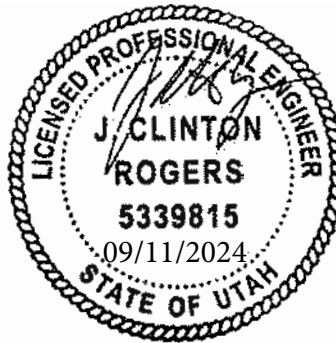


# **MAGNA WATER DISTRICT**

**MAGNA, UTAH**



## **WESTSIDE COLLECTION SYSTEM IMPROVEMENTS PROJECT 1B**

**VOLUME I OF II**

**SEPTEMBER 2024**

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END OF DOCUMENT



## SECTION 00 01 30 - NOTICE INVITING BIDS

**RECEIPT OF BIDS:** Sealed Bids will be received at the office of the Magna Water District, OWNER of the WORK located at 8885 West 3500 South Magna, Utah, 84044, until 3:00PM, on October 24, 2024, for the Magna Westside Collections System Improvements Project 1B. Any Bids received after the specified time and date will not be considered.

**OPENING OF BIDS:** The Bids will be publicly opened and read at **3:00 PM** on **October 24, 2024**, at the above-mentioned office of the OWNER.

**COMPLETION OF WORK:** The WORK must be Substantially Complete within twelve (12) months of Notice to Proceed and Final Completion to occur within 60 days thereafter. Substantial completion of the Open-Cut portion of the WORK is to be no later than July 31, 2025.

**DESCRIPTION OF WORK:** The WORK includes construction of a new sewer line, sewer manholes, pipe trench excavation and backfill, traffic control, trenchless crossing of State Highway-201, and pavement cutting and restoration as shown in the construction drawings and these specifications.

**SITE OF WORK:** The site of the WORK is located on 8000 W between 2100 S and State Highway-201 in Salt Lake County, Utah.

**OBTAINING CONTRACT DOCUMENTS:** The Contract Documents are available for examination at the office of the Engineer: Stantec, 2890 East Cottonwood Parkway, Suite 300, Salt Lake City, UT 84121. Electronic copies (PDF files) are available for download at no charge on the Magna Water District website (<https://www.magnawater.com/procurement-projects>) or by contacting the Project Engineer, Clint Rogers, P.E. ([clint.rogers@stantec.com](mailto:clint.rogers@stantec.com)). Hard copies may also be purchased at reproduction cost from Stantec (2890 East Cottonwood Parkway, Suite 300, Salt Lake City, UT 84121).

All questions regarding the Contract Documents shall be emailed to the District Engineer, Trevor Andra, P.E. ([trevor@magnawaterut.gov](mailto:trevor@magnawaterut.gov)) and the Project Engineer, Clint Rogers, P.E. ([clint.rogers@stantec.com](mailto:clint.rogers@stantec.com)).

**BID SECURITY:** Each Bid shall be accompanied by a certified or cashier's check or Bid Bond in the amount of five (5) percent of the Total Bid Price payable to Magna Water District as a guarantee that the Bidder, if its Bid is accepted, will promptly execute the Agreement. A bid shall not be considered unless one of the forms of Bidder's security is enclosed with it.

**BIDS TO REMAIN OPEN:** The Bidder shall guarantee the Total Bid Price for a period of 60 calendar days from the date of bid opening.

**PRE-BID CONFERENCE AND VISIT TO SITE:** Prospective bidders are required to attend a mandatory pre-bid conference and site visit that will begin at 10:30 AM on September 23, 2024. Send request to Project Engineer, Clint Rogers, P.E. ([clint.rogers@stantec.com](mailto:clint.rogers@stantec.com)) for details on the pre-bid conference and Site visit. The purpose of the pre-bid conference and site visit is to discuss the scope of the project and bidding requirements and to acquaint bidders with site conditions. Detailed technical questions may be submitted in writing but they will be answered, if warranted, by addenda later. Oral statements may not be relied upon and will not be binding or legally effective.

OWNER'S RIGHTS RESERVED: The OWNER reserves the right to reject any or all bids, to waive any informality in a bid, and to make awards to the lowest responsive, responsible bidder as it may best serve the interest of the OWNER.

Magna Water District

- END OF NOTICE INVITING BIDS -

## **SECTION 00 21 13 - INSTRUCTIONS TO BIDDERS**

1. **DEFINED TERMS.** Terms used in these Instructions to Bidders and the Notice Inviting Bids which are defined in the General Conditions have the meanings assigned to them in the General Conditions. The term "Bidder" means one who submits a Bid directly to OWNER, as distinct from a sub-bidder, who submits a price or quote to a Bidder.
2. **LOCAL BUSINESS LICENSE.** All Contractors, including Subcontractors, not already having a local business license for the WORK contemplated, will be required to secure the appropriate license before a Contract can be executed.
3. **INTERPRETATIONS AND ADDENDA.**
  - 3.1 All questions about the meaning or intent of the Contract Documents are to be directed to the ENGINEER. Additions, deletions, or revisions to the Contract Documents considered necessary by the ENGINEER in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by the ENGINEER or OWNER as having received the Contract Documents. Questions received less than 14 days prior to the date of Bids may not be answered. Only answers to such questions issued by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.
  - 3.2 Addenda may also be issued to make other additions, deletions, or revisions to the Contract Documents.
  - 3.3 Bidders shall make no special interpretation or inference of intent from differing formats in the Technical Specifications.
4. **BIDDER'S EXAMINATION OF CONTRACT DOCUMENTS AND SITE.**
  - 4.1 It is the responsibility of each Bidder before submitting a Bid:
    - A. To examine thoroughly the Contract Documents and other related data identified in the Bidding Documents (including "technical" data referred to below);
    - B. To attend the mandatory Pre-Bid Conference. Failure to attend will be grounds for rejection of the Bid.
    - C. To visit the Site to become familiar with local conditions that may affect cost, progress, or performance, of the WORK;
    - D. To consider federal, state, and local Laws and Regulations that may affect cost, progress, or performance of the WORK;
    - E. To study and carefully correlate the Bidder's observations with the Contract Documents; and
    - F. To notify the ENGINEER of all conflicts, errors, ambiguities, or discrepancies in or between the Contract Documents and such other related data.
  - 4.2 Reference is made to the Supplementary General Conditions for identification of:
    - A. Those reports of explorations and tests of subsurface conditions at the Site which have been utilized by the ENGINEER in the preparation of the Contract Documents.

- B. Those drawings of physical conditions in or relating to existing surface and subsurface conditions (except Underground Utilities) which are at or contiguous to the Site have been utilized by the ENGINEER in the preparation of the Contract Documents.
  - C. Those environmental reports or drawings relating to Asbestos, Hazardous Waste, PCBs, Petroleum, and/or Radioactive Materials identified at the Site which have been utilized by the ENGINEER in the preparation of the Contract Documents.
  - D. The ENGINEER makes no representation as to the completeness of the reports or drawings referred to in Paragraphs 4.2A, 4.2B, and 4.2C. above or the accuracy of any data or information contained therein. The Bidder may rely upon the accuracy of the technical data contained in such reports and drawings. However, the Bidder may not rely upon any interpretation of such technical data, including any interpretation or extrapolation thereof, or any non-technical data, interpretations, and opinions contained therein.
- 4.3 Copies of reports and drawings referred to in Paragraph 4.2 will be made available by the OWNER to any Bidder on request, if said reports and drawings are not bound herein. Those reports and drawings are not part of the Contract Documents, but the technical data contained therein upon which the Bidder is entitled to rely, as provided in Paragraph SGC-4.2 of the Supplementary General Conditions, are incorporated herein by reference.
- 4.4 Information and data reflected in the Contract Documents with respect to Underground Utilities at or contiguous to the Site are based upon information and data furnished to the OWNER and the ENGINEER by the owners of such Underground Utilities or others, and the OWNER does not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary General Conditions or Section 01 50 10 - Protection of Existing Facilities.
- 4.5 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders on subsurface conditions, Underground Utilities, and other physical conditions, and possible changes in the Contract Documents due to differing conditions appear in Paragraphs 4.2, 4.3, and 4.4 of the General Conditions.
- 4.6 Before submitting a Bid, each Bidder will, at Bidder's own expense, make or obtain any additional examinations, investigations, explorations, tests, and studies and obtain any additional information and data which pertain to the physical conditions (surface, subsurface, and Underground Utilities) at or contiguous to the Site or otherwise which may affect cost, progress, or performance of the WORK and which the Bidder deems necessary to determine its Bid for performing the WORK in accordance with the time, price, and other terms and conditions of the Contract Documents.
- 4.7 On request a minimum of 2 business days in advance, the OWNER will provide each Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as each Bidder deems necessary for submission of a Bid. Location of any excavation or boring shall be subject to prior approval of OWNER and applicable agencies. Bidder shall fill all holes, restore all pavement to match existing structural section, and shall clean up and restore the Site to its former condition upon completion of such explorations. OWNER reserves the right to require Bidder to execute an Access Agreement with the OWNER prior to accessing the Site.

- 4.8 The lands upon which the WORK is to be performed, rights-of-way, and easements for access thereto and other lands designated for use by the CONTRACTOR in performing the WORK are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by the CONTRACTOR. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by the OWNER unless otherwise provided in the Contract Documents.
- 4.9 The submission of a Bid will constitute an incontrovertible representation by the Bidder that the Bidder has complied with every requirement of this Paragraph 4 and the following:
- A. That the Bid is premised upon performing the WORK required by the Contract Documents without exception and such means, methods, techniques, sequences, or procedures of construction (if any) as may be required by the Contract Documents;
  - B. That Bidder has given the ENGINEER written notice of all conflicts, errors, ambiguities, and discrepancies in the Contract Documents and the written resolution thereof by the ENGINEER is acceptable to the Bidder; and
  - C. That the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the WORK.
5. BID FORMS. The Bid shall be submitted on the Bid Forms bound herein and the pages shall not be removed from the bound volume. All blanks on the Bid Forms shall be completed in ink. All names must be printed below the signatures. The Bid shall be submitted in a sealed envelope which shall be plainly marked in the upper left hand corner with the name and address of the Bidder and shall bear the words "BID FOR" followed by the title of the Contract Documents for the WORK, the name of the OWNER, the address where Bids are to be delivered or mailed to, and the date and hour of opening of Bids.
- 5.1 Certain attachments to the Bid may be required. NOT USED
6. BID CERTIFICATES
- 6.1 Bids by corporations must be executed in the corporate name by the president, a vice-president, or other corporate officer. Such Bid shall be accompanied by the enclosed Certificate of Authority to sign, attested by the secretary or assistant secretary, and with the corporate seal affixed. The corporate address and state of incorporation must appear below the signature.
- 6.2 Bids by partnerships must be executed in the partnership name and be signed by a managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the partnership must appear below the signature.
- 6.3 Bids by joint ventures must be executed in the joint venture name and be signed by a joint venture managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the joint venture must appear below the signature.
7. DISQUALIFICATION OF BIDDERS. More than one Bid from an individual, firm, partnership, corporation, or association under the same or different names will not be considered. If the OWNER believes that any Bidder is interested in more than one Bid for

the WORK contemplated, all Bids in which such Bidder is interested will be rejected. If the OWNER believes that collusion exists among the Bidders, all Bids will be rejected. A party who has quoted prices to a Bidder is not hereby disqualified from quoting prices to other Bidders, or from submitting a Bid directly for the WORK.

8. **QUANTITIES OF WORK.** The quantities of WORK or material stated in Unit Price items of the Bid are supplied only to give an indication of the general scope of the WORK; the OWNER does not expressly or by implication agree that the actual amount of WORK or material will correspond therewith, and reserves the right after award to increase or decrease the quantity of any Unit Price item of the WORK by an amount up to and including 25 percent of any Bid item, without a change in the Unit Price, and shall include the right to delete any Bid item in its entirety, or to add additional Bid items up to and including an aggregate total amount not to exceed 25 percent of the Bid price.
9. **SUBSTITUTE OR "OR EQUAL" ITEMS.** Whenever materials or equipment are specified or described in the Contract Documents by using the name of a particular manufacturer and the name is followed by the words "or equal", the Bidder may write the name of a substitute manufacturer (which the Bidder considers as an "or equal") in the List of Proposed Substitutions in the Bid Forms. These substitute manufacturers will only be considered after award of the Contract. The procedure for the submittal of substitute or "or equal" products is specified in Section 01 60 00 - Products, Materials, Equipment, and Substitutions. The Bidder shall not be relieved of any obligations of the Contract Documents or be entitled to an adjustment in the Contract Price in the event any proposed substitute manufacturer is not subsequently approved.
11. **SUBMISSION OF BIDS.** The Bid shall be delivered by the time and to the place stipulated in the Notice Inviting Bids. It is the Bidder's sole responsibility to see that its Bid is received in proper time and at the proper place.
12. **BID SECURITY, BONDS, AND INSURANCE.** Each Bid shall be accompanied by a certified or cashier's check or approved Bid Bond in the amount stated in the Notice Inviting Bids. Said check or bond shall be made payable to the OWNER and shall be given as a guarantee that the Bidder, if awarded the WORK, will enter into an Agreement with the OWNER, and will furnish the necessary insurance certificates, Payment Bond, and Performance Bond; each of said bonds to be in the amount stated in the Supplementary General Conditions. In case of refusal or failure to enter into said Agreement, the check or Bid Bond, as the case may be, shall be forfeited to the OWNER. If the Bidder elects to furnish a Bid Bond as its Bid security, the Bidder shall use the Bid Bond form bound herein, or one conforming substantially to it in form. Bid Bonds shall comply with the requirements applicable to Payment and Performance Bonds in the General Conditions.
13. **DISCREPANCIES IN BIDS.** In the event there is more than one Bid item in a Bid Schedule, the Bidder shall furnish a price for all Bid items in the Schedule, and failure to do so will render the Bid non-responsive and shall cause its rejection. In the event there are Unit Price Bid items in a Bidding schedule and the amount indicated for a Unit Price Bid item does not equal the product of the Unit Price and quantity, the Unit Price shall govern and the amount will be corrected accordingly, and the BIDDER shall be bound by said correction. In the event there is more than one Bid item in a Bid Schedule and the total indicated for the Schedule does not agree with the sum of the prices Bid on the individual items, the prices Bid on the individual items shall govern and the total for the Schedule will be corrected accordingly, and the BIDDER shall be bound by said correction.

14. **MODIFICATIONS AND UNAUTHORIZED ALTERNATIVE BIDS.** Unauthorized conditions, limitations, or provisos attached to the Bid shall render it informal and may cause its rejection as being non-responsive. The Bid forms shall be completed without interlineations, alterations, or erasures in the printed text. Alternative Bids will not be considered unless called for. Oral, telegraphic, or telephonic Bids or modifications will not be considered.
15. **WITHDRAWAL OF BID.** The Bid may be withdrawn by the Bidder by means of a written request, signed by the Bidder or its properly authorized representative. Such written request must be delivered to the place stipulated in the Notice Inviting Bids for receipt of Bids prior to the scheduled closing time for receipt of Bids.
16. **AWARD OF CONTRACT.** Award of the contract, if awarded, will be made to the lowest responsive, responsible Bidder whose Bid complies with the requirements of the Contract Documents. Unless otherwise specified, any such award will be made within the period stated in the Notice Inviting Bids that the Bids are to remain open. Unless otherwise indicated, a single award will be made for all the Bid items in an individual Bid Schedule. In the event the WORK is contained in more than one Bid Schedule, the OWNER may award Schedules individually or in combination. In the case of two Bid Schedules which are alternative to each other, only one of such alternative schedules will be awarded.
17. **RETURN OF BID SECURITY.** Within 14 days after award of the Contract, the OWNER will, if requested, return the Bid securities accompanying such Bids that are not being considered in making the award. All other Bid securities will be held until the Agreement has been finally executed. They will then be returned, if requested, to the respective Bidders whose Bids they accompany.
18. **EXECUTION OF AGREEMENT.** The Bidder to whom award is made shall execute a written Agreement with the OWNER on the form of agreement provided, shall secure all insurance, and shall furnish all certificates and Bonds required by the Contract Documents within 14 calendar days after receipt of the Agreement forms from the OWNER. Failure or refusal to enter into an Agreement as herein provided or to conform to any of the stipulated requirements in connection therewith shall be just cause for annulment of the award and forfeiture of the Bid security. If the lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the OWNER may award the Contract to the second lowest responsive, responsible Bidder. If the second lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the OWNER may award the Contract to the third lowest responsive, responsible Bidder. On the failure or refusal of such second or third lowest Bidder to execute the Agreement, each such Bidder's Bid securities shall be likewise forfeited to the OWNER.
19. **LIQUIDATED DAMAGES.** Provisions for liquidated damages, if any, are set forth in the Agreement.

