construction to protect work and to avoid nuisance to adjoining property. Where required, provide proper dewatering and piezometric pressure control during construction.
F. Conduct hauling operations so that trucks and other vehicles do not create dirt nuisance in streets. Verify that truck beds are sufficiently tight and loaded in such a manner such that objectionable materials will not spill onto streets. Promptly clear away any dirt, mud or other materials that spill onto streets or are deposited onto streets by vehicle tires.
G. Maintain permanent benchmarks, monumentation and other reference points. Unless otherwise directed, replace those which are damaged or destroyed by the Work.
H. Provide sheeting, shoring and bracing where required to safely complete the Work, to prevent excavation from extending beyond limits indicated on the Drawings and to protect the Work and adjacent structures or improvements. Use sheeting, shoring and bracing to protect workmen and the general public, and which conforms to requirements of Section 02280 – Trench Safety Systems.

I. Prevent voids from forming outside of sheeting. Immediately fill voids with grout, cement-stabilized sand or other material approved by the Project Manager and compact to ninety-five percent (95%) standard density.

J. After completion of the structure, remove sheeting, shoring and bracing unless shown on the Drawings to remain in place or directed by the Project Manager in writing that such temporary structures may remain. Remove sheeting, shoring and bracing in such a manner as to maintain safety during backfilling operations and to prevent damage to the Work and adjacent structures or improvements.

K. Immediately fill and compact voids left or caused by removal of sheeting with cement-stabilized sand or other material approved by the Project Manager and compact to ninety-five percent (95%) standard density.

3.4 HANDLING EXCAVATED MATERIALS

A. Classify excavated materials: Place material which is suitable for use as backfill in orderly piles at sufficient distance from excavation to prevent slides or cave-ins.

B. Provide additional backfill material in accordance with requirements of Section 02110 – Borrow, if adequate quantities of suitable material are not available from excavation and trenching operations at site.

3.5 DEWATERING

A. Provide ground water control per Section 01585 – Control of Ground and Surface Water.

B. Keep ground water surface elevation minimum of two feet (2 Ft) below bottom of foundation base.

C. Maintain ground water control as directed by Section 01585 – Control of Ground and Surface Water and until structure is sufficiently complete to provide required weight to resist hydrostatic uplift with minimum safety factor of one and two tenths (1.2).

3.6 FOUNDATION EXCAVATION

A. Notify the Project Manager at least forty-eight hours (48 Hrs) prior to planned completion of foundation excavations. Do not place foundation base until excavation is accepted by the Project Manager.

B. Excavate to elevations shown on the Drawings to provide space for foundation base, forming a level undisturbed surface free of mud or soft material. Remove pockets of soft or otherwise unstable soils and replace with foundation backfill material or material as directed by the Project Manager. Prior to placing material over it, recompact subgrade where indicated on the Drawings, scarifying as needed, to ninety-five percent (95%) of maximum Standard Dry Density according to ASTM D698. If specified level of compaction cannot be achieved, moisture condition subgrade and recompact until ninety-five percent (95%) is achieved, over-excavate to provide minimum layer of twenty-four inches (24 In) of

foundation backfill material or other means acceptable to the Project Manager.

C. Fill unauthorized excessive excavation with foundation backfill material or other suitable material as directed by the Project Manager.

D. Protect open excavations from rainfall, runoff, freezing groundwater or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition. Keep excavations free of standing water and completely free of water during concrete placement.

E. Remove soils which become unsuitable due to inadequate dewatering, or other causes, after initial excavation to required subgrade and replace with foundation backfill material, as directed by the Project Manager, at no additional cost to the City.

F. Place foundation base or foundation backfill material over subgrade where needed, on same day that excavation is completed to final grade. Where base of excavations are left open for longer periods, protect them with seal slab or cement-stabilized sand.

G. Use filter fabric as specified in Section 02015 – Geotextile to separate crushed aggregate and other free draining Class I materials from native soils or select material backfill. Overlap fabric minimum of twelve inches (12 In) beyond where another material stops contact with soil.

H. Place crushed aggregate and other Class I materials in uniform layers of eight inch (8 In) maximum thickness. Perform compaction by means of at least two (2) passes of vibratory compactor.

3.7 FOUNDATION BASE.

A. Place foundation base after subgrade is properly prepared, including placement of foundation backfill where needed. Use foundation base consisting of twelve inch (12 In) layer of crushed stone aggregate or cement-stabilized sand. Alternately, seal slab with minimum thickness of four inches (4 In) may be placed. Extend foundation base minimum of twelve inches (12 In) beyond edge of structure foundation, unless shown otherwise on the Drawings.

B. Where foundation base and foundation backfill are of same material, both can be placed in one (1) operation.

3.8 BACKFILL

A. Complete backfill to surface of natural ground or to lines and grades shown on the Drawings. Remove forms, lumber, trash and debris from structures. Use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on the Drawings. Deposit backfill in uniform layers and compact each layer as specified.

B. Do not place backfill against concrete walls or similar structures until laboratory test breaks indicate that concrete has reached minimum of eighty-five percent (85%) of specified compressive strength. Where walls are supported by slabs or intermediate walls, do not begin backfill

operations until slab or intermediate walls have been placed and concrete has attained sufficient strength.

C. Remove concrete forms before starting backfill and remove shoring and bracing as work progresses.

D. Maintain backfill material at plus or minus three percent (±3%) of optimum moisture content, unless otherwise approved by the Project Manager. Place fill material in uniform eight inch (8 In) maximum loose layers. Compact fill to at least ninety-five percent (95%) of maximum Standard Proctor Density according to ASTM D698 below paved areas. Compact fill to at least ninety-five percent (95%) around structures below unpaved areas.

E. Where backfill is placed against sloped excavation surface, run compaction equipment across boundary of cut slope and backfill to form compacted slope surface for placement of next layer of backfill.

F. Place backfill using cement-stabilized sand in accordance with Section 02145 – Cement-Stabilized Sand.

G. Hydraulic or pneumatic equipment shall be used for all backfill operations. At no time shall the lift exceed the specifications above, even when using heavy construction equipment as a compact device.

3.9 FIELD QUALITY CONTROL

A. Testing shall be performed under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.

B. Tests shall be performed initially on minimum of one (1) different sample of each material type for plasticity characteristics, in accordance with ASTM D4318 and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.

C. In-place density tests of compacted subgrade and backfill shall be performed according to ASTM D1556 or ASTM D2922 and ASTM D3017 and at following frequencies and conditions:

1. Minimum of one (1) test for each lift of bedding and backfill material at intervals of five hundred feet (500 Ft) measured along the trench centerline or between every manhole, whichever results in greatest number of density tests, as determined by the Project Manager.
2. A minimum of three (3) density tests for each full work shift.
3. Density tests shall be performed in all placement areas.
4. Number of tests shall be increased when inspection determines that soil types or moisture contents are not uniform or when compacting effort is variable and not considered sufficient to attain uniform density.
5. Identify elevation of test with respect to natural ground.
6. Record approximate depth of lift tested.

D. At least one (1) test for moisture-density relationships shall be initially performed for each type of backfill material in accordance with ASTM

D698. Perform additional moisture-density relationship test once a month or whenever there is noticeable change in material gradation or plasticity.

E. When tests indicate work does not meet specified compaction requirements, recondition, recompact and retest at Contractor's expense.

3.10 DISPOSAL OF EXCESS MATERIAL

A. Excess material shall be the property of the Contractor and shall be disposed of properly with no cost to the City. Dispose of excess materials in accordance with requirements of Section 01580 – Waste Material Disposal.

END OF SECTION

SECTION 02125
EXCAVATION AND BACKFILL FOR UTILITIES

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Excavation, trenching, foundation, embedment and backfill for installation of utilities, including manholes and other related structures.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:
   1. No separate payment will be made for trench excavation, embedment and backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit or duct work.
   2. When the Project Manager directs the Contractor to over-excavate trench bottom, the Contractor shall be paid by the unit price bid per linear foot under Bid Item – Six inches (6 In) over-excavation of Trench Bottom.
      a. No payment shall be paid if the Project Manager does not direct the Contractor to over-excavate trench bottom.
      b. No over excavation shall be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01585 – Control of Ground and Surface Water.
   3. No separate payment shall be made for performing Critical Location exploratory excavation. Include cost in the unit price for work requiring critical location.
   4. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):
   1. If Contract is Stipulated Price Contract, payment for Work in this Section shall be included in Total Stipulated Price.

1.3 DEFINITIONS

A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on the Drawings or foundation backfill material placed and compacted in over-excavations.

B. Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe and horizontally from one (1) trench sidewall to opposite sidewall.

C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one (1) trench sidewall to opposite sidewall.

D. Initial Backfill: Portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to level line twelve inches (12 In) above top of pipe and horizontally from one (1) trench sidewall to opposite sidewall.

E. Pipe Embedment: Portion of trench backfill that consists of bedding, haunching and initial backfill.

F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.

G. Unsuitable Material: Unsuitable soil materials are the following:
   1. Materials that are classified as ML, CL-ML, MH, PT, OH and OL according to ASTM D2487.
   2. Materials that cannot be compacted to required density due to gradation, plasticity or moisture content.
   3. Materials that contain large clods, aggregates, stones greater than two inches (2 In) in any dimension, debris, vegetation, waste or any other deleterious materials.
   4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.

I. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.

J. Ground Water Control Systems: Installations external to trench, such as well points, eductors or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01585 – Control of Ground and Surface Water.

K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.

L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.

M. Trench Conditions are defined with regard to stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
   1. Dry Stable Trench: Stable and substantially dry trench

conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.

2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.
   a. Stable Trench with Seepage in Clay Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
   b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.

N. Unstable Trench: Unstable trench conditions exist in pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.

O. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.

P. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.

Q. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on the Drawings and backfilled with foundation backfill material.

R. Foundation Backfill Materials: Natural soil or manufactured aggregate of controlled gradation and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.

S. Trench Safety Systems include both protective systems and shoring systems as defined in Section 02280 – Trench Safety Systems.

T. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave-in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.

U. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins or to prevent movement of ground affecting adjacent installations or improvements.

V. Special Shoring: Shoring system meeting special shoring as specified in

Paragraph 1.8, Special Shoring Design Requirements, for locations identified on the Drawings.

1.4 REFERENCES

A. ASTM – American Society for Testing and Materials.
   1. ASTM C12 – Standard Practice for Installing Vitrified Clay Pipe Lines.
   2. ASTM D558 – Standard Test Methods for Moisture-Density Relations of Soil Cement Mixtures.
   3. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft).
   4. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
   5. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
   6. ASTM D2487 – Standard Classification of Soils for Engineering Purposes.
   7. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   8. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
   9. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

B. CFTS – City of Friendswood Technical Specifications.

C. OSHA – Occupational Safety and Health Administration.
   1. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

D. TxDOT – Texas Department of Transportation.
   1. TxDOT Tex-101-E – Preparing Soil and Flexible Base Materials for Testing.
   2. TxDOT Tex-110-E – Particle Size Analysis of Soils.

1.5 SCHEDULING

A. Schedule work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole or other related structures.

1.6 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.

B. Submit planned typical method of excavation, backfill placement and compaction including:
   1. Trench widths.
   2. Procedures for foundation and pipe zone bedding placement and trench backfill compaction.
   3. Procedures for assuring compaction against undisturbed soil

when pre-manufactured trench safety systems are proposed.

C. Submit backfill material sources and product quality information in accordance with requirements of Section 02140 – Utility Backfill Materials.
D. Submit trench excavation safety program in accordance with requirements of Section 02280 – Trench Safety Systems. Include designs for special shoring meeting requirements defined in Paragraph 1.8, Special Shoring Design Requirements contained herein.
E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts and gradients.
F. Submit eleven inch by seventeen inch (11 In x 17 In) copy of the Drawing with plotted utility or obstruction location titled "Critical Location Report" to the Project Manager.

1.7 TESTING

A. Testing and analysis of backfill materials for soil classification and compaction during construction shall be performed by an independent laboratory in accordance with requirements of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures and as specified in this Section.
B. Perform backfill material source qualification testing in accordance with requirements of Section 02140 – Utility Backfill Materials.

1.8 SPECIAL SHORING DESIGN REQUIREMENTS

A. Have special shoring designed or selected by the Contractor's Professional Engineer to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a premanufactured system selected by the Contractor's Professional Engineer licensed by the State of Texas to meet project site requirements based on manufacturer's standard design.

PART II: PRODUCTS

2.1 EQUIPMENT

A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.
B. Use only hand-operated pneumatic or hydraulic tamping equipment until minimum cover of twelve inches (12 In) is obtained over pipes, conduits and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits or ducts.
C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of

backfill directly against undisturbed native soil.

D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems or other systems meeting requirements as specified in Paragraph 1.8, Special Shoring Design Requirements.

2.2 MATERIAL CLASSIFICATIONS

A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02140 – Utility Backfill Materials.

B. Concrete Backfill: Conform to requirements for Class A concrete as specified in Section 03300 – Structural Concrete.

C. Geotextile (Filter Fabric): Conform to requirements of Section 02015 – Geotextile.

D. Concrete for Trench Dams: Concrete backfill or three (3) sack premixed (bag) concrete.

E. Timber Shoring Left in Place: Untreated oak.

PART III: EXECUTION

3.1 STANDARD PRACTICE

A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D2321 and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

B. Install rigid pipe to conform to standard practice described in ASTM C12 and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

C. Classification of material will be determined by the Project Manager.

3.2 PREPARATION

A. Establish traffic control to conform to requirements of Section 01555 – Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by the Work and are considered hazardous to traffic movements.

B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02280 – Trench Safety Systems.

C. Immediately notify agency or company owning any existing utility line which is damaged, broken or disturbed. Obtain approval from the Project Manager and agency for any repairs or relocations, either temporary or permanent.

D. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02105 – Removing

Existing Pavements and Structures, as applicable.

E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01585 – Control of Ground and Surface Water. Provide stable trench to allow installation in accordance with the Technical Specifications.

F. Maintain permanent benchmarks, monumentation and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 – Field Surveying.

3.3 CRITICAL LOCATION INVESTIGATION

A. Horizontal and vertical location of various underground lines shown on the Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations. **At Critical Locations shown on the Drawings, field verify horizontal and vertical locations of such lines within zone two feet (2 Ft) vertically and four feet (4 Ft) horizontally of the proposed work.**

1. Verify location of existing utilities a minimum of seven working days (7 wD) in advance of pipe laying activities based on daily pipe laying rate. Use extreme caution and care when uncovering these lines.
2. Notify the Project Manager in writing immediately upon identification of obstruction. In event of failure to identify obstruction a minimum of seven days (7 D) in advance, the Contractor shall not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until seven days (7 D) has passed from the time the Project Manager is notified of obstruction.
3. **Verify all locations where there is specified to be a tie-in into existing utilities or infrastructure before the start of excavation, so as to verify all grades and locations.** Failure to do so shall result in the replacement of the installed work at the Contractor's cost for any work installed before finding an error in elevations or locations.

B. Notify involved utility companies of date and time that excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide the Project Manager with at least forty-eight hours (48 Hrs) notice prior to excavation or related work.