- END OF INSTRUCTIONS TO BIDDERS -

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**SECTION 00 41 00  
BID FORMS**

**BID TO: MAGNA WATER DISTRICT**

1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with the OWNER in the form included in the Contract Documents to perform the WORK as specified or indicated in said Contract Documents entitled MAGNA WATER DISTRICT WESTSIDE COLLECTION SYSTEM PROJECT 1B.
2. Bidder accepts all of the terms and conditions of the Contract Documents, including without limitation those in the Notice Inviting Bids and Instructions to Bidders, dealing with the disposition of the Bid security.
3. This Bid will remain open for the period stated in the "Notice Inviting Bids" unless otherwise required by law. Bidder will enter into an Agreement within the time and in the manner required in the "Notice Inviting Bids" and the "Instructions to Bidders", and will furnish the insurance certificates, Payment Bond, and Performance Bond required by the Contract Documents.
4. Bidder has examined copies of all the Contract Documents including the following addenda (receipt of all of which is hereby acknowledged):

Number		Date	
	_____		_____
	_____		_____
	_____		_____
	_____		_____

Failure to acknowledge Addenda shall render the Bid non-responsive and shall be cause for its rejection.

5. Bidder has familiarized itself with the nature and extent of the Contract Documents, WORK, Site, locality where the WORK is to be performed, the legal requirements (federal, state and local laws, ordinances, rules, and regulations), and the conditions affecting cost, progress or performance of the WORK and has made such independent investigations as Bidder deems necessary.

To all the foregoing, and including all Bid Forms contained in this Bid, said Bidder further agrees to complete the WORK required under the Contract Documents within the Contract Time stipulated in said Contract Documents, and to accept in full payment therefor the Contract Price based on the Total Bid Price(s) named in the aforementioned Bid Forms.

Dated: _____	Bidder: _____
	By: _____
	(Signature)
	Title: _____

**BID CERTIFICATE  
(if Corporation)**

STATE OF                                 )  
  )   SS:  
COUNTY OF                             )

I HEREBY CERTIFY that a meeting of the Board of Directors of the \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

a corporation existing under the laws of the State of \_\_\_\_\_, held on  
\_\_\_\_\_, 20\_\_\_\_, the following resolution was duly passed and adopted:

"RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_  
\_\_\_\_\_ President  
of this Corporation, be and is hereby authorized to execute the Bid dated \_\_\_\_\_,  
20\_\_\_\_, to the MAGNA WATER DISTRICT by this Corporation and that his/her execution  
thereof, attested by the Secretary of this Corporation, and with the Corporate Seal affixed,  
shall be the official act and deed of this Corporation."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the  
corporation this \_\_\_\_\_, day of \_\_\_\_\_, 20\_\_\_\_\_.

\_\_\_\_\_  
Secretary

(SEAL)

**BID CERTIFICATE  
(if Partnership)**

STATE OF                                 )  
  )   SS:  
COUNTY OF                             )

I HEREBY CERTIFY that a meeting of the Partners of the \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

a partnership existing under the laws of the State of \_\_\_\_\_, held on  
\_\_\_\_\_, 20\_\_\_\_, the following resolution was duly passed and adopted:

"RESOLVED, that \_\_\_\_\_, as  
General Partner of the Partnership, be and is hereby authorized to execute the Bid  
dated \_\_\_\_\_, 20\_\_\_\_, to the MAGNA WATER DISTRICT by this  
Partnership and that his/her execution thereof, attested by the General Partner shall  
be the official act and deed of this Partnership."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this \_\_\_\_\_, day of \_\_\_\_\_,  
20\_\_\_\_\_.

\_\_\_\_\_  
General Partner

(SEAL)

**BID CERTIFICATE  
(if Joint Venture)**

STATE OF                                 )  
  )   SS:  
COUNTY OF                             )

I HEREBY CERTIFY that a meeting of the Principals of the \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

a joint venture existing under the laws of the State of \_\_\_\_\_, held on  
\_\_\_\_\_, 20\_\_\_\_, the following resolution was duly passed and adopted:

"RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of the Joint Venture,  
be and is hereby authorized to execute the Bid dated \_\_\_\_\_,  
20\_\_\_\_, to the MAGNA WATER DISTRICT by this Joint Venture and that his/her  
execution thereof, attested by the \_\_\_\_\_ shall be the  
official act and deed of this Joint Venture."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this \_\_\_\_\_, day of \_\_\_\_\_,  
20\_\_\_\_\_.

\_\_\_\_\_  
Managing Partner

(SEAL)

## BID SCHEDULE - LUMP SUM

Schedule of prices for construction of Magna Westside Collection System Project 1B in accordance with the Contract Documents.

Item	Description
1.	Bid Prices: Bidder shall complete the Work in accordance with the Contract Documents for the Lump Sum Prices indicated below:
a.	Pipe Material ( pipe, fittings, and install) \$_____
b.	Excavation (excavation, shoring, pipe bedding, groundwater mitigation, imported fill, and backfill) \$_____
c.	Manholes (manholes, fittings, and equipment install) \$_____
d.	Pavement (cutting, roadbase, and restoration) \$_____
e.	Adminstration (permitting and traffic control) \$_____
f.	Trenchless pipe installation under State Highway-201 (launch/reception shaft, boring, casing, corrosion protection) \$_____
g.	Other (mobilization, bonds/insurance, OH&P) \$_____
	<b>Total Lump Sum Bid</b> (Sum items of a through f) \$_____
<hr/>	
(Total Lump Sum Bid Amount in Words)	
<hr/>	

## BID SCHEDULE – ADD OR DEDUCT UNIT PRICE

The Bidder will accept as adjustment to the Lump Sum Bid for quantities of work different than indicated in the Bidding Documents the amount resulting from applying to the difference the following unit prices. The acceptance or rejection of any or all Bid alternates is at the option of the OWNER and will not necessarily be made on the basis of price alone. The contract price shall be the net amount determined by applying the net addition or net deduction specified to the Lump Sum Bid. Schedule of prices for construction of Magna Westside Collection System Project 1B in accordance with the Contract Documents.

Item No.	Description	Estimated Quantity	Unit	Unit Price	Amount
1.	Excavation	<u>100</u>	<u>CY</u>	\$ <u>          </u>	\$ <u>          </u>
2.	Imported Fill	<u>100</u>	<u>CY</u>	\$ <u>          </u>	\$ <u>          </u>
3.	Roadbase	<u>10</u>	<u>CY</u>	\$ <u>          </u>	\$ <u>          </u>
4.	Pavement Cutting	<u>10</u>	<u>SF</u>	\$ <u>          </u>	\$ <u>          </u>
5.	Asphalt	<u>10</u>	<u>SF</u>	\$ <u>          </u>	\$ <u>          </u>
6.		<u>          </u>	<u>          </u>	\$ <u>          </u>	\$ <u>          </u>
7.		<u>          </u>	<u>          </u>	\$ <u>          </u>	\$ <u>          </u>
8.		<u>          </u>	<u>          </u>	\$ <u>          </u>	\$ <u>          </u>
9.		<u>          </u>	<u>          </u>	\$ <u>          </u>	\$ <u>          </u>

## LIST OF SUBCONTRACTORS

The Bidder shall list below the name and the location of the place of business of each Subcontractor who will perform WORK or labor or render service to the prime contractor in or about the construction of the WORK or improvement, or a Subcontractor who, under subcontract to the prime contractor, specially fabricates and installs a portion of the WORK or improvement according to detailed drawings contained in the plans and specifications, in an amount in excess of one-half of 1 percent of the prime contractor's total Bid or, in the case of Bids or offers for the construction of streets or highways, including bridges, in excess of one-half of 1 percent of the prime contractor's total Bid or ten thousand dollars (\$10,000), whichever is greater. The Bidder shall also list below the portion of the WORK which will be performed by each Subcontractor under its contract. The prime contractor shall list only one Subcontractor for each portion as is defined by the prime contractor in its Bid. The Bidder's attention is directed to the provisions of Paragraph entitled "Subcontract Limitations," of the Supplementary General Conditions which stipulates the percent of the WORK to be performed with the Bidder's own forces. Failure to comply with this requirement will render the Bid non-responsive and may cause its rejection.

<u>Work to be Performed</u>	<u>Subcontr. License Number</u>	<u>Percent of Total Bid</u>	<u>Subcontractor's Name &amp; Address</u>
1. _____	_____	_____	_____ _____ _____ _____
2. _____	_____	_____	_____ _____ _____ _____
3. _____	_____	_____	_____ _____ _____ _____
4. _____	_____	_____	_____ _____ _____ _____
5. _____	_____	_____	_____ _____ _____ _____

Note: Attach additional sheets if required.

**LIST OF NAMED EQUIPMENT/MATERIAL MANUFACTURERS**

The Bidder shall indicate below which manufacturer the Bidder intends to use for each item of equipment or material listed on this form by writing in one of the named manufacturers specified in the Technical Specifications for that equipment or material. (Proposed substitutes may be listed on the List of Proposed Substitutions but will only be considered after award of the Contract.) If no manufacturer is named in the Technical Specifications, the Bidder may list any manufacturer whose product meets all of the requirements and technical criteria specified. The listing of more than one manufacturer for each item of equipment/material to be furnished with the words "and/or" will not be permitted. Failure to comply with this requirement may render the Bid non-responsive and may cause its rejection.

<u>Specification Section</u>	<u>Equipment/Material</u>	<u>Named Manufacturer (List Only One)</u>



The Bidder proposes the following substitute or "or equal" products identified below:

Note: Substitute products will only be considered after award of the Contract. The procedure for the submittal of substitute or "or equal" products is specified in the General Requirements.

## INFORMATION REQUIRED OF BIDDER

The Bidder shall furnish the following information. Additional sheets shall be attached as required. Failure to complete Item Nos. 1, 3, and 6, will cause the Bid to be non-responsive and may cause its rejection. In any event, no award will be made until all of the Bidder's General Information is delivered to the OWNER.

- (1) Contractor's name and address:

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- (2) Contractor's telephone number: \_\_\_\_\_

Contractor's fax number: \_\_\_\_\_

- (3) Contractor's license: Primary classification \_\_\_\_\_

State License No. and Expiration Date \_\_\_\_\_

Specialty classifications held, if any: \_\_\_\_\_

Name of Licensee, if different from (1) above: \_\_\_\_\_

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- (4) Name, address, and telephone number of surety company and agent who will provide the required Bonds on this contract:

---

---

---





\_\_\_\_\_

By:

Its:

STATE OF \_\_\_\_\_ )  
:ss.  
COUNTY OF \_\_\_\_\_ )

This is to certify that on the \_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_, before me, the undersigned, a Notary Public, in and for the State of \_\_\_\_\_, duly commissioned and sworn as such, personally appeared \_\_\_\_\_, known to me to be the \_\_\_\_\_ for \_\_\_\_\_ corporation, and acknowledged to me that said \_\_\_\_\_ executed the foregoing instrument as a free and voluntary act and deed of said corporation, for the uses and purposes therein, and on oath state that they were authorized to execute said instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year hereinabove written.

**NOTARY PUBLIC**

## BID BOND

KNOW ALL MEN BY THESE PRESENTS,

That \_\_\_\_\_ as Principal, and  
\_\_\_\_\_ as Surety, are  
held and firmly bound unto Magna Water District, hereinafter called "OWNER," in the sum of dollars,

for the payment of which sum, well and truly to be made, we jointly and severally bind ourselves, our heirs, executors, administrators, successors, and assigns firmly by these presents.

WHEREAS, said Principal has submitted a Bid to said OWNER to perform the WORK required under the Bidding schedule(s) of the OWNER's Contract Documents entitled Magna Westside Collection System Project 1B.

NOW THEREFORE, if said Principal is awarded a contract by said OWNER and, within the time and in the manner required in the "Notice Inviting Bids" and the "Instructions to Bidders" enters into a written Agreement on the form of Agreement bound with said Contract Documents, furnishes the required certificates of insurance, and furnishes the required Performance Bond and Payment Bond, and performs in all other respects the agreement created by this Bid, then this obligation shall be null and void, otherwise it shall remain in full force and effect. The Surety stipulates and agrees that the obligation of said Surety shall in no way be impaired or affected by an extension of the time within which the OWNER may accept such Bid and Surety further waives notice of any such extension. In the event suit is brought upon this Bond by said OWNER and OWNER prevails, said Principal and Surety shall pay all costs incurred by said OWNER in such suit, including reasonable attorney's fees and costs to be fixed by the court.

SIGNED AND SEALED, this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_

\_\_\_\_\_  
(Principal) (SEAL) \_\_\_\_\_ (SEAL)  
(Surety)

By: \_\_\_\_\_ By: \_\_\_\_\_  
(Signature) (Signature)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

- END OF BID FORMS -

## SECTION 00 52 13 - AGREEMENT

THIS AGREEMENT is dated as of the \_\_\_\_\_ day of \_\_\_\_\_ in the year 2024  
by and between Magna Water District (hereinafter called OWNER) and  
\_\_\_\_\_  
(hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

### ARTICLE 1. WORK.

CONTRACTOR shall complete the WORK as specified or indicated in the OWNER'S Contract Documents entitled Magna Westside Collection System Project 1B.

The WORK is generally described in Section 01 10 00 – Summary of Work.

### ARTICLE 2. CONTRACT TIMES.

The WORK shall be Substantially Complete within 12 months from the commencement date stated in the Notice to Proceed. Substantially Complete is defined as pipe and manholes in place, pipe, casing, and corrosion protection installed in trenchless method under State Highway-201, pipe inspection and testing complete, and trenches/shaft(s) ready for paving. Substantial completion of the Open-Cut WORK is to be no later than July 31, 2025. Open-Cut WORK is defined as the WORK between and including Manholes 1 and 8 as shown on the contract drawings. Final completion shall occur within 60 days after approved Substantial Completion.

### ARTICLE 3. LIQUIDATED DAMAGES.

OWNER and the CONTRACTOR recognize that time is of the essence of this Agreement and that the OWNER will suffer financial loss if the WORK is not completed within the time specified in Article 2 herein, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense, and difficulties involved in proving in a legal proceeding the actual loss suffered by the OWNER if the WORK is not completed on time. Accordingly, instead of requiring any such proof, the OWNER and the CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) the CONTRACTOR shall pay the OWNER \$ 500 for each day that expires after the time specified in Article 2 herein.

### ARTICLE 4. CONTRACT PRICE.

OWNER shall pay CONTRACTOR for completion of the WORK in accordance with the Contract Documents in current funds the amount set forth in the Bid Schedule(s).

### ARTICLE 5. PAYMENT PROCEDURES.

CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

### ARTICLE 6. CONTRACT DOCUMENTS.

The Contract Documents which comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK consist of this Agreement and the following attachments to this Agreement:

Notice Inviting Bids (Section 00 00 30).

Instructions to Bidders (Section 00 21 13).

Bid Forms including the Bid, Bid Schedule(s), Information Required of Bidder, Bid Bond, and all required certificates and affidavits (Section 00 41 00).

Performance Bond (Section 00 61 13).

Payment Bond (Section 00 61 16).

General Conditions (Section 00 72 13).

Supplementary General Conditions (Section 00 73 13).

Technical Specifications, as listed in the Table of Contents.

Drawings, as listed in the Sheet Index.

Addenda numbers \_\_\_\_\_ to \_\_\_\_\_, inclusive.

Change Orders which may be delivered or issued after Effective Date of the Agreement and are not attached hereto.

There are no Contract Documents other than those listed in this Article 6. The Contract Documents may only be amended by Change Order as provided in Paragraph 3.5 of the General Conditions.

#### ARTICLE 7. HOLD HARMLESS CLAUSE.

In so far as the CONTRACTOR may legally do so, it shall hold the OWNER, including its elected officials, appointed officials, employees, agents and volunteers, harmless from any liability, damages or claims that may arise in the course of the CONTRACTOR, its agents or Employees performing any activities in connection with said project, or resulting through negligence of the same.



## ARTICLE 8. ASSIGNMENT

No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation monies that may become due and monies that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

OWNER and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns and legal representatives in respect of all covenants, agreements and obligations contained in the Contract Documents.

IN WITNESS WHEREOF, OWNER and CONTRACTOR have caused this Agreement to be executed the day and year first above written.

OWNER \_\_\_\_\_

CONTRACTOR \_\_\_\_\_

By \_\_\_\_\_

By \_\_\_\_\_  
[CORPORATE SEAL]

Attest \_\_\_\_\_

Attest \_\_\_\_\_

Address for giving notices

Address for giving notices

\_\_\_\_\_

\_\_\_\_\_

License No. \_\_\_\_\_

Approved as to Form:

\_\_\_\_\_  
(Signature)

Agent for service of process: \_\_\_\_\_

\_\_\_\_\_  
(Title)

\_\_\_\_\_

**AGREEMENT CERTIFICATE  
(if Corporation)**

STATE OF                                 )  
  )   SS:  
COUNTY OF                             )

I HEREBY CERTIFY that a meeting of the Board of Directors of the \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

a corporation existing under the laws of the State of \_\_\_\_\_, held on \_\_\_\_\_, 20\_\_\_\_, the following resolution was duly passed and adopted:

"RESOLVED, that \_\_\_\_\_, as \_\_\_\_\_, President of the Corporation, be and is hereby authorized to execute the Agreement dated \_\_\_\_\_, 20\_\_\_\_, by and between this Corporation and Magna Water District and that his/her execution thereof, attested by the Secretary of the Corporation, and with the Corporate Seal affixed, shall be the official act and deed of this Corporation."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this \_\_\_\_\_, day of \_\_\_\_\_, 20\_\_\_\_\_.