C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot results on eleven inch by seventeen inch (11 In x 17 In) copy of the Drawings. For large diameter water lines,

submit to the Project Manager for approval, with horizontal and vertical alignment dimensions for connections to existing lines tied into project baseline, and signed and sealed by Registered Professional Land Surveyor (R.P.L.S.) licensed by the State of Texas.

3.4 PROTECTION

A. Protect trees, shrubs, lawns, existing structures and other permanent objects outside of grading limits and within grading limits as designated on Drawings and in accordance with requirements of Section 01560 – Tree and Plant Protection.

B. Protect and support above-grade and below-grade utilities which are to remain.

C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on the Drawings.

D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements or areas with loss of density or pavement failures or potholes occur, repair, recompact and pave those areas at no additional cost to the City.

3.5 EXCAVATION

A. Except as otherwise specified or shown on the Drawings, install underground utilities in open cut trenches with vertical sides.

B. Perform excavation work so that pipe, conduit and ducts can be installed to depths and alignments shown on the Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.

C. Determine trench excavation widths using TABLE 4.1 – TRENCH EXCAVATION WIDTHS as related to pipe outside diameter (O.D.), in this Section.

D. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill and other materials.

E. Upon discovery of unknown utilities, badly deteriorated utilities, utilities not designated for removal or concealed conditions, discontinue work at that location. Notify the Project Manager and obtain instructions before proceeding.

F. Shoring of Trench Walls.

1. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.
2. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports

sufficiently tight to prevent washing trench wall soil out from behind trench wall support.

3. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by the Project Manager. Leave rangers, walers and braces in place as long as required to support sheeting, which has been cut off and trench wall in vicinity of pipe zone.
4. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
5. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of one inch (1 In) thick steel plate. As sheeting is removed, fill in voids left with grouting material.

G. Use of Trench Shields: When trench shield (trench box) is used as worker safety device, the following requirements apply:
   1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.
   2. Move trench shields so that pipe and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re-compact after shield is moved if soil is disturbed.
   3. When required, place, spread and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.
   4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.
   5. Conform to applicable Government regulations.

H. Voids under paving area outside shield caused by the Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with the Contract Documents. Repair damage resulting from failure to provide adequate supports.

I. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.

J. Coordinate excavation within fifteen feet (15 Ft) of any products pipeline with company's representative. Support pipeline with methods agreed to by the Pipeline Company’s representative. Use small, rubber tired

excavator such as a backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within one foot (1 Ft) of the pipeline. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by the Pipeline Company's representative.

K. When, during excavation to uncover pipelines, a screwed collar or an oxyacetylene weld is exposed, immediately notify the Project Manager. Provide supports for collar or welds. Discuss with the Pipeline Company's representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request the Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.

3.6 HANDLING EXCAVATED MATERIALS

A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section 02140 – Utility Backfill Materials. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.

B. When required, provide additional backfill material conforming to requirements of Section 02140 – Utility Backfill Materials.

C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect backfill material to be used on site. Maintain site conditions in accordance with Section 01505 – Temporary Facilities and Controls. Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

3.7 TRENCH FOUNDATION

A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.

B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional six inches (6 In) with approval by the Project Manager. Place non-woven geotextile fabric and then compact twelve inches (12 In) of crushed stone in one lift on top of fabric. Compact crushed stone with four (4) passes of vibratory-type compaction equipment.

C. Perform over-excavation, if directed by the Project Manager, in accordance with Paragraph 3.7.B above. Removal of unstable or unsuitable material may be required if approved by the Project Manager;

1. Even though the Contractor has not determined material to be unsuitable or;
2. If unstable trench bottom is encountered and an adequate

ground water control system is installed and operating according to Section 01585 – Control of Ground and Surface Water.

D. Place trench dams in Class I foundations in line segments longer than one hundred feet (100 Ft) between manholes and not less than one (1) in every five hundred feet (500 Ft) of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than five feet (5 Ft) from manholes.

3.8 PIPE EMBEDMENT, PLACEMENT AND COMPACTION

A. Remove loose, sloughing, caving or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.

B. Place embedment including bedding, haunching and initial backfill as shown on the Drawings.

C. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls or against sheeting which is to remain in place.

D. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.

E. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.

F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.

G. Place haunching material manually around pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sand bags or other suitable means.

H. Place electrical conduit, if used, directly on foundation without bedding.

I. Shovel in-place and compact embedment material using pneumatic or hydraulic tampers in restricted areas and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping or jetting shall not allowed.

J. For water lines construction embedment, use bank run sand concrete sand gem sand pea gravel or crushed limestone as specified in Section 02140 – Utility Backfill Material. For water lines adhere to the following subparagraph numbers 1 and 2; for utility installation other than water, adhere to numbers 3 and 4 below:

1. Class I, II and III Embedment Materials:
    a. Maximum six inches (6 In) compacted lift thickness.

b. Compact to achieve minimum of ninety-five percent (95%) of maximum dry density as determined according to ASTM D698.
c. Moisture content to be within plus or minus three percent (±3%) of optimum as determined according to ASTM D698, unless otherwise approved by the Project Manager.

2. Cement-Stabilized Sand (where required for special installations):
   a. Maximum six inches (6 In) compacted thickness.
   b. Compact to achieve minimum of ninety-five percent (95%) of maximum dry density as determined according to ASTM D698.
   c. Moisture content to be on dry side of optimum as determined according to ASTM D698 but sufficient for effective hydration.
3. Class I Embedment Materials:
   a. Maximum six inches (6 In) compacted lift thickness.
   b. Systematic compaction by at least two (2) passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.
   c. Moisture content as determined by the Contractor for effective compaction without softening soil of trench bottom, foundation or trench walls.
4. Class II Embedment and Cement-Stabilized Sand:
   a. Maximum six inches (6 In) compacted thickness.
   b. Compaction by methods determined by the Contractor to achieve minimum of ninety-five percent (95%) of maximum dry density as determined according to ASTM D698 for Class II materials and according to ASTM D558 for Cement-Stabilized materials.
   c. Moisture content of Class II materials within three percent (±3%) of optimum as determined according to ASTM D698. Moisture content of Cement-Stabilized sands on dry side of optimum as determined according to ASTM D558 but sufficient for effective hydration.

K. Place trench dams in Class I embedment in line segments longer than one hundred feet (100 Ft) between manholes and not less than one (1) in every five hundred feet (500 Ft) of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than five feet (5 Ft) from manholes.

3.9 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for

construction.

B. For water lines, backfill in trench zone, including auger pits, intermediate and site pits, with bank run sand select fill or random backfill material as specified in Section 02140 – Utility Backfill materials.

C. For sewer pipes, use backfill materials described by trench limits. For "trench zone backfill" under pavement and to within one foot (1 Ft) back of curb, use Cement-Stabilized sand for pipes of nominal sizes thirty-six inches (36 In) in diameter and smaller to level twelve inches (12 In) below the pavement. For sewer pipes forty-two inches (42 In) in diameter and larger, under pavement or natural ground, in satisfactory soil conditions, backfill from twelve inches (12 In) above top of pipe to twelve inches (12 In) below pavement with suitable on-site material or select backfill. For sewer pipes forty-two inches (42 In) in diameter and larger, under pavement or natural ground, in unsatisfactory soil conditions, backfill from twelve inches (12 In) above top of pipe to twelve inches (12 In) below pavement with suitable on-site material or select backfill. Use select backfill for rigid pavements or flexible base material for asphalt pavements for twelve (12) inch backfill directly under pavement. For backfill materials reference Section 02140 – Utility Backfill Materials.

D. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting one and one-half feet (1-1/2 Ft) or more above crown of pipe. Remove trench supports within five feet (5 Ft) from ground surface.

E. When shown on Drawings, random backfill of suitable material may be used in trench zone for trench excavations outside pavements.

F. Place trench zone backfill in lifts and compact. Fully compact each lift before placement of next lift.

1. Class I, II, III or IV or combination thereof (Random Backfill):
    a. Maximum eight inches (8 In) compacted lift thickness.
    b. Compact by vibratory equipment to minimum of ninety-five percent (95%) of maximum dry density determined according to ASTM D698.
    c. Moisture content within plus or minus three percent (±3%) of optimum determined according to ASTM D698, unless otherwise approved by the Project Manager.
2. Cement-Stabilized Sand:
    a. Maximum lift thickness determined by the Contractor to achieve uniform placement and required compaction, but not to exceed twelve inches (12 In).
    b. Compact by vibratory equipment to minimum of ninety-five percent (95%) of maximum dry density determined according to ASTM D558.
    c. Moisture content on dry side of optimum determined according to ASTM D558 but sufficient for cement hydration.
3. Select Backfill:

a. Place in maximum eight inch (8 In) loose layers.
b. Compaction by equipment providing tamping or kneading impact to minimum of ninety-five percent (95%) of maximum dry density determined according to ASTM D698.
c. Moisture content within plus or minus three percent (±3%) above optimum determined according to ASTM D698, unless approved by the Project Manager.

G. Unless otherwise shown on the Drawings, for trench excavations not under pavement or in the right of way, random backfill of suitable material may be used in trench zone as directed by the Project Manager.
1. Fat clays (CH) may be used as trench zone backfill outside paved areas at the Contractor's option. When required density is not achieved, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements or use different suitable material at no additional cost to the City.
2. Maximum eight inch (8 In) compacted lift thickness for clayey soils and maximum eight inch (8 In) lift thickness for granular soils.
3. Compact to minimum of ninety percent (90%) of maximum dry density determined according to ASTM D698.
4. Moisture content as necessary to achieve density.

H. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

I. Water soaking, jetting or compaction by backhoe bucket is not acceptable and shall not be used.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

A. Meet requirements of adjoining utility installations for backfill of pipeline structures, as shown on the Drawings.

B. Below paved areas, encapsulate manhole with Cement-Stabilized sand; minimum of one foot (1 Ft) below base, minimum one foot (1 Ft) around walls, up to within twelve inches (12 In) of pavement subgrade. Compact in accordance with Paragraph 3.9.F.2 of this Section.

C. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on the Drawings. Deposit backfill in uniform layers and compact each layer as specified. Maintain backfill material at plus or minus three percent (±3%) of optimum moisture content, unless otherwise approved by the Project Manager. Place fill material in uniform eight inch (8 In) maximum loose layers. Compact fill to at least ninety-five percent (95%) of maximum Standard Proctor Density according to ASTM D698.

3.11 FIELD QUALITY CONTROL

A. Test for material source qualifications as defined in Section 02140 – Utility Backfill Materials.

B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to the City.

C. Tests will be performed on minimum of three (3) different samples of each material type for plasticity characteristics, in accordance with ASTM D4318 and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests shall be performed whenever there is noticeable change in material gradation or plasticity or when requested by the Project Manager.

D. At least three (3) tests for moisture-density relationships shall be performed initially for backfill materials in accordance with ASTM D698 and for cement-stabilized sand in accordance with ASTM D558. Perform additional moisture-density relationship tests once a month or whenever there is noticeable change in material gradation or plasticity.

E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials shall be performed according to ASTM D1556 or ASTM D2922 and ASTM D3017 and at following frequencies and conditions:

1. For open cut construction projects and auger pits: Unless otherwise approved by the Project Manager, successful compaction to be measured by one (1) test per one hundred linear feet (100 Lf) measured along pipe for compacted embedment and one (1) test per one hundred linear feet (100 Lf) measured along pipe for compacted trench zone backfill material and one (1) test at each auger pit.
2. A minimum of three (3) density tests for each full shift of Work.
3. Density tests shall be distributed among placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.
4. The number of tests shall be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.
5. Density tests at various depths below fill surface, if required, shall be performed by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
6. Two (2) verification tests shall be performed adjacent to in-place tests showing density less than acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
7. Recompacted placement shall be retested at same frequency as first test series, including verification tests.
8. Identify elevation of test with respect to natural ground or pavement.

F. Recondition, recompact and retest at the Contractor's expense if tests indicate the Work does not meet specified compaction requirements. For

hardened soil cement with nonconforming density, core and test for compressive strength at the Contractor's expense.

G. Acceptability of crushed rock compaction will be determined by inspection.

3.12 DISPOSAL OF EXCESS MATERIAL

A. Excess material shall be the property of the Contractor and shall be disposed of properly with no cost to the City. Dispose of excess materials in accordance with requirements of Section 01580 – Waste Material Disposal.

PART IV: TABLES

4.1 TABLE EXCAVATION WIDTHS

Nominal Pipe Size, inches	Minimum Trench Width, inches
Less than 18”	O.D. + 18”
18” to 30”	O.D. + 24”
36” to 42”	O.D. + 36”
Greater than 42”	O.D. + 48”

END OF SECTION

SECTION 02130
EXTRA UNIT PRICE WORK FOR EXCAVATION AND BACKFILL

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Measurement and payment applicable to extra unit price work items for excavation and backfill made necessary by unusual or unforeseen circumstances encountered during utility installations.

B. Extra unit price work for excavation and backfill shall be paid only when authorized in advance by the Project Manager.

1.2 UNIT PRICES:

A. Extra Excavation Around Obstructions: Payment for excavation around obstructions shall be on a cubic yard basis, measured in place, without deduction for volume occupied by portions of pipes, ducts, or other structures left in place across trenches excavated under this item.

B. Extra Hand Excavation: Payment for extra hand excavation shall be on a cubic yard basis, measured in place.

C. Extra Machine Excavation: Payment for extra machine excavation shall be on a cubic yard basis, measured in place.

D. Extra Placement of Backfill Material: Payment for extra placement of backfill material shall be on a cubic yard basis, measured in place, for material installed as part of the Work. At discretion of the Project Manager, measurement of cubic yards may be calculated from volume of Extra Hand Excavation or Extra Machine Excavation for which replacement is made, minus volume of any Extra Placement of Granular Backfill authorized in conjunction with the Work.

E. Extra Placement of Granular Backfill: Payment for extra placement of granular backfill material shall be on a cubic yard basis, measured in place.

F. No separate payment will be made for surface water control, groundwater control, or for excavation drainage. Refer to Section 01270 – Measurement and Payment for unit price procedures.

1.3 DEFINITIONS

A. Excavation Around Obstructions: Excavation necessitated by obstruction of pipes (other than service connections three inches (3 in) in diameter or less), ducts, or other structures, not shown on the Drawings, and of an unusual or unforeseen nature which interfere with installation of utility piping by normal methods of excavation or auguring.

B. Extra Hand Excavation: Excavation by manual labor made necessary by unusual or unforeseen circumstances at locations approved in advance by the Project Manager.

C. Extra Machine Excavation: Excavation by machine at or near project site

to perform related work not included in original project scope but added for convenience of the City, as approved in advance by the Project Manager.

D. Extra Replacement of Backfill Material: Handling, backfill, and compaction of excavated material authorized under extra work bid items for Extra Hand Excavation or Extra Machine Excavation as approved in advance by the Project Manager. Placement and compaction shall conform to requirements specified for excavation and backfill in Division 2 - Site Work.

E. Extra Placement of Granular Backfill: Hauling, placing, and compacting granular backfill materials as approved by the Project Manager in conjunction with Extra Replacement of Backfill Material. Materials placed under this item shall conform to requirements for Bank Run Sand, Cement Stabilized Sand, Concrete Sand, Gem Sand, Crushed Stone, or Crushed Concrete specified for backfill material in Division 2 - Site Work.