\_\_\_\_\_  
Secretary

(SEAL)

**AGREEMENT CERTIFICATE  
(if Partnership)**

STATE OF                                 )  
  )   SS:  
COUNTY OF                             )

I HEREBY CERTIFY that a meeting of the Partners of the \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

a partnership existing under the laws of the State of \_\_\_\_\_, held on \_\_\_\_\_, 20\_\_\_\_, the following resolution was duly passed and adopted:

"RESOLVED, that \_\_\_\_\_, as \_\_\_\_\_ of the Partnership, be and is hereby authorized to execute the Agreement dated \_\_\_\_\_, 20\_\_\_\_, by and between this Partnership and Magna Water District and that his/her execution thereof, attested by the \_\_\_\_\_ shall be the official act and deed of this Partnership."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this \_\_\_\_\_, day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
Partner

(SEAL)

**AGREEMENT CERTIFICATE  
(if Joint Venture)**

STATE OF                                 )  
  )   SS:  
COUNTY OF                             )

I HEREBY CERTIFY that a meeting of the Principals of the \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

a joint venture existing under the laws of the State of \_\_\_\_\_, held on  
\_\_\_\_\_, 20\_\_\_\_, the following resolution was duly passed and adopted:

"RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of the Joint Venture,  
be and is hereby authorized to execute the Agreement dated \_\_\_\_\_,  
20\_\_\_\_, by and between this Joint Venture and Magna Water District and that his/her  
execution thereof, attested by the \_\_\_\_\_ shall be the  
official act and deed of this Joint Venture."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this \_\_\_\_\_, day of \_\_\_\_\_,  
20\_\_\_\_\_.

\_\_\_\_\_  
Managing Partner

(SEAL)

- END OF AGREEMENT -

**SECTION 00 61 13 - PERFORMANCE BOND**

KNOW ALL MEN BY THESE PRESENTS,

That \_\_\_\_\_ as CONTRACTOR,  
and \_\_\_\_\_ as Surety,  
are held and firmly bound unto Magna Water District hereinafter called "OWNER," in the sum of  
\_\_\_\_\_ dollars,

for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that said CONTRACTOR has been awarded and is about to enter into the annexed Agreement with said OWNER to perform the WORK as specified or indicated in the Contract Documents entitled Magna Westside Collection System Project 1B.

NOW THEREFORE, if said CONTRACTOR shall perform all the requirements of said Contract Documents required to be performed on its part, at the times and in the manner specified therein, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

PROVIDED, that any alterations in the WORK to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of said Contract Documents, shall not in any way release said CONTRACTOR or said Surety hereunder, nor shall any extensions of time granted under the provisions of said Contract Documents, release either said CONTRACTOR or said Surety, and notice of such alterations or extensions of the Agreement is hereby waived by said Surety.

IN WITNESS WHEREOF, we have hereunder set our hands this \_\_\_\_\_ day  
of \_\_\_\_\_, 20\_\_\_\_\_.

(SEAL)

(SEAL)

(CONTRACTOR)

(Surety)

By: \_\_\_\_\_  
(Signature and SEAL)

By: \_\_\_\_\_  
(Signature and SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

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**SECTION 00 61 16 - PAYMENT BOND**

KNOW ALL MEN BY THESE PRESENTS,

That \_\_\_\_\_ as CONTRACTOR,  
and \_\_\_\_\_ as Surety,  
are held and firmly bound unto Magna Water District hereinafter called "OWNER," in the sum of  
\_\_\_\_\_ dollars,

for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that said CONTRACTOR has been awarded and is about to enter into the annexed Agreement with said OWNER to perform the WORK as specified or indicated in the Contract Documents entitled Magna Westside Collection System Project 1B.

NOW THEREFORE, if said CONTRACTOR, or Subcontractor, fails to pay for any materials, equipment, or other supplies, or for rental of same, used in connection with the performance of WORK contracted to be done, or for amounts due under applicable State law for any WORK or labor thereon, said Surety will pay for the same in an amount not exceeding the sum specified above, and, in the event suit is brought upon this Bond, reasonable attorney's fees to be fixed by the court. This Bond shall inure to the benefit of any persons, companies, or corporations entitled to file claims under applicable State law so as to give a right of action to them or their assigns in any suit brought upon this Bond.

PROVIDED, that any alterations in the WORK to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of said Contract Documents, shall not in any way release said CONTRACTOR or said Surety thereunder, nor shall any extensions of time granted under the provisions of said Contract Documents release either said CONTRACTOR or said Surety, and notice of such alterations or extensions of the Agreement is hereby waived by said Surety.

IN WITNESS WHEREOF, we have hereunto set our hands and seals this \_\_\_\_\_ day  
of \_\_\_\_\_, 20\_\_\_\_\_.

\_\_\_\_\_  
(CONTRACTOR)

\_\_\_\_\_  
(Surety)

By: \_\_\_\_\_  
(Signature and SEAL)

By: \_\_\_\_\_  
(Signature and SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

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## ARTICLE 1 -- DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated in this Article 1 which meanings are applicable to both the singular and plural thereof. If a word which is entirely in upper case in these definitions is found in lower case in the Contract Documents, then the lower case word will have its ordinary meaning.

**Addenda** - Written or graphic instruments issued prior to the opening of Bids which make additions, deletions, or revisions to the Contract Documents.

**Agreement** - The written contract between the OWNER and the CONTRACTOR covering the WORK to be performed; other documents are attached to the Agreement and made a part thereof as provided therein.

**Application for Payment** - The form accepted by the ENGINEER which is to be used by the CONTRACTOR to request progress payments or final payment and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

**Asbestos** - Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

**Base Bid** – The offer or proposal of the Bidder submitted on the prescribed form setting forth the price or prices for the WORK, excluding any amounts proposed for additive or deductive items called out in the Bid Schedule.

**Bid** - The offer or proposal of the Bidder submitted on the prescribed form setting forth the price or prices for the WORK.

**Bonds** - Bid, Performance, and Payment Bonds and other instruments of security.

**Change Order** - A document recommended by the ENGINEER, which is signed by the CONTRACTOR and the OWNER, and authorizes an addition, deletion, or revision in the WORK, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

**Clarification** - A document issued by the ENGINEER to the CONTRACTOR that interprets the requirement(s) and/or design intent of the Contract Documents, which may not represent an addition, deletion, or revision in the WORK or an adjustment in the Contract Price or the Contract Times.

**Contract** - Depending on the context, (a) the Agreement, or (b) respectively, the Contract Documents which establish the respective obligations of the OWNER and the CONTRACTOR.

**Contract Documents**- The Notice Inviting Bids, Instructions to Bidders, Bid Forms (including the Bid, Bid Schedule(s), Information Required of Bidder, Bid Bond, and all required certificates, affidavits and other documentation), Agreement, Performance Bond, Payment Bond, General Conditions, Supplementary General Conditions, Technical Specifications, Drawings, all Addenda, and Change Orders executed pursuant to the provisions of the Contract Documents. Shop Drawings are not Contract Documents.

**Contract Price**- The total monies payable by the OWNER to the CONTRACTOR under the terms and conditions of the Contract Documents.

**Contract Times** - The number or numbers of successive Days or dates stated in the Contract Documents for the completion of the WORK.

**CONTRACTOR** - The individual, partnership, corporation, joint-venture, or other legal entity with whom the OWNER has executed the Agreement.

**Day**- A calendar day of 24 hours measured from midnight to the next midnight.

**Defective WORK** - WORK that is unsatisfactory, faulty, or deficient; or that does not conform to the Contract Documents; or that does not meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents; or WORK that has been damaged prior to the ENGINEER'S recommendation of final payment.

**Drawings** - The drawings, plans, maps, profiles, diagrams, and other graphic representations which indicate the character, location, nature, extent, and scope of the WORK and which have been prepared by the ENGINEER and are included and/or referred to in the Contract Documents. Shop Drawings are not Drawings as so defined.

**Effective Date of the Agreement** - The date indicated in the Agreement on which it becomes effective, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the 2 parties to sign and deliver.

**ENGINEER** - The individual, partnership, corporation, joint-venture, or other legal entity named as such by the OWNER as set forth in the Supplementary General Conditions.

**Field Order** - A written order issued by the ENGINEER which may or may not involve a change in the WORK.

**General Requirements** - Division 1 of the Technical Specifications.

**Hazardous Material** - The term "Hazardous Material" as used herein shall mean any flammable materials, explosives, petroleum products, hazardous wastes, toxic substances, or related materials, including without limitation, asbestos, asbestos-containing materials, polychlorinated biphenyl (PCB), PCB-containing materials, and any substances defined as or included in the definition of "hazardous substances", "hazardous wastes", "hazardous materials", or "toxic substances", under any applicable federal, state, or local laws or regulations, now in effect or enacted prior to Substantial Completion of the Project.

**Laws and Regulations; Laws or Regulations** - Any and all applicable laws, rules, regulations, ordinances, codes, and/or orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.

**Lien or Mechanic's Lien** - A form of security, an interest in real property, which is held to secure the payment of an obligation. When related to public works construction, Lien or Mechanic's Lien may be called Stop Notice.

**Milestone** - A principal event specified in the Contract Documents relating to an intermediate completion date of a separately identifiable part of the WORK or a period of time within which the separately identifiable part of the WORK should be performed prior to Substantial Completion of all the WORK.

**Notice of Award** - The written notice by the OWNER to the apparent successful Bidder stating that upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein within the time specified, the OWNER will enter into an Agreement.

**Notice of Completion** - A form signed by the ENGINEER and the CONTRACTOR recommending to the OWNER that the WORK is Substantially Complete and fixing the date of Substantial Completion. After acceptance of the WORK by the OWNER'S governing body, the form is signed by the OWNER and filed with the County Recorder. This filing starts the 30 Day Lien filing period on the WORK.

**Notice to Proceed** - The written notice issued by the OWNER to the CONTRACTOR authorizing the CONTRACTOR to proceed with the WORK and establishing the date of commencement of the Contract Times.

**OWNER** - The public body or authority, corporation, association, firm, or person with whom the CONTRACTOR has entered into the Agreement and for whom the WORK is to be provided.

**Partial Utilization** - Use by the OWNER of a substantially completed part of the WORK for the purpose for which it is intended prior to Substantial Completion of all the WORK.

**PCBs** - Polychlorinated biphenyls.

**Petroleum** - Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Materials and crude oils.

**Project** - The total construction project of which the WORK to be provided under the Contract Documents may be the whole, or a part as indicated elsewhere in the Contract Documents.

**Radioactive Material** - Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

**Resident Project Representative** - The authorized representative of the ENGINEER who is assigned to the Site or any part thereof.

**Samples** - Physical examples of materials, equipment, or workmanship that are representative of some portion of the WORK and which establish the standards by which such portion of the WORK will be judged.

**Shop Drawings** - All drawings, diagrams, illustrations, schedules, and other data which are specifically prepared by or for the CONTRACTOR and submitted by the CONTRACTOR to illustrate some portion of WORK.

**Site** - Lands or other areas designated in the Contract Documents as being furnished by the OWNER for the performance of the construction, storage, or access.

**Specifications** - (Same definition as for Technical Specifications hereinafter).

**Stop Notice** - A legal remedy for subcontractors and suppliers who contribute to public works, but who are not paid for their work, which secures payment from construction funds possessed by the OWNER.

**Subcontractor** - An individual, partnership, corporation, joint-venture, or other legal entity having a direct contract with the CONTRACTOR or with any other Subcontractor for the performance of a part of the WORK at the Site.

**Substantial Completion** - The time at which the WORK (or specified part thereof) has progressed to the point where it is sufficiently complete, in accordance with the Contract Documents so that the WORK (or specified part) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to any WORK refer to Substantial Completion thereof.

**Supplementary General Conditions** - The part of the Contract Documents which make additions, deletions, or revisions to these General Conditions.

**Supplier** - A manufacturer, fabricator, distributor, materialman, or vendor having a direct contract with the CONTRACTOR or with any Subcontractor to furnish materials, equipment, or product to be incorporated in the WORK by the CONTRACTOR or any Subcontractor.

**Technical Specifications** - Divisions 1 through 43 of the Contract Documents consisting of the General Requirements and written technical descriptions of products and execution of the WORK.

**Total Bid Price** – The offer or proposal of the Bidder submitted on the prescribed form setting forth the price or prices for the WORK including the Base Bid and any amounts proposed for additive or deductive items called out in the Bid Schedule.

**Utilities** - All pipelines, conduits, ducts, cables, wires, tracks, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities which have been installed underground or above the ground to furnish any of the following services or materials: water, sewage, sludge, drainage, fluids, electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, traffic control, or other control systems. Utilities as used herein do not include any facilities that CONTRACTOR is to install pursuant to the Contract Documents.

**WORK** - The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. WORK is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents.

## **ARTICLE 2 -- PRELIMINARY MATTERS**

### **2.1 DELIVERY OF BONDS AND INSURANCE CERTIFICATES**

- A. When the CONTRACTOR delivers the signed Agreement to the OWNER, the CONTRACTOR shall also deliver to the OWNER such Bonds and insurance policies and certificates as the CONTRACTOR may be required to furnish in accordance with the Contract Documents.

### **2.2 COPIES OF DOCUMENTS**

- A. The OWNER will furnish to the CONTRACTOR the required number of copies of the Contract Documents specified in the Supplementary General Conditions.

### **2.3 COMMENCEMENT OF CONTRACT TIMES; NOTICE TO PROCEED**

- A. The Contract Times will start to run on the commencement date stated in the Notice to Proceed.



## 2.4 STARTING THE WORK

- A. The CONTRACTOR shall begin to perform the WORK on the commencement date stated in the Notice to Proceed, but no WORK shall be done at the Site prior to said commencement date.
- B. Before undertaking each part of the WORK, the CONTRACTOR shall review the Contract Documents in accordance with Paragraph 3.3.

## 2.5 PRECONSTRUCTION CONFERENCE

- A. The CONTRACTOR is required to attend a preconstruction conference. This conference will be attended by the OWNER, ENGINEER, and others as appropriate in order to discuss the WORK in accordance with the applicable procedures specified in Section 01 10 00 - Summary of Work.
- B. The CONTRACTOR shall provide its initial schedule submittals no fewer than 3 Days prior to the preconstruction conference. The CONTRACTOR'S initial schedule submittals for Shop Drawings, obtaining permits, and Plan of Operation and CPM Schedule will be reviewed and finalized. As a minimum, the CONTRACTOR'S representatives should include its project manager and schedule expert. The CONTRACTOR should plan on this meeting taking no more than 4 hours. If the submittals are not finalized at the end of the meeting, additional meetings will be held so that the submittals can be finalized prior to the submittal of the first Application for Payment. No Application for Payment will be processed prior to receiving acceptable initial submittals from the CONTRACTOR.

## ARTICLE 3 -- INTENT AND USE OF CONTRACT DOCUMENTS

### 3.1 INTENT

- A. The Contract Documents comprise the entire agreement between the OWNER and the CONTRACTOR concerning the WORK. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the State in which the Project is located.
- B. It is the intent of the Contract Documents to describe the WORK, functionally complete, to be constructed in accordance with the Contract Documents. CONTRACTOR shall provide any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result whether or not called for specifically.
- C. When words or phrases which have a well-known technical or construction industry or trade meaning are used to describe WORK, materials, or equipment, such words or phrases shall be interpreted in accordance with that meaning unless a definition has been provided in Article 1 of the General Conditions.

### 3.2 REFERENCE TO STANDARDS

- A. Reference to standard specifications, manuals, or codes of any technical society, organization, or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual or code shall be effective to change the duties and responsibilities of the OWNER, the CONTRACTOR, the ENGINEER, or any of their consultants, agents, or employees, from those set forth in the Contract Documents, nor shall it be effective to assign to OWNER, ENGINEER, or any of ENGINEER'S consultants, agents, or employees any duty or authority to direct the performance of the WORK or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

### 3.3 REVIEW OF CONTRACT DOCUMENTS

- A. If, during the performance of the WORK, CONTRACTOR discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any such Law or Regulation applicable to the performance of the WORK or of any such standard, specification, manual, or code, or of any instruction of any Supplier, CONTRACTOR shall report it to ENGINEER in writing at once, and CONTRACTOR shall not proceed with the WORK affected thereby (except in an emergency as authorized by Paragraph 6.12) until a Clarification, Field Order, or Change Order to the Contract Documents has been issued.

### 3.4 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

- A. In resolving conflicts resulting from errors or discrepancies in any of the Contract Documents, the order of precedence shall be as follows:
  - 1. Permits from other agencies as may be required by Law or Regulations
  - 2. Change Orders
  - 3. Agreement
  - 4. Addenda
  - 5. CONTRACTOR'S Bid (Bid Form)
  - 6. Supplementary General Conditions
  - 7. Notice Inviting Bids
  - 8. Instructions to Bidders
  - 9. General Conditions
  - 10. Technical Specifications
  - 11. Referenced Standard Specifications
  - 12. Drawings
- B. With reference to the Drawings the order of precedence is as follows:
  - 1. Figures govern over scaled dimensions
  - 2. Detail drawings govern over general drawings
  - 3. Addenda/Change Order drawings govern over any other drawings
  - 4. Drawings govern over standard drawings

## 1.5 AMENDING CONTRACT DOCUMENTS

- A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the WORK or to modify the terms and conditions thereof by a Change Order issued in accordance with Article 10.