1.4 REFERENCES

A. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS – Not Used

PART III: EXECUTION – Not Used

END OF SECTION

SECTION 02135
EXCAVATION FOR ROADWAY

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Excavation and compaction of materials for roadways.
- B. Excavation and compaction of materials for roadside ditches.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for roadway excavation shall be on a cubic yard basis.
  2. No payment will be made for material excavated under the following conditions:
     - a. More than two feet (2 Ft) outside of vertical planes behind back of curbs.
     - b. For portion within limits of trench for utilities twenty-four inch (24 In) and greater constructed by open-cut methods.
     - c. As indicated otherwise on the Drawings.
  3. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for work in this Section shall be included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44 ft-lbf/ft^3).
  2. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
  3. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  4. ASTM D3017 – Standard Test Method for Water content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
  5. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- B. CFTS – City of Friendswood Technical Specifications.
- C. TCEQ – Texas Commission on Environmental Quality.
- D. TDH – Texas Department of Health.
- E. RRC – Railroad Commission of Texas.

PART II: PRODUCTS

2.1 MATERIALS

A. Provide topsoil conforming to requirements of Section 02905 – Topsoil.

B. Provide backfill which is excavated material, graded free of roots, lumps greater than six inches (6 In), rocks larger than three inches (3 In), organic material and debris.

C. Provide structural backfill which is select material meeting following requirements:

1. Plasticity index: Not less than twelve (12) or more than twenty (20).
2. Maximum liquid limit: Forty-five (45).

PART III: EXECUTION

3.1 PREPARATION

A. Identify required lines, levels and datum. Coordinate with Section 01725 – Field Surveying.

B. Identify and flag surface and aerial utilities.

C. Notify utility companies to remove or relocate utilities.

D. Identify, stake and flag known utility locations below grade. Make temporary or permanent relocation of underground pipes, ducts or utilities where indicated on the Drawings.

E. Upon discovery of unknown or badly deteriorated utilities or concealed conditions, discontinue work. Notify the Project Manager and obtain instructions before proceeding in such areas.

F. Obtain approval of top soil quality before excavating and stockpiling.

3.2 PROTECTION

A. Protect following from damage or displacement:

1. Trees, shrubs, lawns, existing structures and other features outside of grading limits.
2. Utilities either above or below grade, which are to remain.

3.3 TOPSOIL REMOVAL

A. Strip off topsoil from area to be excavated to minimum depth of six inches (6 In), unless indicated otherwise on the Drawings.

B. Stockpile topsoil in designated location for reuse. Stockpile topsoil to depth not exceeding eight feet (8 Ft). Cover to protect from erosion.

3.4 SOIL EXCAVATION

A. Excavate to lines and grades shown on the Drawings.

B. Remove unsuitable material not meeting specifications. Backfill with embankment materials and compact to requirements of Section 02115 – Embankment.

C. Record location and plug and fill inactive water and oil wells. Conform to Texas Department of Health, Texas Commission on Environmental Quality and Texas Railroad Commission requirements. Notify the Project Manager prior to plugging wells.
D. At intersections, grade back at minimum slope of one inch per foot (1 In/Ft). Produce smooth riding junction with intersecting street. Maintain proper drainage.
E. When area is inadvertently over-excavated, fill area in accordance with requirements of Section 02115 – Embankment at no additional cost to the City.
F. Remove material not qualified for use and excess soil not being reused from site in accordance with requirements of Section 01580 – Waste Material Disposal.

3.5 COMPACTION
A. Maintain optimum moisture content of subgrade to attain required density.
B. Compact to following minimum densities at moisture content of optimum to plus or minus three percent (±3%) optimum as determined by ASTM D698, unless otherwise indicated on the Drawings:
1. Areas under future paving and shoulders: Minimum density of ninety-five percent (95%) of maximum dry density.
2. Other areas: Minimum density of ninety percent (90%) of maximum dry density.

3.6 TOLERANCES
A. Top of Compacted Surface: Plus or minus one-half inch (±1/2 In) in cross section or in sixteen feet (16 Ft) longitudinally.

3.7 FIELD QUALITY CONTROL
A. Testing shall be performed under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.
B. Test and analysis of soil materials shall be performed in accordance with ASTM D4318, ASTM D2216 and ASTM D698.
C. Compaction testing shall be performed in accordance with ASTM D698 or ASTM D2922 and ASTM D3017.
D. A minimum of three (3) tests shall be taken for each one thousand linear feet (1000 Lf) per lane of roadway at random locations as specified by the the Project Manager.
E. When tests indicate work does not meet specified compaction requirements, recondition, recompact and retest at no additional cost to the City.

3.8 PROTECTION

A. Prevent erosion at all times. Maintain ditches and cut temporary swales to allow natural drainage in order to avoid damage to roadway. Do not allow water to pond.

B. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

C. Maintain excavation and embankment areas until start of subsequent work. Repair and recompact slides, washouts, settlements or areas with loss of density.

END OF SECTION

SECTION 02140
UTILITY BACKFILL MATERIALS

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Material Classifications.
- B. Utility Backfill Materials:
  1. Concrete sand.
  2. Gem sand.
  3. Pea gravel.
  4. Crushed stone.
  5. Crushed concrete.
  6. Bank run sand.
  7. Select backfill.
  8. Random backfill.
- C. Material Handling and Quality Control Requirements.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No separate payment will be made for backfill material. Include payment in unit price for applicable utility installation.
  2. Payment for backfill material, when included as separate pay item or when directed by the Project Manager, shall be on a cubic yard basis for material placed and compacted within theoretical trench width limits and thickness of material according to the Drawings or as directed by the Project Manager.
  3. Payment for backfill of authorized over-excavation is in accordance with Section 02130 – Extra Unit Price Work for Excavation and Backfill.
  4. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for work in this Section shall be included in Total Stipulated Price.

1.3 DEFINITIONS
- A. Unsuitable Material:
  1. Materials classified as ML, CL-ML, MH, PT, OH and OL according to ASTM D2487.
  2. Materials that cannot be compacted to required density due to gradation, plasticity or moisture content.
  3. Materials containing large clods, aggregates or stones greater than four inches (4 In) in any dimension; debris, vegetation or waste; or any other deleterious materials.

4. Materials contaminated with hydrocarbons or other chemical contaminants.

B. Suitable Material:
   1. Materials meeting specification requirements.
   2. Unsuitable materials meeting specification requirements for suitable soils after treatment with lime or cement.

C. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material shall be placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs as directed by the Project Manager.

D. Foundation Base: Crushed stone aggregate with filter fabric as required, cement-stabilized sand or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.

E. Backfill Material: Classified soil material meeting specified quality requirements for designated application as embedment or trench zone backfill.

F. Embedment Material: Soil material placed under controlled conditions within embedment zone extending vertically upward from top of foundation to an elevation twelve inches (12 In) above top of pipe and including pipe bedding, haunching and initial backfill.

G. Trench Zone Backfill: Classified soil material meeting specified quality requirements and placed under controlled conditions in trench zone from top of embedment zone to base course in paved areas or to surface grading material in unpaved areas.

H. Foundation: Either suitable soil of trench bottom or material placed as backfill of over-excavation for removal and replacement of unsuitable or otherwise unstable soils.

I. Source: Source selected by the Contractor for supply of embedment or trench zone backfill material. Selected source may be project excavation, off-site borrow pits, commercial borrow pits or sand and aggregate production or manufacturing plants, subject to approval by the Project Manager.

J. Refer to Section 02125 – Excavation and Backfill for Utilities for other definitions regarding utility installation by trench construction.

1.4 REFERENCES

A. ASTM – American Society for Testing and Materials.
   1. ASTM C33 – Standard Specification for Concrete Aggregate.
   2. ASTM C40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   3. ASTM C123 – Standard Test Method for Lightweight Particles in Aggregate.
   4. ASTM C131 – Standard Test Method for Resistance to

Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in Los Angeles Machine.

5. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
6. ASTM C142 – Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
7. ASTM D1140 – Standard Test Method for Amount of Material in Soils Finer Than No. 200 Sieve.
8. ASTM D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
9. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
10. ASTM D4643 – Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Method.

B. CFTS – City of Friendswood Technical Specifications.

C. TxDOT – Texas Department of Transportation.

1. TxDOT Tex-110-E – Determining Particle Size Analysis of Soils.
2. TxDOT Tex-460-A – Material Finer Than 75 Fm (No.200) Sieve In Mineral Aggregates (Decantation Test for Concrete Aggregates).

1.5 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.

B. Submit description of source, material classification and product description, production method and application of backfill materials.

C. Submit test results for samples of off-site backfill materials. Comply with Paragraph 2.3, Material Testing.

D. Before stockpiling materials, submit copy of approval from landowner for stockpiling backfill material on a private property.

E. Provide delivery ticket which includes source location for each delivery of material that is obtained from off-site sources or is being paid as a specific bid item.

1.6 TESTS

A. Perform tests of sources for backfill material in accordance with Paragraph 2.3.B.

B. Verification tests of backfill materials shall be performed by the City in accordance with Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures and in accordance with Paragraph 3.3.

1.7 EMBEDEMENT

A. Gravity Sanitary Sewers and Storm sewers shall use Cement-Stabilized Sand for bedding, haunching and initial backfill.

B. Water lines and Force Main Sewers shall use Bank run sand for bedding, haunching and initial backfill.

PART II: PRODUCTS

2.1 MATERIAL CLASSIFICATIONS

A. Classify materials for backfill for purpose of quality control in accordance with Unified Soil Classification Symbols as defined in ASTM D2487. Material use and application is defined in utility installation specifications and the Drawings either by class, as described in Paragraph 2.1.B or by product descriptions, as given in Paragraph 2.2.

B. Class Designations Based on Laboratory Testing:

1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
   a. Plasticity index: Non-plastic.
   b. Gradation: D_{60}/D_{10} – greater than four percent (4%); amount passing No. 200 sieve – less than or equal to five percent (5%).
2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines (GM, GP, SP, SM):
   a. Plasticity index: Non-plastic to four (4).
   b. Gradations:
      1) Gradation (GP, SP): amount passing No. 200 sieve – less than five percent (5%).
      2) Gradation (GM, SM): amount passing No. 200 sieve – between twelve percent (12%) and fifty percent (50%).
      3) Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve – between five percent (5%) and twelve percent (12%).
3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt and clay (GC, SC and dual classifications, e.g., SP-SC):
   a. Plasticity index: Greater than seven (7).
   b. Gradation: Amount passing No. 200 sieve – between twelve percent (12%) and fifty percent (50%).
4. Class IVA: Lean clays (CL).
   a. Plasticity Indexes:
      1) Plasticity index: Greater than seven (7) and above A line.
      2) Borderline plasticity with dual classifications (CL-ML): PI between four (4) and seven (7).
   b. Liquid limit: Less than fifty (50).
   c. Gradation: Amount passing No. 200 sieve – greater than fifty percent (50%).
   d. Inorganic.
5. Class IVB: Fat clays (CH).

a. Plasticity index: Above A line.
b. Liquid limit: Fifty (50) or greater.
c. Gradation: Amount passing No. 200 sieve – greater than fifty percent (50%).
d. Inorganic.

6. Use soils with dual class designation according to ASTM D2487 and which are not defined above, according to more restrictive class.

2.2 PRODUCT DESCRIPTIONS

A. Soils classified as silt (ML) silty clay (CL-ML with PI of four (4) to seven (7), elastic silt (MH), organic clay and organic silt (OL, OH) and organic matter (PT) are not acceptable as backfill materials. These soils may be used for site grading and restoration in unimproved areas as approved by the Project Manager. Soils in Class IVB, fat clay (CH) may be used as backfill materials where allowed by applicable backfill installation specification. Refer to Section 02120 – Excavation and Backfill for Structures and Section 02125 – Excavation and Backfill for Utilities.

B. Provide backfill material that is free of stones greater than six inches (6 In), free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to following limits for deleterious materials:
1. Clay lumps: Less than one-half percent (1/2%) for Class I and less than two percent (2%) for Class II, when tested in accordance with ASTM C142.
2. Lightweight pieces: Less than five percent (5%) when tested in accordance with ASTM C123.
3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C40.

C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in product specification and as approved by the Project Manager, provided that physical property criteria are determined to be satisfactory by testing.

D. Bank Run Sand: Durable bank run sand classified as SP, SW or SM by Unified Soil Classification System (ASTM D2487) meeting following requirements:
1. Less than fifteen percent (15%) passing No. 200 sieve when tested in accordance with ASTM D1140. Amount of clay lumps or balls may not exceed two percent (2%).
2. Material passing No. 40 sieve shall meet the following requirements when tested in accordance with ASTM D4318: Plasticity index: not exceeding seven (7).

E. Concrete Sand: Natural sand, manufactured sand or combination of natural and manufactured sand conforming to requirements of ASTM C33 and graded within limits specified in Table 4.1 – SIEVE ANALYSIS REQUIREMENTS FOR CONCRETE SAND in this section, when tested

in accordance with ASTM C136.

F. Gem Sand: Sand conforming to requirements of ASTM C33 for course aggregates specified for No. 8 size and graded within the limits specified in Table 4.2 – SIEVE ANALYSIS REQUIREMENTS FOR GEM SAND in this section, when tested in accordance with ASTM C136.

G. Pea Gravel: Durable particles composed of small, smooth, rounded stones or pebbles and graded within the limits specified in Table 4.3 – SIEVE ANALYSIS REQUIREMENTS FOR PEA GRAVEL in this section, when tested in accordance with ASTM C136.

H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:
   1. Materials of one (1) product delivered for same construction activity from single source, unless otherwise approved by the Project Manager.
   2. Non-plastic fines.
   3. Los Angeles abrasion test wear not exceeding forty-five percent (45%) when tested in accordance with ASTM C131.
   4. Crushed aggregate shall have minimum of ninety percent (90%) of particles retained on a No. 4 sieve with two (2) or more crushed faces as determined by Tex-460-A, Part I.
   5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from naturally occurring single source. Uncrushed gravel is not acceptable materials for embedment where crushed stone is shown on applicable utility embedment drawing details.
   6. Crushed Concrete: Crushed concrete is an acceptable substitute for crushed stone as utility backfill. Gradation and quality control test requirements are same as crushed stone. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate) or debris.
   7. Gradations, as determined in Table 4.4 – SIEVE ANALYSIS REQUIREMENTS FOR CRUSHED AGGREGATE in this section, in accordance with Tex-110-E.

I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with plasticity index between seven (7) and twenty (20) or clayey soils treated with lime in accordance with Section 02845 – Pavement Repair and Resurfacing, to meet plasticity criteria.

J. Random Backfill: Any suitable soil or mixture of soils within Classes I, II, III and IV; or fat clay (CH) where allowed by applicable backfill installation specification. Refer to Section 02120 – Excavation and Backfill for Structures and Section 02125 – Excavation and Backfill for Utilities.