## 1.6 REUSE OF DOCUMENTS

- A. Neither the CONTRACTOR, nor any Subcontractor or Supplier, nor any other person or organization performing any of the WORK under a contract with the OWNER shall have or acquire any title to or ownership rights in any of the Drawings, Technical Specifications, or other documents used on the WORK, and they shall not reuse any of them on the extensions of the Project or any other project without written consent of OWNER.

# ARTICLE 4 -- SITE OF THE WORK

## 4.1 AVAILABILITY OF LANDS

- A. The OWNER will furnish, as indicated in the Contract Documents, the lands upon which the WORK is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of the CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by the OWNER, unless otherwise provided in the Contract Documents. Nothing contained in the Contract Documents shall be interpreted as giving the CONTRACTOR exclusive occupancy of the lands or rights-of-way provided. The CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment; provided, that the CONTRACTOR shall not enter upon nor use any property not under the control of the OWNER until a written temporary construction easement agreement has been executed by the CONTRACTOR and the property owner, and a copy of said easement furnished to the ENGINEER prior to said use; and said easement shall expressly provide that neither the OWNER nor the ENGINEER will be liable for any claims or damages resulting from the CONTRACTOR'S trespass on or use of any such properties. The CONTRACTOR shall provide the OWNER with a signed release from the property owner confirming that the lands have been satisfactorily restored upon completion of the WORK.

## 4.2 REPORTS OF PHYSICAL CONDITIONS

- A. **Subsurface Explorations:** Reference is made to the Supplementary General Conditions for identification of those reports of explorations and tests of subsurface conditions at the Site that have been utilized by the ENGINEER in the preparation of the Contract Documents.
- B. **Existing Structures:** Reference is made to the Supplementary General Conditions for identification of those drawings of physical conditions in or relating to existing surface and subsurface structures (except underground Utilities referred to in Paragraph 4.3 herein) which are at or contiguous to the Site that have been utilized in the preparation of the Contract Documents.
- C. Neither the OWNER nor ENGINEER makes any representation as to the completeness of the reports or drawings referred to in Paragraph 4.2 A or B above or the accuracy of any data or information contained therein. The CONTRACTOR may rely upon the accuracy of the technical data contained in such reports and drawings. However, the CONTRACTOR may not rely upon any interpretation of such technical data, including any interpolation or

extrapolation thereof, or any non-technical data, interpretations, and opinions contained therein.

#### 4.3 PHYSICAL CONDITIONS - UNDERGROUND UTILITIES

- A. **Indicated:** The information and data indicated in the Contract Documents with respect to existing underground Utilities at or contiguous to the Site are based on information and data furnished to the OWNER or the ENGINEER by the owners of such underground Utilities or by others. Unless it is expressly provided in the Supplementary General Conditions and/or Section 01 50 10 - Protection of Existing Facilities, the OWNER and the ENGINEER will not be responsible for the accuracy or completeness of any such information or data, and the CONTRACTOR shall have full responsibility for reviewing and checking all such information and data, for locating all underground Utilities indicated in the Contract Documents, for coordination of the WORK with the owners of such underground Utilities during construction, for the safety and protection thereof and repairing any damage thereto resulting from the WORK, the cost of all of which are deemed to have been included in the Contract Price.
- B. **Not Indicated:** If an underground Utility is uncovered or revealed at or contiguous to the Site which was not indicated in the Contract Documents and which the CONTRACTOR could not reasonably have been expected to be aware of, the CONTRACTOR shall identify the owner of such underground Utility and give written notice thereof to that owner and shall notify the ENGINEER in accordance with the requirements of the Supplementary General Conditions and Section 01 50 10 - Protection of Existing Facilities.

#### 4.4 DIFFERING SITE CONDITIONS

- A. The CONTRACTOR shall notify the ENGINEER, in writing, of the following unforeseen conditions, hereinafter called differing Site conditions, promptly upon their discovery (but in no event later than 2 Days after their discovery) and before they are disturbed:
  - 1. Subsurface or latent physical conditions at the Site of the WORK differing materially from those indicated, described, or delineated in the Contract Documents, including those reports discussed in Paragraph 4.2, 4.3, and 4.5; and
  - 2. Unknown physical conditions at the Site of the WORK of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents, including those reports and documents discussed in Paragraph 4.2, 4.3, and 4.5.
- B. The ENGINEER will review the pertinent conditions, determine the necessity of obtaining additional explorations or tests with respect thereto, and advise the OWNER, in writing, of the ENGINEER'S findings and conclusions.
- C. If the OWNER concludes that because of newly discovered conditions a change in the Contract Documents is required, a Change Order will be issued as provided in Article 10 to reflect and document the consequences of the difference.
- D. In each such case, an increase or decrease in the Contract Price or an extension or shortening of the Contract Times, or any combination thereof, will be allowable to the extent that they are attributable to any such difference. If the OWNER and the CONTRACTOR are unable to agree as to the amount or length thereof, a claim may be made therefor as provided in Articles 11 and 12.

- E. The CONTRACTOR'S failure to give notice of differing Site conditions within 2 Days of their discovery and before they are disturbed shall constitute a waiver of all claims in connection therewith, whether direct or consequential in nature.

#### 4.5 HAZARDOUS MATERIALS

- A. Reference is made to the Supplementary General Conditions for identification of those reports and drawings relating to Hazardous Material identified at the Site that have been utilized by the ENGINEER in the preparation of the Contract Documents.
- B. OWNER shall be responsible for any Hazardous Material uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the WORK and which may present a substantial danger to persons or property exposed thereto in connection with the WORK at the Site. OWNER will not be responsible for any such material brought to the Site by CONTRACTOR, Subcontractors, Suppliers, or anyone else for whom CONTRACTOR is responsible.
  - 1. Upon discovery of any Hazardous Material that was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of WORK, the CONTRACTOR shall immediately stop all WORK in any area affected thereby (except in an emergency as required by Paragraph 6.13) and notify OWNER and ENGINEER (and thereafter confirm such notice in writing). CONTRACTOR shall not be required to resume any WORK in any such affected area until after OWNER has obtained any required permits related thereto and delivered to CONTRACTOR special written notice. Such written notice will specify that such condition and any affected area is or has been rendered safe for the resumption of the WORK or specify any special conditions under which the WORK may be resumed safely. If OWNER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of adjustment, if any, in Contract Price or Contract Times as a result of such WORK stoppage or such special conditions under which WORK is agreed by CONTRACTOR to be resumed, either party may make a claim therefor as provided in Articles 11 and 12.
  - 2. If, after receipt of such special written notice, CONTRACTOR does not agree to resume such WORK based on a reasonable belief it is unsafe, or does not agree to resume such WORK under special conditions, then OWNER may order such portion of the WORK that is in connection with such hazardous condition or in such affected area to be deleted from the WORK. If OWNER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of deleting such portion of the WORK, then either party may make a claim therefor as provided in Articles 11 and 12. OWNER may have such deleted portion of the WORK performed by OWNER'S own forces or others in accordance with Article 7.
  - 3. To the fullest extent permitted by Laws and Regulations, OWNER will indemnify and hold harmless CONTRACTOR, Subcontractors, ENGINEER, ENGINEER'S consultants, and the officers, directors, employees, agents, other consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages arising out of or resulting from such Hazardous Material discovered on the Site; provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the WORK itself), including the loss of use resulting therefrom.

Nothing in this Paragraph shall obligate OWNER to indemnify a person or entity from and against the consequences of that person's or entity's own negligence.

- C. The provisions of Paragraphs 4.2, 4.3, and 4.4 are not intended to apply to Hazardous Material uncovered or revealed at the Site.
- D. In the event that Hazardous Materials are brought on to the Site or are discharged or released by the CONTRACTOR, any Subcontractor, Supplier, or any person or entity under the direct or indirect control of any of them, and notwithstanding any other item or provision of the Contract, the CONTRACTOR agrees to defend, indemnify, and hold the OWNER and the ENGINEER and the officers, directors, employees, agents, other consultants, and subcontractors of each and any of them harmless from and against any and all claims, liability, fines, penalties, response costs, damages, or judgments associated with the presence, discharge, release, or escape of such materials or contamination. Upon request of the OWNER, the CONTRACTOR shall take such steps, at its own expense, as are reasonably necessary to remove from the Site the Hazardous Material or contamination brought onto the Site by the CONTRACTOR, Subcontractor, Supplier, or any person or entity under the direct control of any of them. The requirements of this paragraph are in addition to, and do not replace, the provisions of Paragraph 6.17 Indemnification. CONTRACTOR shall not be responsible for pre-existing Hazardous Material, and the foregoing indemnification obligation shall not apply thereto, unless CONTRACTOR causes Hazardous Material to be discharged, or fails to respond promptly and appropriately to the discovery or discharge of Hazardous Material.

#### 4.6 REFERENCE POINTS

- A. The OWNER will provide one bench mark, near or on the Site of the WORK, and will provide 2 points near or on the Site to establish a base line for use by the CONTRACTOR for alignment control. Unless otherwise specified in the Supplementary General Conditions, the CONTRACTOR shall furnish all other lines, grades, and bench marks required for proper execution of the WORK.
- B. The CONTRACTOR shall preserve all bench marks, stakes, and other survey marks, and in case of their removal or destruction by any party, the CONTRACTOR shall be responsible for the accurate replacement of such reference points by personnel qualified under the applicable state codes governing land surveyors.

### ARTICLE 5 -- BONDS AND INSURANCE

#### 5.1 BONDS

- A. The CONTRACTOR shall furnish Performance and Payment Bonds, each in the amount set forth in the Supplementary General Conditions, as security for the faithful performance and payment of all the CONTRACTOR'S obligations under the Contract Documents. The CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary General Conditions.
- B. All Bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Audit Staff, Bureau of Government Financial Operations, U.S. Treasury Department. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.

- C. If the surety on any Bond furnished by the CONTRACTOR is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the WORK is located, the CONTRACTOR shall within 7 Days thereafter substitute another Bond and surety, which must be acceptable to the OWNER.
- D. All Bonds required by the Contract Documents to be purchased and maintained by CONTRACTOR shall be obtained from surety companies that are duly licensed or authorized in the State in which the Project is located to issue Bonds for the limits so required. Such surety companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary General Conditions.

## 5.2 INSURANCE

- A. The CONTRACTOR shall purchase and maintain the insurance required under this Paragraph. Such insurance shall include the specific coverages set out herein and be written for not less than the limits of liability and coverages provided in the Supplementary General Conditions, or required by Laws or Regulations, whichever are greater. All insurance shall be maintained continuously during the life of the Agreement up to the date of Substantial Completion and at all times thereafter when the CONTRACTOR may be correcting, removing, or replacing Defective Work in accordance with Paragraph 13.5. The CONTRACTOR'S liabilities under this Agreement shall not be deemed limited in any way to the insurance coverage required.
- B. All insurance required by the Contract Documents to be purchased and maintained by the CONTRACTOR shall be obtained from insurance companies that are duly licensed or authorized to issue insurance policies for the limits and coverages so required in the State in which the Project is located. Such insurance companies shall have a current Best's Rating of at least an "A" (Excellent) general policy holder's rating and a Class VII financial size category and shall also meet such additional requirements and qualifications as may be provided in the Supplementary General Conditions.
- C. The CONTRACTOR shall furnish the OWNER, with copies to each additional insured who is indicated in the Supplementary General Conditions, with certificates and original endorsements showing the type, amount, class of operations covered, effective dates and dates of expiration of policies. All of the policies of insurance so required to be purchased and maintained (or the certificates or other evidence thereof) shall contain a provision or endorsement that the coverage afforded will not be canceled, reduced in coverage, or renewal refused until at least 30 Days prior written notice has been given to the OWNER and additional insureds by certified mail. All such insurance required herein (except for worker's compensation and employer's liability) shall name the OWNER, the ENGINEER, and their consultants and subconsultants and their officers, directors, agents, and employees as "additional insureds" under the policies. The CONTRACTOR shall purchase and maintain the following insurance:
  - 1. Workers' Compensation and Employer's Liability: This insurance shall protect the CONTRACTOR against all claims under applicable workers' compensation laws or federal acts, including claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of a workers' compensation law. This insurance shall include an "all states" endorsement. In the event of a "monopolistic" state, CONTRACTOR shall certify all employees are covered by the state fund or shall provide a separate policy providing "all states" benefits. Employer's liability "stop gap" coverage for monopolistic states shall be provided under either a worker's compensation policy or general liability policy. The

CONTRACTOR shall require each Subcontractor similarly to provide workers' compensation insurance for all of the latter's employees to be engaged in such WORK unless such employees are covered by the protection afforded by the CONTRACTOR'S workers' compensation insurance. In case any class of employees is not protected under the workers' compensation laws, the CONTRACTOR shall provide and shall cause each Subcontractor to provide adequate employer's liability insurance for the protection of such of its employees as are not otherwise protected. The CONTRACTOR and each Subcontractor shall provide a waiver of subrogation in favor of the OWNER and ENGINEER.

2. Commercial General Liability: This insurance shall be written in comprehensive form and shall protect the CONTRACTOR against all claims arising from
  - a. Injuries to persons other than its employees or
  - b. damage to property of the OWNER or others arising out of any act or omission of the CONTRACTOR or its agents, employees, or Subcontractors.

The policy shall also include protection against claims insured by personal injury liability coverage and contractual coverage to insure the contractual liability assumed by the CONTRACTOR under the indemnification provisions in the General Conditions. To the extent that the CONTRACTOR'S WORK, or WORK under its direction, may require blasting, explosive conditions, or underground operations, the comprehensive or commercial general liability coverage shall specifically include coverage relative to blasting, explosion, collapse, and/or underground hazards.

3. Commercial Automobile Liability: This insurance shall be written in comprehensive form and shall protect the CONTRACTOR against all claims for injuries to members of the public and damage to property of others arising from the use of motor vehicles, and shall cover operation on or off the Site of all motor vehicles licensed for highway use, whether they are owned, nonowned, or hired.
4. Subcontractor's Public Liability and Property Damage Insurance and Vehicle Liability Insurance: The CONTRACTOR shall either require each of the Subcontractors to procure and to maintain subcontractor's public liability and property damage insurance and vehicle liability insurance of the type and in the same amounts specified in the Supplementary General Conditions for the CONTRACTOR or insure the activities of the Subcontractors under the CONTRACTOR'S own policies.
5. Builder's Risk:
  - a. This insurance shall be of the "all risks" type, shall be written in completed value form, and shall protect the CONTRACTOR, Subcontractors, the OWNER, and the ENGINEER, against risks of damage to buildings, structures, and materials and equipment (including any stored off-Site and while in transit), CONTRACTOR'S equipment, debris removal and including demolition and contingent loss occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for ENGINEER'S services and expenses required as a result of such insured loss. The amount of such insurance shall be not less than the insurable value of the WORK at completion plus equipment. Builder's Risk



insurance shall provide for losses to be payable to the CONTRACTOR and the OWNER, as their interests may appear. This insurance shall contain a provision that in the event of payment for any loss under the coverage provided, the insurance company shall have no rights of recovery against the CONTRACTOR, the OWNER, and the ENGINEER. This insurance shall insure against all risks of loss (including earthquake, flood and collapse) and, at the option of the OWNER, shall include comprehensive boiler and machinery coverage including coverage for installation and testing.

- b. If the OWNER finds it necessary to occupy or use a portion or portions of the Project prior to Substantial Completion thereof, such occupancy shall not commence prior to the time mutually agreed to by the OWNER and CONTRACTOR and to which the insurance company or companies providing the Builder's Risk Insurance have consented by endorsement to the policy or policies.

## **ARTICLE 6 -- CONTRACTOR'S RESPONSIBILITIES**

### **6.1 COMMUNICATIONS**

- A. Written communications with the OWNER shall be only through or as directed by the ENGINEER.

### **6.2 SUPERVISION AND SUPERINTENDENCE**

- A. The CONTRACTOR shall supervise, inspect, and direct the WORK competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the WORK in accordance with the Contract Documents. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction and all safety precautions and programs incidental thereto. The CONTRACTOR shall be responsible to see that the completed WORK complies accurately with the Contract Documents.
- B. The CONTRACTOR shall designate in writing and keep on the Site at all times during the performance of the WORK a technically qualified, English-speaking superintendent, who is an employee of the CONTRACTOR and who shall not be replaced without written notice to the OWNER and the ENGINEER. The superintendent will be the CONTRACTOR'S representative at the Site and shall have authority to act on behalf of the CONTRACTOR. All communications given to the superintendent shall be as binding as if given to the CONTRACTOR.
- C. The CONTRACTOR'S superintendent shall be present at the Site at all times while WORK is in progress and shall be available by phone for emergencies 24 hours per day, 7 days per week. Failure to observe this requirement shall be considered suspension of the WORK by the CONTRACTOR until such time as such superintendent is again present at the Site.

### **6.3 LABOR, MATERIALS, AND EQUIPMENT**

- A. The CONTRACTOR shall provide competent, suitably qualified personnel to survey and lay out the WORK and perform construction as required by the Contract Documents. The CONTRACTOR shall furnish, erect, maintain, and remove the construction plant and any required temporary works. The CONTRACTOR shall at all times maintain good discipline

and order at the Site. Except in connection with the safety or protection of persons or the WORK or property at the Site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all WORK at the Site shall be performed during regular working hours, and the CONTRACTOR will not permit overtime WORK or the performance of WORK on Saturday, Sunday, or any federally observed holiday without the OWNER'S written consent. The CONTRACTOR shall apply for this consent through the ENGINEER in writing a minimum of 24 hours in advance.

- B. Except as otherwise provided in this Paragraph, the CONTRACTOR shall receive no additional compensation for overtime WORK, i.e., WORK in excess of 8 hours in any one calendar day or 40 hours in any one calendar week, even though such overtime WORK may be required under emergency conditions and may be ordered by the ENGINEER in writing. Additional compensation will be paid to the CONTRACTOR for overtime WORK only in the event extra WORK is ordered by the ENGINEER and the Change Order specifically authorizes the use of overtime WORK and then only to such extent as overtime wages are regularly being paid by the CONTRACTOR for overtime WORK of a similar nature in the same locality.
- C. All increased costs of inspection and testing performed during overtime WORK by the CONTRACTOR which is allowed solely for the convenience of the CONTRACTOR shall be borne by the CONTRACTOR. The OWNER has the authority to deduct the cost of all such inspection and testing from any partial payments otherwise due to the CONTRACTOR.
- D. Unless otherwise specified in the Contract Documents, the CONTRACTOR shall furnish and assume full responsibility for all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, lubricants, power, light, heat, telephone, water, sanitary facilities, and all other facilities, consumables, and incidentals necessary for the furnishing, performance, testing, start-up, and completion of the WORK.
- E. All materials and equipment incorporated into the WORK shall be of specified quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Specifications shall expressly run to the benefit of the OWNER. If required by the ENGINEER, the CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the source, kind and quality of materials and equipment. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with the instructions of the applicable Supplier except as otherwise provided in the Contract Documents; but no provisions of any such instructions will be effective to assign to the OWNER, ENGINEER, or any of their consultants, agents, or employees, any duty or authority to supervise or direct the furnishing or performance of the WORK or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.9 C.

#### 6.4 SCHEDULE

- A. The CONTRACTOR shall comply with the schedule requirements in the General Requirements.

#### 6.5 SUBSTITUTES OR "OR EQUAL" ITEMS

- A. The CONTRACTOR shall submit proposed substitutes or "or equal" items in accordance with the provisions of Section 01 60 00 - Products, Materials, Equipment, and Substitutions.

## 6.6 CONCERNING SUBCONTRACTORS, SUPPLIERS, AND OTHERS

- A. The CONTRACTOR shall be responsible to the OWNER and the ENGINEER for the acts and omissions of its Subcontractors, Suppliers, and their employees to the same extent as CONTRACTOR is responsible for the acts and omissions of its own employees. Nothing contained in this Paragraph shall create any contractual relationship between any Subcontractor and the OWNER or the ENGINEER nor relieve the CONTRACTOR of any liability or obligation under the Contract Documents. The CONTRACTOR shall include these General Conditions and the Supplementary General Conditions as a part of all its subcontract and supply agreements.

## 6.7 PERMITS

- A. Unless otherwise provided in the Supplementary General Conditions, the CONTRACTOR shall obtain and pay for all construction permits and licenses from the agencies having jurisdiction, including the furnishing of insurance and bonds if required by such agencies. The enforcement of such requirements shall not be made the basis for claims for additional compensation by CONTRACTOR. When necessary, the OWNER will assist the CONTRACTOR, in obtaining such permits and licenses. The CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the WORK, which are applicable at the time of opening of Bids. The CONTRACTOR shall pay all charges of Utility owners for inspection or connections to the WORK.

## 6.8 PATENT FEES AND ROYALTIES

- A. The CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the WORK or the incorporation in the WORK of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the WORK and if to the actual knowledge of the OWNER or the ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed by the OWNER in the Contract Documents. The CONTRACTOR'S indemnification obligation under this Paragraph 6.7 A. for all claims and liabilities arising out of any infringement of patent rights or copyrights incident to the use in the performance of the WORK or resulting from the incorporation in the WORK of any invention, design, process, product, or device not specified in the Contract Documents shall be in accordance with Paragraph 6.16 of these General Conditions.

## 6.9 LAWS AND REGULATIONS

- A. The CONTRACTOR shall observe and comply with all Laws and Regulations which in any manner affect those engaged or employed on the WORK, the materials used in the WORK, or the conduct of the WORK. If any discrepancy or inconsistency should be discovered between the Contract Documents and any such Laws or Regulations, the CONTRACTOR shall report the same in writing to the ENGINEER. Any particular Law or Regulation specified or referred to elsewhere in the Contract Documents shall not in any way limit the obligation of the CONTRACTOR to comply with all other provisions of federal, state, and local laws and regulations. The CONTRACTOR'S indemnification obligations for all claims or liability arising from violation of any such law, ordinance, code, order, or regulation, whether by CONTRACTOR or by its employees, Subcontractors or Suppliers shall be in accordance with Paragraph 6.16 of these General Conditions.

## 6.10 TAXES

- A. The CONTRACTOR shall pay all sales, consumer, use, and other similar taxes required to be paid by the CONTRACTOR in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the WORK.

## 6.11 USE OF PREMISES

- A. The CONTRACTOR shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site, the land and areas identified in and permitted by the Contract Documents, and the other land and areas permitted by Laws and Regulations, rights-of-way, permits, and easements. The CONTRACTOR shall assume full liability and responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any land or areas contiguous thereto, resulting from the performance of the WORK. Should any claim be made against the OWNER or the ENGINEER by any such owner or occupant because of the performance of the WORK, the CONTRACTOR shall promptly attempt to settle with such other party by agreement or otherwise resolve the claim through litigation at the CONTRACTOR'S sole liability expense. The CONTRACTOR'S indemnification obligations for all claims and liability, arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any such owner or occupant against the OWNER, the ENGINEER, their consultants, subconsultants, and the officers, directors, employees and agents of each and any of them to the extent caused by or based upon the CONTRACTOR'S performance of the WORK shall be in accordance with Paragraph 6.16 of these General Conditions.

## 6.12 SAFETY AND PROTECTION

- A. The CONTRACTOR shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the WORK. The CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
  - 1. All persons at the Site and other persons and organizations who may be affected thereby;
  - 2. All the WORK and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
  - 3. Other property at the Site or adjacent thereto, including but not limited to trees, shrubs, lawns, walks, pavements, roadways, structures, and Utilities not designated for removal, relocation, or replacement in the course of the performance of the WORK.
- B. The CONTRACTOR shall comply with all applicable Laws and Regulations relating to the safety of persons or property or to the protection of persons or property from damage, injury, or loss and shall erect and maintain all necessary safeguards for such safety and protection. The CONTRACTOR shall notify owners of adjacent property and Utilities when prosecution of the WORK may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property. CONTRACTOR'S duties and responsibilities for safety and for protection of the WORK shall continue until such time as all the WORK is completed or OWNER has issued written notification in accordance with Paragraph 14.7 (except as otherwise expressly provided in connection with Substantial Completion).

- C. The CONTRACTOR shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.
- D. Materials that contain hazardous substances or mixtures may be required on the WORK. A Material Safety Data Sheet shall be made available at the Site by the CONTRACTOR for every hazardous product used.
- E. Material usage shall strictly conform to OSHA safety requirements and all manufacturer's warnings and application instructions listed on the Material Safety Data Sheet and on the product container label.
- F. The CONTRACTOR shall be responsible for the exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.
- G. The CONTRACTOR shall notify the ENGINEER in writing if it considers a specified product or its intended use to be unsafe. This notification must be given to the ENGINEER prior to the product being ordered, or if provided by some other party, prior to the product being incorporated in the WORK.

#### 6.13 EMERGENCIES

- A. In emergencies affecting the safety or protection of persons or the WORK or property at the Site or adjacent thereto, CONTRACTOR, without special instruction or authorization from OWNER or ENGINEER, is obligated to immediately act to prevent threatened damage, injury, or loss. CONTRACTOR shall give ENGINEER prompt written notice if CONTRACTOR believes that any significant changes in the WORK or variations from the Contract Documents have been caused thereby. If ENGINEER determines that a change in the Contract Documents is required because of the action taken by CONTRACTOR in response to such an emergency, a Change Order will be issued to document the consequences of such action.

#### 6.14 SUBMITTALS

- A. After checking and verifying all field measurements and after complying with applicable procedures specified in the General Requirements, the CONTRACTOR shall submit to the ENGINEER for review all Shop Drawings in accordance with the accepted schedule of Shop Drawing submittals specified in Section 01 33 00 - Contractor Submittals.
- B. The ENGINEER'S review will be only to determine if the items covered by the submittals will, after installation or incorporation in the WORK, generally conform to the Contract Documents and with the design concept of the completed Project.
- C. The CONTRACTOR shall also submit to the ENGINEER for review all Samples in accordance with the accepted schedule of Sample submittals specified in Section 01 33 00 - Contractor Submittals.
- D. Before submittal of each Shop Drawing or Sample, the CONTRACTOR shall have determined and verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereto and reviewed or coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the WORK and the Contract Documents. The

CONTRACTOR shall provide submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.

#### 6.15 CONTINUING THE WORK

- A. No claim, potential claim, dispute, or controversy shall interfere with the progress and performance of the WORK, or any changes thereto, and the CONTRACTOR shall proceed in all instances with its WORK, including any disputed WORK, or any changes thereto, and any failure of the CONTRACTOR to comply herewith and to proceed with the WORK shall be deemed a material breach of the Agreement entitling the OWNER to all remedies available under Article 15 of the General Conditions or other provisions of the Contract Documents and applicable law. Except as provided elsewhere in the Contract Documents, the OWNER will continue to make undisputed payments in accordance with the Contract Documents.

#### 6.16 CONTRACTOR'S GENERAL WARRANTY AND GUARANTEE

- A. CONTRACTOR warrants and guarantees that all WORK will be in accordance with the Contract Documents and will not be defective. CONTRACTOR's warranty and guarantee hereunder excludes defects or damage caused by:
1. Abuse, modification, or improper maintenance or operation by persons other than CONTRACTOR, Subcontractors, or Suppliers, or any other individual or entity for whom CONTRACTOR is responsible;
  2. Normal wear and tear under normal usage.
- B. CONTRACTOR's obligation to perform and complete the WORK in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of WORK that is not in accordance with the Contract Documents or a release of CONTRACTOR'S obligation to perform the WORK (including CONTRACTOR'S obligations under the general warranty and guaranty of Paragraph 6.16 A) in accordance with the Contract Documents:
1. Observations by ENGINEER;
  2. Recommendation by ENGINEER or payment by OWNER of any progress or final payment;
  3. The issuance of a Certificate of Completion by the OWNER;
  4. Use or occupancy of the WORK or any part thereof by the OWNER;
  5. Any acceptance by OWNER or any failure to do so;
  6. Any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice or acceptability by ENGINEER pursuant to Paragraph 14.7 B.;
  7. Any inspection, test, or approval by others; or
  8. Any correction of Defective WORK by OWNER.

## 6.17 INDEMNIFICATION

- A. To the fullest extent permitted by Laws and Regulations, the CONTRACTOR shall indemnify, defend, and hold harmless the OWNER, the ENGINEER, their consultants, subconsultants, and the officers, directors, employees, and agents of each and any of them, against and from all claims and liability arising under, by reason of, related, or incidental to the Contract Documents or any performance of the WORK, in any and all situations, including situations involving the concurrent active or passive negligence of any indemnified party, but not from the sole negligence or willful misconduct of the OWNER and/or the ENGINEER. Such indemnification by the CONTRACTOR shall include, but not be limited to, the following:
1. Liability or claims resulting directly or indirectly from the negligence or carelessness of the CONTRACTOR and its Subcontractors, Suppliers, and the employees, agents, permittees, and invitees of any of them in the performance of the WORK, or in guarding or maintaining the same, or from any improper materials, implements, or appliances used in its construction, or by or on account of any act or omission of the CONTRACTOR, its employees, or agents;
  2. Liability or claims arising directly or indirectly from bodily injury, occupational sickness or disease, or death of the CONTRACTOR, and its Subcontractor, Supplier, and the employees, agents, permittees and invitees of any of them engaged in the WORK resulting in actions brought by or on behalf of such employees against the OWNER and/or the ENGINEER;
  3. Liability or claims arising directly or indirectly from or based on the violation of any Laws or Regulations, whether by the CONTRACTOR and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them;
  4. Liability or claims arising directly or indirectly from the use or manufacture by the CONTRACTOR and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them in the performance of this Agreement of any copyrighted or uncopyrighted composition, secret process, patented or unpatented invention, article, or appliance, unless otherwise specifically stipulated in this Agreement;
  5. Liability or claims arising directly or indirectly from the breach of any warranties, whether express or implied, made to the OWNER and/or ENGINEER or any other parties by the CONTRACTOR, and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them;
  6. Liability or claims arising directly or indirectly from the willful misconduct of the CONTRACTOR, and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them;
  7. Liability or claims arising directly or indirectly from any breach of the obligations assumed in this Agreement by the CONTRACTOR;
  8. Liability or claims arising directly or indirectly from, relating to, or resulting from a hazardous condition created by the CONTRACTOR, and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them, and;
  9. Liability or claims arising directly, or indirectly, or consequentially out of any action, legal or equitable, brought against the OWNER, the ENGINEER, their consultants,

subconsultants, and the officers, directors, employees and agents of each or any of them, to the extent caused by the CONTRACTOR'S and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them use of any premises acquired by permits, rights of way, or easements, the Site, or any land or areas contiguous thereto or its performance of the WORK thereon.

- B. The CONTRACTOR shall reimburse the OWNER and the ENGINEER for all costs and expenses, (including but not limited to fees and charges of engineers, architects, attorneys, and other professionals and court costs including all costs of appeals) incurred by said OWNER and ENGINEER in enforcing the provisions of this Paragraph 6.17.
- C. The indemnification obligation under this Paragraph 6.17 shall not be limited in any way by any limitation on the amount or type of insurance carried by CONTRACTOR or by the amount or type of damages, compensation, or benefits payable by or for the CONTRACTOR or any Subcontractor or other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts.
- D. CONTRACTOR'S obligation to defend and indemnify shall not be excused because of CONTRACTOR'S inability to evaluate liability or because the CONTRACTOR evaluated liability and determined that the CONTRACTOR is not liable to the claimant. The CONTRACTOR will respond within 30 Days to the tender of any claim for defense and indemnity by the OWNER, unless that time has been extended by the OWNER. If the CONTRACTOR fails to accept or reject the tender of defense in indemnity within 30 Days, in addition to any other remedy authorized by Law, so much of the money due the CONTRACTOR under and by virtue of the Contract as shall reasonably be considered necessary by the OWNER, may be retained by the OWNER until disposition has been made of the claim or suit for damages, or until the CONTRACTOR accepts or rejects the tender of defense, whichever occurs first.
- E. With respect to third party claims against the CONTRACTOR, the CONTRACTOR waives any and all rights of any type to express or implied indemnity against the OWNER, its directors, officers, employees, or agents.

#### 6.18 CONTRACTOR'S DAILY REPORTS

- A. The CONTRACTOR shall complete a daily report indicating location worked, total manpower for each construction trade, major equipment on Site, each Subcontractor's manpower and equipment, weather conditions, and other related information involved in the performance of the WORK. The daily report shall be submitted to the ENGINEER at the conclusion of each Day. The daily report shall comment on the daily progress and status of each major component of the WORK. These components will be decided by the ENGINEER.

### ARTICLE 7 -- OTHER WORK

#### 7.1 RELATED WORK AT SITE

- A. The OWNER may perform other work related to the Project at or adjacent to the Site by the OWNER'S own forces, have other work performed by utility owners, or let other direct contracts for such other work. The CONTRACTOR shall include in its Bid all costs associated with coordinating and connecting its WORK with adjoining work performed under other contracts. The CONTRACTOR shall be solely responsible for aligning and coordinating its WORK with other portions of the Project performed by others.



- B. The CONTRACTOR shall afford each person who is performing the other work (including the OWNER's employees) proper and safe access to the Site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the WORK with theirs. The CONTRACTOR shall do all cutting, fitting, and patching of the WORK that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. The CONTRACTOR shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of the ENGINEER and the others whose work will be affected.
- C. If the proper execution or results of any part of the CONTRACTOR'S WORK depends upon such other work by another, the CONTRACTOR shall inspect and report to the ENGINEER in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for such proper execution and results. The CONTRACTOR'S failure to report such delays, defects, or deficiencies will constitute an acceptance of the other work as fit and proper for integration with the CONTRACTOR's WORK except for latent or nonapparent defects and deficiencies in the other work.