K. Cement-Stabilized Sand: Conform to requirements of Section 02145 – Cement-Stabilized Sand.

L. Concrete Backfill: Conform to Class A concrete as specified in Section 03300 – Structural Concrete.
M. Flexible Base Course Material: Conform to requirements of applicable portions of Section 02700 – Cement-Stabilized Base Course, Section 02705 – Crushed Concrete Base Course and Section 02715 – Hot-Mix Asphaltic Base Course.

2.3 MATERIAL TESTING
A. Source Qualification: Perform testing to obtain tests by suppliers for selection of material sources and products not from the project site. Test samples of processed materials from current production representing material to be delivered. Use tests to verify that materials meet specification requirements. Repeat qualification test procedures each time source characteristics change or there is planned change in source location or supplier. Include the following qualification tests, as applicable:
1. Gradation: Report complete sieve analyses regardless of specified control sieves from largest particle through No. 200 sieve.
2. Plasticity of material passing No. 40 sieve.
3. Los Angeles abrasion wear of material retained on a No. 4 sieve.
4. Clay lumps.
5. Lightweight pieces.
6. Organic impurities.
B. Production Testing: Provide reports to the Project Manager from an independent testing laboratory that backfill materials to be placed in the Work meet applicable specification requirements.
C. Assist the Project Manager in obtaining material samples for verification testing at source or at production plant.

PART III: EXECUTION

3.1 SOURCES
A. Use of existing material in trench excavations is acceptable, provided applicable Technical Specification requirements are satisfied.
B. Identify off-site sources for backfill materials at least fourteen days (14 D) ahead of intended use so that the Project Manager may obtain samples for verification testing.
C. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet requirements of specifications shall be rejected. Do not use material which, after approval, has become unsuitable for use due to segregation, mixing with other materials or by contamination. Once material is approved by the Project Manager, expense for sampling and testing required to change to different material shall be arranged and paid for by the Contractor.

D. Bank run sand, select backfill and random backfill, if available in project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete work from off-site sources.
E. The City does not represent or guarantee that any soil found in excavation work will be suitable and acceptable as backfill material.

3.2 MATERIAL HANDLING

A. When backfill material is obtained from either commercial or non-commercial borrow pit, open pit to expose vertical faces of various strata for identification and selection of approved material to be used. Excavate selected material by vertical cuts extending through exposed strata to achieve uniformity in product.
B. Establish temporary stockpile locations for practical material handling, control and verification testing by the Project Manager in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.
C. When stockpiling backfill material near project site, use appropriate covers to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering drainage system.
D. Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

3.3 FIELD QUALITY CONTROL

A. Quality Control.
    1. The Project Manager may sample and test backfill at:
        a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.
        b. On-site stockpiles.
        c. Materials placed in the Work.
    2. The Project Manager may re-sample material at any stage of work or location if changes in characteristics are apparent.
B. Production Verification Testing: A Certified testing laboratory as described in Section 01470 – Testing Laboratory Services, will provide verification testing on backfill materials, as directed by the Project Manager. Samples may be taken at source or at production plant, as applicable.

PART IV: TABLES

4.1 SIEVE ANALYSIS REQUIREMENTS FOR CONCRETE SAND

Sieve	Percent Passing
3/8”	100%
No. 4	95% to 100%
No. 8	80% to 100%
No. 16	50% to 85%
No. 30	25% to 60%
No. 50	10% to 30%
No. 100	2% to 10%

4.2 SIEVE ANALYSIS REQUIREMENTS FOR GEM SAND

Sieve	Percent Passing
3/8”	95% to 100%
No. 4	60% to 80%
No. 8	15% to 40%

4.3 SIEVE ANALYSIS REQUIREMENTS FOR PEA GRAVEL

Sieve	Percent Passing
1/2"	100%
3/8”	85% to 100%
No. 4	10% to 30%
No. 8	0% to 10%
No. 16	0% to 5%

4.4 SIEVE ANALYSIS REQUIREMENTS FOR CRUSHED AGGREGATES

Sieve	Percent Passing by Weight for Pipe Embedment by Ranges of Nominal Pipe Sizes		
	>15”	**15” to 8”**	**<8”**
1”	95% to 100%	100%	- -
3/4"	60% to 90%	90% to 100%	100%
1/2"	25% to 60%	- -	90% to 100%
3/8”	- -	20% to 55%	40% to 70%
No. 4	0% to 5%	0% to 10%	0% to 15%
No. 8	- -	0% to 5%	0% to 5%

END OF SECTION

SECTION 02145
CEMENT-STABILIZED SAND

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Cement-stabilized sand.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No separate payment will be made for work performed under this Section. Include cost of such work in Contract unit prices for items listed in Unit Price Form requiring cement-stabilized sand.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for work in this Section shall be included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM C33 – Standard Specification for Concrete Aggregates (Fine Aggregate).
  2. ASTM C40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
  3. ASTM C42 – Standard Test Methods for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
  4. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
  5. ASTM C123 – Standard Test Method for Lightweight Particles in Aggregate.
  6. ASTM C142 – Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
  7. ASTM C150 – Specification for Portland Cement.
  8. ASTM D558 – Standard Test Method for Moisture-Density Relations of Soil Cement-Mixtures.
  9. ASTM D1632 – Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory.
  10. ASTM D1633 – Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders.
  11. ASTM D2487 – Standard Test Method for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  12. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  13. ASTM D3665 – Standard Practice for Random Sampling of

Construction Materials.

14. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

B. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.

B. Submit proposed target cement content and production data for sand-cement mixture in accordance with requirements of Paragraph 2.3, Materials Qualifications.

1.5 DESIGN REQUIREMENTS

A. Use sand-cement mixture producing minimum unconfined compressive strength of one hundred (100 psi) in forty-eight hours (48 Hrs).

1. Design will be based on strength specimens molded in accordance with ASTM D558 at moisture content within three percent (3%) above or below of optimum moisture content and within four hours (4 Hrs) of batching.
2. Determine minimum cement content from production data and statistical history. Provide no less than one and one tenth (1.1) sacks of cement per ton of dry sand.

PART II: PRODUCTS

2.1 MATERIALS

A. Cement: Type I Portland cement conforming to ASTM C150.

B. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C33 or requirements for bank run sand of Section 02140 – Utility Backfill Materials and the following requirements:

1. Classified as SW, SP, SW-SM, SP-SM or SM by Unified Soil Classification System of ASTM D2487.
2. Deleterious materials:
   a. Clay lumps, ASTM C142 – less than one-half percent (1/2%).
   b. Lightweight pieces, ASTM C123; less than five percent (5%).
   c. Organic impurities, ASTM C40, color no darker than standard color.
3. Plasticity index of four (4) or less when tested in accordance with ASTM D4318.

C. Water: Potable water, free of oils, acids, alkalies, organic matter or other deleterious substances, meeting requirements of ASTM C94.

2.2 MIXING MATERIALS

A. Add required amount of water and mix thoroughly in pugmill-type mixer.

B. Stamp batch ticket at plant with time of loading. Reject material not placed and compacted within four hours (4 Hrs) after mixing.

2.3 MATERIAL QUALIFICATION

A. Determine target cement content of material as follows:
   1. Obtain samples of sand-cement mixtures at production facility representing range of cement content consisting of at least three (3) points.
   2. Complete molding of samples within four hours (4 Hrs) after addition of water.
   3. Perform strength tests [average of two (2) specimens] at forty-eight hours (48 Hrs) and seven days (7 D).
   4. Perform cement content tests on each sample.
   5. Perform moisture content tests on each sample.
   6. Plot average forty-eight hour (48 Hr) strength vs. cement content.
   7. Record scale calibration date, sample date, sample time, molding time, cement feed dial settings and silo pressure (if applicable).