## 7.2 COORDINATION

- A. If the OWNER contracts with others for the performance of other work at the Site, OWNER will have sole authority and responsibility in respect of such coordination unless otherwise provided in the Supplementary General Conditions.

## ARTICLE 8 -- OWNER'S RESPONSIBILITIES

### 8.1 COMMUNICATIONS

- A. Except as may be otherwise provided in these General Conditions or the Supplementary General Conditions, the OWNER will issue all its communications to the CONTRACTOR through the ENGINEER.

### 8.2 PAYMENTS

- A. The OWNER will make payments to the CONTRACTOR as provided in Article 14.

### 8.3 LANDS, EASEMENTS, AND SURVEYS

- A. The OWNER'S duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.1 and 4.6.

### 8.4 REPORTS AND DRAWINGS

- A. The OWNER will identify and make available to the CONTRACTOR copies of reports of physical conditions at the Site and drawings of existing structures which have been utilized in preparing the Contract Documents as set forth in Paragraph 4.2.

### 8.5 CHANGE ORDERS

- A. The OWNER will execute Change Orders as indicated in Article 10.

### 8.6 INSPECTIONS AND TESTS

- A. The OWNER'S responsibility for inspections and tests is set forth in Paragraph 13.3.

#### 8.7 SUSPENSION OF WORK

- A. The OWNER'S right to stop WORK or suspend WORK is set forth in Paragraphs 13.4 and 15.1.

#### 8.8 TERMINATION OF AGREEMENT

- A. The OWNER'S right to terminate services of the CONTRACTOR is set forth in Paragraphs 15.2 and 15.3.

#### 8.9 LIMITATION ON OWNER'S RESPONSIBILITIES

- A. The OWNER shall not supervise, direct or have control or authority over, nor be responsible for CONTRACTOR'S means, methods, techniques, sequences, or procedures of construction or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of the WORK. OWNER will not be responsible for CONTRACTOR'S failure to perform or furnish the WORK in accordance with the Contract Documents.

#### 8.10 UNDISCLOSED HAZARDOUS ENVIRONMENTAL CONDITIONS

- A. OWNER'S responsibility in respect to an undisclosed hazardous environmental condition is set forth in Paragraph 4.5.

### **ARTICLE 9 -- ENGINEER'S STATUS DURING CONSTRUCTION**

#### 9.1 OWNER'S REPRESENTATIVE

- A. The ENGINEER will be the OWNER'S representative during the construction period. The duties and responsibilities and the limitations of authority of the ENGINEER as the OWNER'S representative during construction are set forth in the Contract Documents.

#### 9.2 OBSERVATIONS ON THE SITE

- A. The ENGINEER will make observations on the Site during construction to monitor the progress and quality of the WORK and to determine, in general, if the WORK is proceeding in accordance with the Contract Documents. The level or frequency of the ENGINEER'S inspections of the quality or quantity of the WORK will not relieve the CONTRACTOR from any of its obligations or liability for the WORK under the Contract Documents or otherwise.

#### 9.3 PROJECT REPRESENTATION

- A. The ENGINEER may furnish a Resident Project Representative to assist in observing the performance of the WORK. The duties, responsibilities, and limitations of authority of any such Resident Project Representative will be as provided in the Supplementary General Conditions.

#### 9.4 CLARIFICATIONS

- A. The ENGINEER will issue with reasonable promptness such written Clarifications of the requirements of the Contract Documents as the ENGINEER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

#### 9.5 AUTHORIZED VARIATIONS IN WORK

- A. The ENGINEER may authorize variations in the WORK from the requirements of the Contract Documents. These may be accomplished by a Field Order and will require the CONTRACTOR to perform the WORK involved in a manner that minimizes the impact to the WORK and the Contract Times. If the CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Times, the CONTRACTOR may make a claim therefor as provided in Article 11 or 12.

#### 9.6 REJECTING DEFECTIVE WORK

- A. The ENGINEER will have authority to reject Defective WORK and will also have authority to require special inspection or testing of the WORK as provided in Article 13.

#### 9.7 CONTRACTOR SUBMITTALS, CHANGE ORDERS, AND PAYMENTS

- A. In accordance with the procedures set forth in the General Requirements, the ENGINEER will review all CONTRACTOR submittals.
- B. The ENGINEER'S responsibilities for Change Orders are set forth in Articles 10, 11, and 12.
- C. The ENGINEER'S responsibilities for Applications for Payment are set forth in Article 14.

#### 9.8 DECISIONS ON DISPUTES

- A. The ENGINEER will be the initial interpreter of the requirements of the Contract Documents and of the acceptability of the WORK thereunder. Claims, disputes, and other matters relating to the acceptability of the WORK and interpretation of the requirements of the Contract Documents pertaining to the performance of the WORK shall be determined by the ENGINEER. Any claims in respect to changes in the Contract Price or Contract Times shall be resolved in accordance with the requirements set forth in Articles 10, 11, and 12.

#### 9.9 LIMITATION ON ENGINEER'S RESPONSIBILITIES

- A. Neither the ENGINEER'S authority to act under this Article 9 or other provisions of the Contract Documents nor any decision made by the ENGINEER in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of the ENGINEER to the CONTRACTOR, any Subcontractor, any Supplier, any surety for any of them, or any other person or organization performing any of the WORK.
- B. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as reviewed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," or "satisfactory," or adjectives of like effect or import are used to describe a requirement, direction, review, or judgment of the ENGINEER as to the WORK, it is intended that such requirement,

direction, review, or judgment will be solely to evaluate the WORK for compliance with the requirements of the Contract Documents, and conformance with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, unless there is a specific statement indicating otherwise. The use of any such term or adjective shall not be effective to assign to the ENGINEER any duty or authority to supervise or direct the performance of the WORK or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.9 C.

- C. The ENGINEER will not supervise, direct, control, or have authority over or be responsible for the CONTRACTOR'S means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of the CONTRACTOR to comply with Laws and Regulations applicable to the performance of the WORK. The ENGINEER will not be responsible for the CONTRACTOR'S failure to perform the WORK in accordance with the Contract Documents. The ENGINEER will not be responsible for the acts or omissions of the CONTRACTOR nor of any Subcontractor, Supplier, or any other person or organization performing any of the WORK.

## **ARTICLE 10-- CHANGES IN THE WORK**

### **10.1 GENERAL**

- A. Without invalidating the Agreement and without notice to any surety, the OWNER may at any time or from time to time, order additions, deletions, or revisions in the WORK. Such additions, deletions or revisions will be authorized by a Change Order or Field Order. Upon receipt of any such document, CONTRACTOR shall promptly proceed to implement the additions, deletions, or revisions in the WORK in accordance with the applicable conditions of the Contract Documents.
- B. The CONTRACTOR shall not be entitled to an increase in the Contract Price nor an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented by Change Order.
- C. The OWNER and the CONTRACTOR shall execute appropriate Change Orders covering:
  - 1. Changes in the WORK which are ordered by the OWNER pursuant to Paragraph 10.1 A.;
  - 2. Changes required because of acceptance of Defective WORK under Paragraph 13.6; and
  - 3. Changes in the Contract Price or Contract Times which are agreed to by the parties under Articles 11 and/or 12, respectively.
- D. If notice of any change in the WORK is required to be given to a surety, the giving of any such notice shall be the CONTRACTOR'S responsibility. If the change in the WORK affects the Contract Price, the OWNER may require an adjustment to the amount of any applicable Bond and the amount of each applicable Bond shall be adjusted accordingly.
- E. If the OWNER and CONTRACTOR agree as to the extent, if any, of an increase in the Contract Price or an extension or shortening of the Contract Times that should be allowed as a result of a Field Order, the CONTRACTOR shall proceed so as to minimize the impact on and delays to the WORK pending the issuance of a Change Order.

- F. If the OWNER and the CONTRACTOR are unable to agree as to the extent, if any, of an increase in the Contract Price or an extension or shortening of the Contract Times that should be allowed as a result of a Field Order, the ENGINEER can direct the CONTRACTOR to proceed on the basis of time and materials so as to minimize the impact on and delays to the WORK, and the CONTRACTOR may make a claim as provided in Articles 11 and 12.
- G. OWNER may from time to time issue requests for additional WORK. However, once the OWNER has received a price for the additional WORK from the CONTRACTOR, OWNER may or may not issue a Change Order for such additional WORK. In the event that OWNER does not issue a Change Order for such WORK, CONTRACTOR has no obligation to perform the WORK so requested but not ordered.

## 10.2 ALLOWABLE QUANTITY VARIATIONS

- A. In the event of an increase or decrease in the quantity of any Bid item under a unit price contract, the total amount of WORK actually done or materials or equipment furnished will be paid for according to the unit price established for such WORK under the Contract Documents, wherever such unit price has been established; provided, that an adjustment in the Contract Price may be made for changes which result in an increase or decrease in excess of 25 percent of the estimated quantity of any unit price bid item of the WORK.
- B. In the event a part of the WORK is to be entirely eliminated and no lump sum or unit price is named in the Contract Documents to cover such eliminated work, the price of the eliminated WORK shall be agreed upon by the OWNER and the CONTRACTOR by Change Order.

## ARTICLE 11 -- CHANGE OF CONTRACT PRICE

### 11.1 GENERAL

- A. The Contract Price constitutes the total compensation payable to the CONTRACTOR for performing the WORK. All duties, responsibilities, and obligations assigned to or undertaken by the CONTRACTOR to complete the WORK shall be at its expense without change in the Contract Price.
- B. The Contract Price may only be changed by a Change Order. The value of any WORK covered by a Change Order or of any claim for an increase or decrease in the Contract Price shall be determined in one of the following ways:
  - 1. Where the WORK involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved.
  - 2. By mutual acceptance of a lump sum, which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.4; or
  - 3. On the basis of the cost of WORK (determined as provided in Paragraph 11.3) plus the CONTRACTOR's overhead and profit (determined as provided in Paragraph 11.4).
- C. Any claim for an increase in the Contract Price shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 10 Days) after the start of the event giving rise to the claim and shall state the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered within 60

Days after the start of such event (unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the CONTRACTOR'S written statement that the amount claimed covers all known amounts (direct, indirect, and consequential) to which the CONTRACTOR is entitled as a result of such event. All claims for adjustment in the Contract Price will be determined by the ENGINEER. No claim for an adjustment in the Contract Price will be valid if not submitted in accordance with this Paragraph 11.1 C.

## 11.2 COSTS RELATING TO WEATHER

- A. The CONTRACTOR shall have no claims against the OWNER for damages for any injury to work, materials, or equipment, resulting from the action of the elements. If, however, in the opinion of the ENGINEER, the CONTRACTOR has made all reasonable efforts to protect the materials, equipment, and work, the CONTRACTOR may be granted a reasonable extension of Contract Times to make proper repairs, renewals, and replacements of the WORK, materials, or equipment at CONTRACTOR'S own cost..

## 11.3 COST OF WORK (BASED ON TIME AND MATERIALS)

- A. **General:** The term "cost of work" means the sum of all costs necessarily incurred and paid by the CONTRACTOR for labor, materials, and equipment in the proper performance of extra WORK. Except as otherwise may be agreed to in writing by the OWNER, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in Paragraph 11.5.
- B. **Labor:** The costs of labor will be the actual cost for wages prevailing for each craft or type of workers performing the extra WORK at the time the extra WORK is done, plus employer payments of payroll taxes, workers compensation insurance, liability insurance, health and welfare, pension, vacation, apprenticeship funds, and other direct costs resulting from federal, state or local laws, as well as assessments or benefits required by lawful collective bargaining agreements. Labor costs for equipment operators and helpers will be paid only when such costs are not included in the invoice for equipment rental. The labor costs for foremen shall be proportioned to all of their assigned WORK and only that applicable to extra WORK shall be paid. Nondirect labor costs including superintendence shall be considered part of the markup set out in Paragraph 11.4.
- C. **Materials:** The cost of materials reported shall be at invoice or lowest current price at which materials are locally available and delivered to the Site in the quantities involved, plus the cost of freight, delivery and storage, subject to the following:
  - 1. All trade discounts and rebates shall accrue to the OWNER, and the CONTRACTOR shall make provisions so that they may be obtained;
  - 2. For materials secured by other than a direct purchase and direct billing to the purchaser, the cost shall be deemed to be the price paid to the actual supplier as determined by the ENGINEER. Except for actual costs incurred in the handling of such materials, markup will not be allowed;
  - 3. Payment for materials from sources owned wholly or in part by the purchaser shall not exceed the price paid by the purchaser for similar materials from said sources on extra WORK items or the current wholesale price for such materials delivered to the Site, whichever price is lower; and

4. If in the opinion of the ENGINEER the cost of material is excessive, or the CONTRACTOR does not furnish satisfactory evidence of the cost of such material, then the cost shall be deemed to be the lowest current wholesale price for the quantity concerned delivered to the Site less trade discount. The OWNER reserves the right to furnish materials for the extra WORK and no claim will be allowed by the CONTRACTOR for costs and profit on such materials.
- D. **Equipment:** The CONTRACTOR will be paid for the use of equipment at the rental rate listed for such equipment specified in the Supplementary General Conditions. Such rental rate will be used to compute payments for equipment whether the equipment is under the CONTRACTOR'S control through direct ownership, leasing, renting, or another method of acquisition. The rental rate to be applied for use of each item of equipment will be the rate resulting in the least total cost to the OWNER for the total period of use. If it is deemed necessary by the CONTRACTOR to use equipment not listed in the publication specified in the Supplementary General Conditions, an equitable rental rate for the equipment will be established by the ENGINEER. The CONTRACTOR may furnish cost data which might assist the ENGINEER in the establishment of the rental rate. Payment for equipment shall be subject to the following:
1. All equipment shall, in the opinion of the ENGINEER, be in good working condition and suitable for the purpose for which the equipment is to be used;
  2. Before construction equipment is used on the extra work, the CONTRACTOR shall plainly stencil or stamp an identifying number thereon at a conspicuous location, and shall furnish to the ENGINEER, in duplicate, a description of the equipment and its identifying number;
  3. Unless otherwise specified, manufacturer's ratings and manufacturer approved modifications shall be used to classify equipment for the determination of applicable rental rates. Equipment which has no direct power unit shall be powered by a unit of at least the minimum rating recommended by the manufacturer;
  4. Individual pieces of equipment or tools having a replacement value of \$500 or less, whether or not consumed by use, will be considered to be small tools and no payment will be made therefore.
- E. **Equipment Rental Time:** The rental time to be paid for equipment on the Site will be the time the equipment is in productive operation on the extra WORK being performed and, in addition, will include the time required to move the equipment to the location of the extra WORK and return it to the original location or to another location requiring no more time than that required to return it to its original location; except, that moving time will not be paid if the equipment is used on other than the extra WORK, even though located at the Site of the extra WORK. Loading and transporting costs will be allowed, in lieu of moving time, when the equipment is moved by means other than its own power, except that no payment will be made for loading and transporting costs when the equipment is used at the Site of the extra WORK on other than the extra WORK. Rental time will not be allowed while equipment is inoperative due to breakdowns. The rental time of equipment on the work Site will be computed subject to the following:
1. When hourly rates are listed, any part of an hour less than 30 minutes of operation will be considered to be half-hour of operation, and any part of an hour in excess of 30 minutes will be considered one hour of operation;

2. When daily rates are listed, any part of a day less than 4 hours operation will be considered to be half-day of operation. When owner-operated equipment is used to perform extra WORK to be paid for on a time and materials basis, the CONTRACTOR will be paid for the equipment and operator, as set forth in Paragraphs 3, 4, and 5, following;
3. Payment for the equipment will be made in accordance with the provisions in Paragraph 11.3 D., herein;
4. Payment for the cost of labor and subsistence or travel allowance will be made at the rates paid by the CONTRACTOR to other workers operating similar equipment already on the Site, or in the absence of such labor, established by collective bargaining agreements for the type of workmen and location of the extra WORK, whether or not the operator is actually covered by such an agreement. A labor surcharge will be added to the cost of labor described herein in accordance with the provisions of Paragraph 11.3 B., herein, which surcharge shall constitute full compensation for payments imposed by state and federal Laws and all other payments made to or on behalf of workers other than actual wages; and
5. To the direct cost of equipment rental and labor, computed as provided herein, will be added the allowances for equipment rental and labor as provided in Paragraph 11.4, herein.

**F. Special Services:** Special WORK or services are defined as that WORK characterized by extraordinary complexity, sophistication, innovation, or a combination of the foregoing attributes which are unique to the construction industry. The ENGINEER will make estimates for payment for special services and may consider the following:

1. When the ENGINEER and the CONTRACTOR, determine that a special service or WORK is required which cannot be performed by the forces of the CONTRACTOR or those of any of its Subcontractors, the special service or WORK may be performed by an entity especially skilled in the WORK to be performed. After validation of invoices and determination of market values by the ENGINEER, invoices for special services or WORK based upon the current fair market value thereof may be accepted without complete itemization of labor, material, and equipment rental costs;
2. When the CONTRACTOR is required to perform WORK necessitating special fabrication or machining process in a fabrication or a machine shop facility away from the Site, the charges for that portion of the WORK performed at the off-Site facility may, by agreement, be accepted as a special service and accordingly, the invoices for the WORK may be accepted without detailed itemization; and
3. All invoices for special services will be adjusted by deducting all trade discounts. In lieu of the allowances for overhead and profit specified in Paragraph 11.4, herein, an allowance of 15 percent will be added to invoices for special services.

**G. Sureties:** All WORK performed hereunder shall be subject to all of the provisions of the Contract Documents and the CONTRACTOR'S sureties shall be bound with reference thereto as under the original Agreement. Copies of all amendments to Bonds or supplemental Bonds shall be submitted to the OWNER for review prior to the performance of any WORK hereunder.



#### 11.4 CONTRACTOR'S OVERHEAD AND PROFIT

- A. Extra WORK ordered on the basis of time and materials will be paid for at the actual necessary cost as determined by the ENGINEER, plus allowances for overhead and profit. The allowance for overhead and profit will include full compensation for superintendence, taxes, field office expense, extended overhead, home office overhead, and all other items of expense or cost not included in the cost of labor, materials, or equipment provided for under Paragraph 11.3. The allowance for overhead and profit will be made in accordance with the following schedule:

Overhead and Profit Allowance	
Labor	15 percent
Materials	10 percent
Equipment	10 percent

To the sum of the costs and markups provided for in this Article, an additional one percent of the sum will be added as compensation for Bonds and insurance.

- B. It is understood that labor, materials, and equipment for extra WORK may be furnished by the CONTRACTOR or by the Subcontractor on behalf of the CONTRACTOR. When all or any part of the extra WORK is performed by a Subcontractor, the allowance specified herein will be applied to the labor, materials, and equipment costs of the Subcontractor, to which the CONTRACTOR may add 5 percent of the Subcontractor's total cost for the extra WORK. Regardless of the number of hierarchical tiers of Subcontractors, the 5 percent increase above the Subcontractor's total cost which includes the allowances for overhead and profit specified herein may be applied one time only .

#### 11.5 EXCLUDED COSTS

- A. The term "cost of the work" shall not include any of the following:
1. Payroll costs and other compensation of CONTRACTOR's officers, executives, proprietors, partners, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by CONTRACTOR whether at the Site or in CONTRACTOR'S principal or a branch office for general administration of the WORK all of which are to be considered administrative costs covered by the CONTRACTOR'S allowance for overhead and profit;
  2. Expenses of CONTRACTOR'S principal and branch offices other than CONTRACTOR'S office at the Site;
  3. Any part of CONTRACTOR'S capital expenses, including interest on CONTRACTOR'S capital employed for the WORK and charges against CONTRACTOR for delinquent payments;
  4. Cost of premiums for all Bonds and for all insurance whether or not CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except as provided by Paragraph 11.4 above);

5. Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of Defective WORK, disposal of materials or equipment wrongly supplied, and making good any damage to property; and
6. Other overhead or general expense costs of any kind and the cost of any item not specifically and expressly included in Paragraph 11.4.

#### 11.6 CONTRACTOR'S EXTRA WORK REPORT

- A. In order to be paid for extra WORK, the CONTRACTOR must submit a daily extra WORK report on the form furnished by the ENGINEER. The form must be completely filled out based on the provisions of Paragraphs 11.3 through 11.5 and signed by the CONTRACTOR and ENGINEER at the end of each working Day. Failure to complete the form and obtain appropriate signatures by the next working Day after the extra WORK of the previous day was completed will result in CONTRACTOR'S costs for extra WORK being disallowed.

### ARTICLE 12-- CHANGE OF CONTRACT TIMES

#### 12.1 GENERAL

- A. The Contract Times may only be changed by a Change Order. Any claim for an extension of the Contract Times shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 10 Days) after the start of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered within 30 Days after the start of such event (unless the ENGINEER allows an additional period of time for the submission of additional or more accurate data in support of the claim) and shall be accompanied by the CONTRACTOR'S written statement that the adjustment claimed is the entire adjustment to which the CONTRACTOR is entitled as a result of said event. All claims for adjustment in the Contract Times will be determined by the ENGINEER. No claim for an adjustment in the Contract Times will be valid if not submitted in accordance with the requirements of this Paragraph 12.1 A. An increase in Contract Times does not mean that the CONTRACTOR is due an increase in Contract Price. Only compensable time extensions will result in an increase in Contract Price.
- B. All time limits stated in the Contract Documents are of the essence of the Agreement.
- C. When CONTRACTOR is prevented from completing any part of the WORK within the Contract Times (or Milestones) due to delay beyond the control of CONTRACTOR, the Contract Times (or Milestones) will be extended in an amount equal to the time lost on the critical path of the WORK due to such delay, if a claim is made therefor as provided in Paragraph 12.1.A. Delays beyond the control of CONTRACTOR shall include, but not be limited to, acts or neglect by OWNER; acts or neglect of those performing other work as contemplated by Article 7; and fires, floods, epidemics, terrorist acts, acts of the public enemy, acts of war, abnormal weather conditions, or acts of God. Delays attributable to and within the control of any Subcontractor or Supplier shall be deemed to be delays within the control of the CONTRACTOR.
- D. In no event will OWNER be liable to CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any surety for or employee or agent of any of them,

for any increase in the Contract Price or other damages arising out or resulting from the following:

1. Delays caused by or within the control of CONTRACTOR; or
2. Delays beyond the control of both OWNER and CONTRACTOR including but not limited to fires, floods, epidemics, terrorist acts, acts of the public enemy, acts of war, abnormal weather conditions, acts of God, or acts or neglect by those performing other work as contemplated by Article 7.

## 12.2 EXTENSIONS OF CONTRACT TIMES FOR DELAY DUE TO WEATHER

- A. The CONTRACTOR'S construction schedule shall anticipate delay due to unusually severe weather.
- B. Contract Times may be extended by the ENGINEER because of delays in excess of the anticipated delay. The CONTRACTOR shall, within 10 Days of the beginning of any such delay, notify the ENGINEER in writing and request an extension of Contract Times. The ENGINEER will ascertain the facts and the extent of the delay and extend the Contract Times when, in its judgement, the findings of the fact justify such an extension.

## **ARTICLE 13 -- INSPECTIONS AND TESTS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK**

### 13.1 NOTICE OF DEFECTIVE WORK

- A. Prompt notice of Defective WORK known to the OWNER or ENGINEER will be given to the CONTRACTOR. All Defective WORK, whether or not in place, may be rejected, corrected, or accepted as provided in this Article 13. Defective WORK may be rejected even if approved by prior inspection.

### 13.2 ACCESS TO WORK

- A. OWNER, ENGINEER, their consultants, subconsultants, other representatives and personnel of OWNER, independent testing laboratories, and governmental agencies with jurisdictional interests shall have access to the WORK at reasonable times for their observation, inspecting, and testing. CONTRACTOR shall provide them proper and safe conditions for such access and advise them of CONTRACTOR'S Site safety procedures and programs so that they may comply therewith as applicable.

### 13.3 INSPECTIONS AND TESTS

- A. The CONTRACTOR shall give the ENGINEER not less than 24 hours notice of readiness of the WORK for all required inspections, tests, or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. The OWNER shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:
  1. For inspection, tests, or approvals covered by Paragraphs 13.3C. and 13.3D. below;
  2. That costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.3H. shall be paid as provided in said Paragraph 13.3H.; and

3. As otherwise provided in the Contract Documents.
- C. If Laws and Regulations of any public body having jurisdiction require any WORK (or any part thereof) to be inspected, tested, or approved by an employee or other representative of such public body, CONTRACTOR shall assume full responsibility for arranging and obtaining such inspections, tests or approvals; pay all costs in connection therewith; and furnish the ENGINEER the required certificates of inspection or approval.
- D. The CONTRACTOR shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for the ENGINEER'S acceptance of materials or equipment to be incorporated in the WORK or acceptance of materials, mix designs, or equipment submitted for approval prior to the CONTRACTOR'S purchase thereof for incorporation in the WORK. Such inspections, tests, or approvals shall be performed by organizations acceptable to the ENGINEER.
- E. The ENGINEER will make, or have made, such inspections and tests as the ENGINEER deems necessary to see that the WORK is being accomplished in accordance with the requirements of the Contract Documents. Unless otherwise specified in the Supplementary General Conditions, the cost of such inspection and testing will be borne by the OWNER. In the event such inspections or tests reveal non-compliance with the requirements of the Contract Documents, the CONTRACTOR shall bear the cost of corrective measures deemed necessary by the ENGINEER, as well as the cost of subsequent reinspection and retesting. Neither observations by the ENGINEER nor inspections, tests, or approvals by others shall relieve the CONTRACTOR from the CONTRACTOR'S obligation to perform the WORK in accordance with the Contract Documents.
- F. If any WORK (including the work of others) that is to be inspected, tested, or approved is covered without written concurrence of the ENGINEER, it must, if requested by the ENGINEER, be uncovered for observation. Such uncovering shall be at the CONTRACTOR'S expense unless the CONTRACTOR has given the ENGINEER not less than 24 hours notice of the CONTRACTOR'S intention to perform such test or to cover the same and the ENGINEER has not acted with reasonable promptness in response to such notice.
- G. If any WORK is covered contrary to the written request of the ENGINEER, it must, if requested by the ENGINEER, be uncovered for the ENGINEER'S observation and recovered at the CONTRACTOR'S expense.
- H. If the ENGINEER considers it necessary or advisable that covered WORK be observed by the ENGINEER or inspected or tested by others, the CONTRACTOR, at the ENGINEER'S request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as the ENGINEER may require, that portion of the WORK in question, furnishing all necessary labor, material, and equipment. If it is found that such WORK is Defective WORK, the CONTRACTOR shall bear all direct, indirect, and consequential costs and damages of such uncovering, exposure, observation, inspection, and testing and of satisfactory reconstruction, including but not limited to, fees and charges of engineers, architects, attorneys, and other professionals. However, if such WORK is not found to be Defective WORK, the CONTRACTOR will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, the CONTRACTOR may make a claim therefor as provided in Articles 11 and 12.

#### 13.4 OWNER MAY STOP THE WORK

- A. If Defective WORK is identified, the OWNER may order the CONTRACTOR to stop performance of the WORK, or any portion thereof, until the cause for such order has been eliminated; however, this right of the OWNER to stop the WORK shall not give rise to any duty on the part of the OWNER to exercise this right for the benefit of the CONTRACTOR or any other party.

#### 13.5 CORRECTION OR REMOVAL OF DEFECTIVE WORK

- A. If required by the ENGINEER, the CONTRACTOR shall promptly either correct all Defective WORK, whether or not fabricated, installed, or completed, or, if the WORK has been rejected by the ENGINEER, remove it from the Site and replace it with non-defective WORK. The CONTRACTOR shall bear all direct, indirect, and consequential costs and damages of such correction or removal, including but not limited to fees and charges of engineers, architects, attorneys, and other professionals made necessary thereby.

#### 13.6 ACCEPTANCE OF DEFECTIVE WORK

- A. If, instead of requiring correction or removal and replacement of Defective WORK, the OWNER prefers to accept the Defective WORK, the OWNER may do so. The CONTRACTOR shall bear all direct, indirect, and consequential costs attributable to the OWNER's evaluation of and determination to accept such Defective WORK. If any such acceptance occurs prior to final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the WORK, and the OWNER shall be entitled to an appropriate decrease in the Contract Price.

#### 13.7 OWNER MAY CORRECT DEFECTIVE WORK

- A. If the CONTRACTOR fails within a reasonable time after written notice from the ENGINEER to correct Defective WORK, or to remove and replace Defective WORK as required by the ENGINEER in accordance with Paragraph 13.5A., or if the CONTRACTOR fails to perform the WORK in accordance with the Contract Documents, or if the CONTRACTOR fails to comply with any other provision of the Contract Documents, the OWNER may, after 7 Days written notice to the CONTRACTOR, correct and remedy any such deficiency.
- B. In exercising the rights and remedies under this paragraph, the OWNER shall proceed with corrective and remedial action. In connection with such corrective and remedial action, the OWNER may exclude the CONTRACTOR from all or part of the Site, take possession of all or part of the WORK, and suspend the CONTRACTOR'S services related thereto and incorporate in the WORK all materials and equipment for which the OWNER has paid the CONTRACTOR whether stored at the Site or elsewhere. The CONTRACTOR shall provide the OWNER, OWNER'S representatives, ENGINEER, and ENGINEER'S consultants access to the Site to enable OWNER to exercise the rights and remedies under this paragraph.
- C. All direct, indirect, and consequential costs and damages incurred by the OWNER in exercising the rights and remedies under this paragraph will be charged against the CONTRACTOR and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the WORK; and the OWNER shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, the OWNER may make a claim therefor as provided in Article

11. Such claim will include, but not be limited to, all costs of repair or replacement of work of others, destroyed or damaged by correction, removal, or replacement of CONTRACTOR'S Defective WORK and all direct, indirect, and consequential damages associated therewith.

- D. The CONTRACTOR shall not be allowed an extension of Contract Times (or Milestones) because of any delay in the performance of the WORK attributable to the exercise by OWNER of OWNER'S rights and remedies under this paragraph.

#### 13.8 CORRECTION PERIOD

- A. The correction period for Defective WORK shall be the longer of:
1. One year after the date of final acceptance;
  2. Such time as may be prescribed by Laws and Regulations;
  3. Such time as specified by the terms of any applicable special guarantee required by the Contract Documents; or
  4. Such time as specified by any specific provision of the Contract Documents.
- B. If, during the correction period as defined in Paragraph 13.8A above, any WORK is found to be Defective WORK, the OWNER shall have the same remedies as set forth in Paragraphs 13.5, 13.6, and 13.7 above.
- C. Where Defective WORK (and damage to other work resulting therefrom) has been corrected, removed, or replaced under this paragraph, the correction period hereunder with respect to such WORK will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

### ARTICLE 14-- PAYMENTS TO CONTRACTOR AND COMPLETION

#### 14.1 SCHEDULE OF VALUES (LUMP SUM PRICE BREAKDOWN)

- A. The schedule of values or lump sum price breakdown established as provided in the General Requirements shall serve as the basis for progress payments and shall be incorporated into a form of Application for Payment acceptable to the ENGINEER.

#### 14.2 UNIT PRICE BID SCHEDULE

- A. Progress payments on account of unit price work will be based on the number of units completed as verified by the ENGINEER in accordance with Section 01 29 00 – Measurement and Payment. The ENGINEER'S determination of quantities shall be final and binding on the parties.

#### 14.3 APPLICATION FOR PROGRESS PAYMENT

- A. Unless otherwise prescribed by law, on the 25th of each month, the CONTRACTOR shall submit to the ENGINEER for review, the Application for Payment filled out and signed by the CONTRACTOR covering the WORK completed as of the date of the Application for Payment and accompanied by such supporting documentation as is required by the Contract Documents.

- B. The Application for Payment shall identify, as a subtotal, the amount of the CONTRACTOR total earnings to date; plus the value of materials stored at the Site which have not yet been incorporated in the WORK; and less a deductive adjustment for materials installed which were not previously incorporated in the WORK, but for which payment was allowed under the provisions for payment for materials stored at the Site, but not yet incorporated in the WORK.
- C. The Application for Payment shall show the payment claimed by the CONTRACTOR, from which shall be deducted the amount of retainage specified in the Supplementary General Conditions and the total amount of all previous payments made to the CONTRACTOR.
- D. The value of materials stored at the Site shall be an amount equal to the specified percent of the value of such materials as set forth in the Supplementary General Conditions. Said amount shall be based upon the value of all acceptable materials and equipment not incorporated in the WORK but delivered and suitably stored at the Site or at another location agreed to in writing; provided, each such individual item has a value of more than \$5,000 and will become a permanent part of the WORK. The Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that the CONTRACTOR has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect the OWNER'S interest therein, all of which will be satisfactory to the OWNER. At the OWNER'S request, the CONTRACTOR shall execute a security agreement and UCC-1 Financing Statement as a condition of receiving payment for materials stored at another location.

#### 14.4 CONTRACTOR'S WARRANTY OF TITLE

- A. The CONTRACTOR warrants and guarantees that title to all WORK, materials, and equipment covered by an Application for Payment, whether incorporated in the WORK or not, will pass to the OWNER no later than the time of payment, free and clear of all Liens.

#### 14.5 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

- A. The ENGINEER will, within 7 Days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the application to the OWNER, or return the application to the CONTRACTOR indicating in writing the ENGINEER'S reasons for refusing to recommend payment. In the latter case, the CONTRACTOR may make the necessary corrections and resubmit the application. If the ENGINEER still disagrees with a portion of the application, it will submit the application recommending the undisputed portion of the application to the OWNER for payment and provide reasons for recommending non-payment of the disputed amount. Thirty Days after presentation of the Application for Payment with the ENGINEER'S recommendation to the OWNER, the amount recommended will (subject to the provisions of Paragraph 14.5B.) become due and when due will be paid by the OWNER to the CONTRACTOR.
- B. The ENGINEER, in its discretion, may refuse to recommend the whole or any part of any payment. ENGINEER may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in ENGINEER'S opinion to protect OWNER from loss because:
  - 1. The WORK is Defective WORK or the completed WORK has been damaged requiring correction or replacement.