B. Test raw sand for following properties at point of entry into pug-mill:
   1. Gradation.
   2. Plasticity index.
   3. Organic impurities.
   4. Clay lumps and friable particles.
   5. Lightweight pieces.
   6. Moisture content.
   7. Classification.

C. Present data obtained in format similar to that provided in sample data form attached to this Section.

PART III: EXECUTION

3.1 PLACING

A. Place sand-cement mixture in maximum twelve inch (12 In) thick loose lifts and compact to ninety-five percent (95%) of maximum density as determined in accordance with ASTM D558, unless otherwise specified. Refer to related specifications for thickness of lifts in other applications. Target moisture content during compaction is plus or minus three percent (±3%) of optimum moisture content. Perform and complete compaction of sand-cement mixture within four hours (4 Hrs) after addition of water to mix at plant.

B. Do not place or compact sand-cement mixture in standing or free water.

3.2 FIELD QUALITY CONTROL

A. Testing shall be performed under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.

B. One (1) sample of cement-stabilized sand shall be obtained for each one hundred fifty tons (150 Tn) of material placed per day with no less than one (1) sample per day of production. Random samples of delivered cement-stabilized sand shall be taken in the field at point of delivery in accordance with ASTM D3665. Obtain three (3) individual samples of approximately twelve pounds (12 Lbs.) to fifteen pounds (15 Lbs.) each from the first (1st), middle and last third (3rd) of the truck and composite them into one sample for test purpose.

C. Prepare and mold four (4) specimens (for each sample obtained) in accordance with ASTM D558, Method A, without adjusting moisture content. Samples shall be molded at approximately same time material is being used, but no later than four hours (4 Hrs) after water is added to mix.

D. After molding, specimens shall be removed from molds and cured in accordance with ASTM D1632.

E. Specimens shall be tested for compressive strength in accordance with ASTM D1633, Method A. Two (2) specimens shall be tested at forty-eight hours (48 Hrs) plus or minus two hours (±2 Hrs) and two (2) specimens shall be tested at seven days (7 D) plus or minus four hours (±4 Hrs).

F. A strength test shall be the average of strengths of two (2) specimens molded from the same sample of material and tested at the same age. The average daily strength shall be the average of strengths of all specimens molded during one day's (1 D) production and tested at same the age.

G. Precision and Bias: Test results shall meet recommended guideline for precision in ASTM D1633 Section 9.

H. Reporting: Test reports shall contain, as a minimum, as specified in TABLE 4.1 – CEMENT-STABILIZED SAND REPORT in this section, the following information:

1. Supplier and plant number.
2. Time material was batched.
3. Time material was sampled.
4. Test age (exact hours).
5. Average forty-eight hour (48 Hr) strength.
6. Average seven day (7 D) strength.
7. Technical Specification section number.
8. Indication of compliance / non-compliance.
9. Mixture identification.
10. Truck and ticket numbers.
11. The time of molding.
12. Moisture content at time of molding.
13. Required strength.

14. Test method designations.
15. Compressive strength data as required by ASTM D1633.
16. Supplier mixture identification.
17. Specimen diameter and height, in.
18. Specimen cross-sectional area, sq.in.

3.3 ACCEPTANCE

A. Strength level of material shall be considered satisfactory if:
   1. The average forty-eight hour (48 Hr) strength is greater than one hundred pounds per square inch (100 psi) with no individual strength test below seventy pounds per square inch (70 psi).
   2. All seven day (7 D) individual strength tests [average of two (2) specimens] are greater than or equal to one hundred pounds per square inch (100 psi).

B. The material shall be considered unacceptable and subject to removal and replacement at the Contractor's expense when individual strength test [average of two (2) specimens) has seven day (7 D) strength] less than one hundred pounds per square inch (100 psi).

C. When the moving average of three (3) daily forty-eight hour (48 Hr) averages falls below one hundred pounds per square inch (100 psi), discontinue shipment to project until plant is capable of producing material, which exceeds one hundred pounds per square inch (100 psi) at forty hours (48 Hrs). Five (5) – forty eight hour (48 Hr) strength tests shall be made in this determination with no individual strength tests less than one hundred one hundred pounds per square inch (100 psi).

D. The Testing laboratory shall notify the Contractor, the Project Manager and the material supplier of tests by facsimile indicating results falling below specified strength requirements within twenty-four hours (24 Hrs).

E. If any strength test of laboratory cured specimens falls below the specified strength, the Contractor may, at his own expense, request testing of cores drilled from the area(s) in question in accordance with ASTM C42. In such cases, three (3) cores shall be taken for each strength test that falls below the values given in paragraph 3.3.A.

F. Cement-stabilized sand in an area represented by core tests shall be considered satisfactory if the average of three (3) cores is equal to at least one hundred pounds per square inch (100 psi). Additional testing of cores extracted from locations represented by erratic core strength results shall be permitted.

PART IV: TABLES

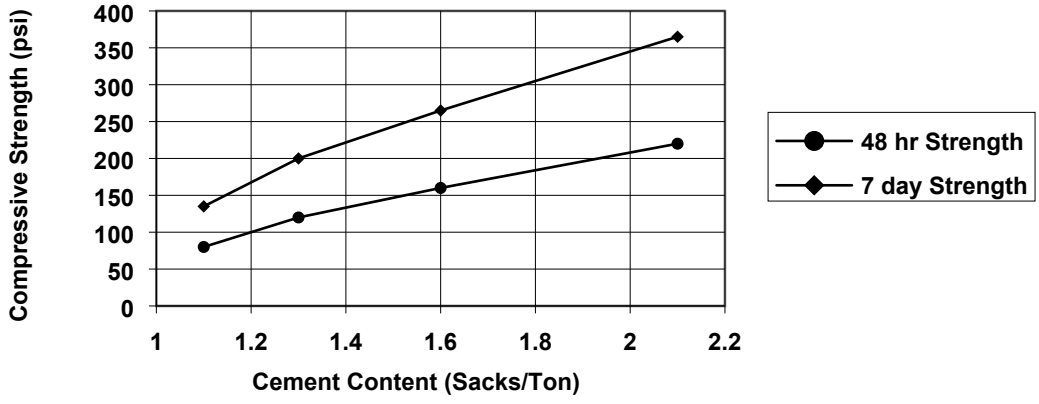
4.1 CEMENT-STABILIZED SAND REPORT

Supplier: Stabilized Sand Co.	**Plant No.:** 3 – Friendswood		**Date of Tests:** June 3, 2005		
Item	Raw Sand	1.1 Sack	100 psi	1.5 Sack	2.0 Sack
Moisture Content	10.9	15.7	14.0	13.8	13.7
Cement Feed Dial Setting	--	2.25	2.5	2.75	3.75
Silo Pressure (psi)	--	4	4	4	4
Batch Time	10:00	10:10	10:15	10:20	10:25
Sample Time	--	10:10	10:15	10:20	10:25
Molding Time	--	12:30	12:45	1:00	1:15
Cement Content (sacks/ton)	--	1.1	1.3	1.6	2.1
Compressive Strength as 48 hrs (avg of 2)	--	80	120	160	220
Compressive Strength at 7 days (avg of 2)	--	135	200	265	365

Sieve Size	**Percent Passing**	**COF Spec. Section 02140**
3/8 Inch	100%	100%
No. 200	30%	30%

Raw Sand Tests	**Result**	**City of Friendswood**
Plasticity Index	Non-Plastic	4 Maximum
Organic Impurities	Passing	No Darker Than
Clay Lumps & Friable Parts (%)	0.0	0.5 % Maximum
Lightweight Pieces (%)	0.0	5.0 % Maximum
Classification	SP – SM	SW, SP, SW-SM, SP-SM, SM

Compressive Strength vs Cement Content



END OF SECTION