2. The Contract Price has been reduced by written amendment or Change Order.
  3. The OWNER has been required to correct Defective WORK or complete WORK in accordance with Paragraph 13.7.
  4. ENGINEER has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.1 through 15.4 inclusive.
- C. The OWNER may refuse to make payment of the full amount recommended by the ENGINEER because:
1. Claims have been made against OWNER on account of CONTRACTOR'S performance or furnishing of the WORK.
  2. Liens have been filed in connection with the WORK, except where CONTRACTOR has delivered a specific Bond satisfactory to OWNER to secure the satisfaction and discharge of such Liens.
  3. There are other items entitling OWNER to a set-off against the amount recommended, or
  4. OWNER has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.5B. through 14.5C and 15.1 through 15.4 inclusive.

The OWNER must give the CONTRACTOR immediate written notice (with a copy to the ENGINEER) stating the reasons for such action and promptly pay the CONTRACTOR the amount so withheld, or any adjustment thereto agreed to by OWNER and CONTRACTOR, when CONTRACTOR corrects to OWNER'S satisfaction the reasons for such action.

#### 14.6 SUBSTANTIAL COMPLETION

- A. When the CONTRACTOR considers the WORK ready for its intended use, the CONTRACTOR shall notify the OWNER and the ENGINEER in writing that the WORK is substantially complete. The CONTRACTOR shall attach to this request a list of all WORK items that remain to be completed and a request that the ENGINEER prepare a Notice of Completion. Within a reasonable time thereafter, the OWNER, the CONTRACTOR, and the ENGINEER shall make an inspection of the WORK to determine the status of completion. If the ENGINEER does not consider the WORK substantially complete, or the list of remaining work items to be comprehensive, the ENGINEER will notify the CONTRACTOR in writing giving the reasons therefor. If the ENGINEER considers the WORK substantially complete, the ENGINEER will prepare and deliver to the OWNER for its execution and recordation the Notice of Completion signed by the ENGINEER and CONTRACTOR, which shall fix the date of Substantial Completion.

#### 14.7 PARTIAL UTILIZATION

- A. The OWNER shall have the right to utilize or place into service any item of equipment or other usable portion of the WORK prior to completion of the WORK. Whenever the OWNER plans to exercise said right, the CONTRACTOR will be notified in writing by the OWNER, identifying the specific portion or portions of the WORK to be so utilized or otherwise placed into service.



- B. It shall be understood by the CONTRACTOR that until such written notification is issued, all responsibility for care and maintenance of all of the WORK shall be borne by the CONTRACTOR. Upon issuance of said written notice of Partial Utilization, the OWNER will accept responsibility for the protection and maintenance of all such items or portions of the WORK described in the written notice.
- C. The CONTRACTOR shall retain full responsibility for satisfactory completion of the WORK, regardless of whether a portion thereof has been partially utilized by the OWNER, and the CONTRACTOR'S one year correction period shall commence only after the date of Substantial Completion for the WORK.

#### 14.8 FINAL APPLICATION FOR PAYMENT

- A. After the CONTRACTOR has completed all of the remaining WORK items referred to in Paragraph 14.6 and delivered all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, marked-up record documents (as provided in the General Requirements), and other documents, all as required by the Contract Documents, and after the ENGINEER has indicated that the WORK is acceptable, the CONTRACTOR may make application for final payment following the procedure for progress payments. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents, together with complete and legally effective releases or waivers (satisfactory to the OWNER) of all claims arising out of or filed in connection with the WORK.

#### 14.9 FINAL PAYMENT AND ACCEPTANCE

- A. Upon completion of the WORK, including all items of the final punch list of deficiencies and upon completion of final cleaning, the CONTRACTOR shall notify the ENGINEER in writing. Upon receipt of the written notice, the OWNER, CONTRACTOR, and ENGINEER will conduct the final inspection to determine the actual conformance of the WORK to the requirements of the Contract Documents.
- B. Upon confirmation by the OWNER and ENGINEER that a satisfactory final inspection has been conducted, the CONTRACTOR shall submit an application for final payment to the ENGINEER. The request shall include a completed and signed Application for Payment and shall include, but not be limited to, the following documentation:
  - 1. Certified payroll records in accordance with Article 14 of these General Conditions.
  - 2. Final technical manual in accordance with Section 01 33 00 – Contractor Submittals.
  - 3. Final record drawings in accordance with Section 01 33 00 – Contractor Submittals.
  - 4. Final CPM schedule in accordance with Section 01 32 16 – CPM Construction Schedule showing the sequence of WORK as actually constructed.
  - 5. Certificates or other evidence of any insurance policy that will expire in the next 30 Days.
  - 6. Conditional waiver and release of Lien upon progress payment forms from all Subcontractors and Suppliers included in the current payment application.

7. Unconditional waiver and release of Lien upon progress payment forms from all Subcontractors and Suppliers included in the previous month's payment application.
  8. An inventory of all spare parts and maintenance materials the CONTRACTOR has provided the OWNER.
  9. As a condition of final payment, the CONTRACTOR shall be required to execute a release on the form provided by OWNER, releasing the OWNER from any and all claims of liability for payment on the Project except for such amounts as may be specifically described and excluded from the release.
- C. If, on the basis of the ENGINEER'S observation of the WORK during construction and final inspection, and the ENGINEER'S review of the final Application for Payment and accompanying documentation, all as required by the Contract Documents, the ENGINEER is satisfied that the WORK has been completed and the CONTRACTOR'S other obligations under the Contract Documents have been fulfilled, the ENGINEER will, within 14 Days after receipt of the final Application for Payment, indicate in writing the ENGINEER'S recommendation of payment and present the application to the OWNER for payment.
- D. Following receipt of all required submittals and the ENGINEER'S written statement that the construction is complete, and the OWNER accepts the WORK, the OWNER will file a Notice of Completion.
- E. Thirty five Days after recording the Notice of Completion, the OWNER will make final payment to the CONTRACTOR of the amount remaining after deducting all prior payments and all amounts to be kept or retained under the provisions of the Contract Documents, including the following items:
1. Liquidated damages, as applicable;
  2. Amounts withheld by OWNER under Paragraph 14.5B. and C. which have not been released; and
  3. Two times the value of outstanding items of correction WORK or punch list items yet uncompleted or uncorrected, as applicable. All such WORK shall be completed or corrected to the satisfaction of the OWNER within the time stated on the Notice of Completion, otherwise the CONTRACTOR does hereby waive any and all claims to all monies withheld by the OWNER to cover the value of all such uncompleted or uncorrected items.
- F. As a condition of final payment, the CONTRACTOR shall be required to execute a release on the form provided by OWNER, releasing the OWNER from any and all claims of liability for payment on the Project except for such amounts as may be specifically described and excluded from the release.

#### 14.10 RELEASE OF RETAINAGE AND OTHER DEDUCTIONS

- A. After executing the necessary documents to initiate the Lien period, and not more than 45 Days thereafter (based on a 30 Day Lien filing period and 15 Day processing time), the OWNER will release to the CONTRACTOR the retainage funds withheld pursuant to the Agreement, less any deductions to cover pending claims against the OWNER pursuant to Paragraph 14.9E.

- B. After filing of the necessary documents to initiate the Lien period, the CONTRACTOR shall have 30 Days to complete any outstanding items of correction WORK remaining to be completed or corrected as listed on a final punch list made a part of the Notice of Completion. Upon expiration of the time limit referred to in Paragraph 14.10A., the amounts withheld pursuant to the provisions of Paragraph 14.9E. herein, for all remaining WORK items will be returned to the CONTRACTOR; provided, that said WORK has been completed or corrected to the satisfaction of the OWNER within said 30 Days. Otherwise, the CONTRACTOR does hereby waive any and all claims for all monies withheld by the OWNER under this Agreement to cover two times the value of such remaining uncompleted or uncorrected items.

## **ARTICLE 15 -- SUSPENSION OF WORK AND TERMINATION**

### **15.1 SUSPENSION OF WORK BY OWNER**

- A. The OWNER may, at any time and without cause, suspend the WORK or any portion thereof for a period of not more than 90 Days by notice in writing to the CONTRACTOR. The CONTRACTOR shall resume the WORK on receipt of a notice of resumption of WORK. The CONTRACTOR will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension if the CONTRACTOR makes an approved claim therefor as provided in Articles 11 and 12.

### **15.2 TERMINATION OF AGREEMENT BY OWNER FOR DEFAULT**

- A. In the event of default by the CONTRACTOR, the OWNER may give seven Days written notice to the CONTRACTOR of OWNER'S intent to terminate the Agreement and provide the CONTRACTOR an opportunity to remedy the conditions constituting the default within a specified period of time. It will be considered a default by the CONTRACTOR whenever CONTRACTOR shall:
1. Declare bankruptcy, become insolvent, or assign its assets for the benefit of its creditors;
  2. Disregard or violate the Laws or Regulations of any public body having jurisdiction;
  3. Fail to provide materials or workmanship meeting the requirements of the Contract Documents;
  4. Disregard or violate provisions of the Contract Documents or ENGINEER'S instructions;
  5. Fail to prosecute the WORK according to the approved progress schedule;
  6. Fail to provide a qualified superintendent, competent workmen, or materials or equipment meeting the requirements of the Contract Documents; or
  7. Disregard the authority of the ENGINEER.
- B. If the CONTRACTOR fails to remedy the conditions constituting default within the time allowed, the OWNER may then issue the notice of termination.
- C. In the event the Agreement is terminated in accordance with Paragraph 15.2A., herein, the OWNER may take possession of the WORK and may complete the WORK by whatever

method or means the OWNER may select. The cost of completing the WORK will be deducted from the balance which would have been due the CONTRACTOR had the Agreement not been terminated and the WORK completed in accordance with the Contract Documents. If such cost exceeds the balance which would have been due, the CONTRACTOR shall pay the excess amount to the OWNER. If such cost is less than the balance which would have been due, the CONTRACTOR shall not have claim to the difference.

### 15.3 TERMINATION OF AGREEMENT BY OWNER FOR CONVENIENCE

- A. Upon seven Days written notice to the CONTRACTOR and the ENGINEER, the OWNER may, without cause and without prejudice to any other right or remedy of the OWNER, elect to terminate the Agreement. In such case, the CONTRACTOR shall be paid (without duplication of any items):
1. For completed and acceptable WORK executed in accordance with the Contract Documents, prior to the effective date of termination, including fair and reasonable sums for overhead and profit of such WORK;
  2. For expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted WORK, plus fair and reasonable sums for overhead and profit on such expenses;
  3. For all reasonable claims, costs, losses, and damages incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and
  4. For reasonable expenses directly attributable to termination.
- B. CONTRACTOR shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

### 15.4 TERMINATION OF AGREEMENT BY CONTRACTOR

- A. The CONTRACTOR may terminate the Agreement upon 14 Days written notice to the OWNER, whenever:
1. The WORK has been suspended under the provisions of Paragraph 15.1, herein, for more than 90 consecutive Days through no fault or negligence of the CONTRACTOR, and notice to resume WORK or to terminate the Agreement has not been received from the OWNER within this time period; or
  2. The OWNER should fail to pay the CONTRACTOR any monies due in accordance with the terms of the Contract Documents and within 60 Days after presentation to the OWNER by the CONTRACTOR of a request therefor, unless within said 14 day period the OWNER shall have remedied the condition upon which the payment delay was based.
- B. In the event of such termination, the CONTRACTOR shall have no claims against the OWNER except for those claims specifically enumerated in Paragraph 15.3, herein, and as determined in accordance with the requirements of said paragraph.

## ARTICLE 16 -- MISCELLANEOUS

## 16.1 GIVING NOTICE

- A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice. A notice sent by facsimile will be deemed delivered upon receipt. A notice sent by recognized overnight delivery service will be deemed delivered the next business day after the notice is sent to the last business address known to the giver of the notice.

## 16.2 TITLE TO MATERIALS FOUND ON THE WORK

- A. The OWNER reserves the right to retain title to all soils, stone, sand, gravel, and other materials developed and obtained from excavations and other operations connected with the WORK. Unless otherwise specified in the Contract Documents, neither the CONTRACTOR nor any Subcontractor shall have any right, title, or interest in or to any such materials. The CONTRACTOR will be permitted to use in the WORK, without charge, any such materials which meet the requirements of the Contract Documents.

## 16.3 RIGHT TO AUDIT

- A. If the CONTRACTOR submits a claim to the OWNER for additional compensation, the OWNER shall have the right, as a condition to considering the claim, and as a basis for evaluation of the claim, and until the claim has been settled, to audit the CONTRACTOR'S books to the extent they are relevant. This right shall include the right to examine books, records, documents, and other evidence and accounting procedures and practices, sufficient to discover and verify all direct and indirect costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The right to audit shall include the right to inspect the CONTRACTOR'S plant, or such parts thereof, as may be or have been engaged in the performance of the WORK. The CONTRACTOR further agrees that the right to audit encompasses all subcontracts and is binding upon Subcontractors. The rights to examine and inspect herein provided for shall be exercisable through such representatives as the OWNER deems desirable during the CONTRACTOR'S normal business hours at the office of the CONTRACTOR. The CONTRACTOR shall make available to the OWNER for auditing, all relevant accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the OWNER.

## 16.4 SURVIVAL OF OBLIGATIONS

- A. All representations, indemnifications, warranties, and guaranties made in, required by or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the WORK or termination or completion of the Agreement.

## 16.5 CONTROLLING LAW

- A. This Agreement is to be governed by the law of the state in which the Project is located. Venue for any action brought for the purpose of enforcing any provision of this Agreement, including without limitation for damages by reason of any alleged breach of any provision of this Agreement or a declaration of rights or obligations under this Agreement, or for any other judicial remedy, shall be brought in the appropriate state court located in the county where the project is located. CONTRACTOR agrees to joinder of claims and parties with

respect to any matter arising hereunder that may involve the work of another owner, contractor, or consultant.

#### 16.6 SEVERABILITY

- A. If any term or provision of this Agreement is declared invalid or unenforceable by any court of lawful jurisdiction, the remaining terms and provisions of the Agreement shall not be affected thereby and shall remain in full force and effect.

#### 16.7 WAIVER

- A. The waiver by the OWNER or ENGINEER of any breach or violation of any term, covenant or condition of this Agreement or of any provision, ordinance, or law shall not be deemed to be a waiver of any other term, covenant, condition, ordinance, or law or of any subsequent breach or violation of the same or of any other term, covenant, condition, ordinance, or law. The subsequent payment of any monies or fee by the OWNER which may become due hereunder shall not be deemed to be a waiver of any preceding breach or violation by CONTRACTOR or any term, covenant, condition of this Agreement or of any applicable law or ordinance.

- END OF GENERAL CONDITIONS -

## SECTION 00 73 13 - SUPPLEMENTARY GENERAL CONDITIONS

### PART 1-- GENERAL

These Supplementary General Conditions make additions, deletions, or revisions to the General Conditions as indicated herein. All provisions which are not so added, deleted, or revised remain in full force and effect. Terms used in these Supplementary General Conditions which are defined in the General Conditions have the meanings assigned to them in the General Conditions.

#### SGC-1 DEFINITIONS

Add the following definitions to Article 1:

ENGINEER - In accordance with its contract with the OWNER, the ENGINEER is further defined as the firm of Stantec Consulting Services, Inc., located at 2890 E Cottonwood Parkway, Suite 300, Salt Lake City, Utah 84121.

OWNER - The OWNER is further defined as Magna Water District, located at 8885 West 3500 South, Magna, Utah 84044.

#### SGC-2.2 COPIES OF DOCUMENTS

The OWNER shall furnish to the CONTRACTOR electronic (.pdf) copies of the Contract Documents.

#### SGC-2.4 STARTING THE WORK

Add the following as Paragraphs 2.4C and 2.4D of the General Conditions:

- C. The CONTRACTOR shall notify Magna Water District staff at least 48 hours in advance of the commencement of WORK at any Site.
- D. The CONTRACTOR shall be responsible for making itself aware of Utility company facilities, and shall be liable for any and all damages stemming from repair or delay costs or any other expenses resulting from the unanticipated discovery of underground Utilities.

#### SGC-3.4 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

NOT USED

#### SGC-4.2 REPORTS OF PHYSICAL CONDITIONS

In the preparation of the Contract Documents, the ENGINEER has relied upon:

- A. The following reports of explorations and tests of subsurface conditions at the Site:
  - 1. Report dated July 15, 2022 prepared by Intermountain GeoEnvironmental Services, Inc., entitled "Geotechnical Investigation: MWD Sewer Influent Line Project 1B" consisting of 62 pages. This report will be made available to all prospective bidders.

- B. As provided in Paragraph 4.2 of the General Conditions and as identified and established above, the CONTRACTOR may rely upon the accuracy of the technical data contained in such reports and drawings, except for such physical dimensions that can be field verified; however, the interpretation of such technical data, including any interpolation or extrapolation thereof, and opinions contained in such reports and drawings are not to be relied on by the CONTRACTOR.

#### SGC-4.5 HAZARDOUS MATERIALS

NOT USED

#### SGC-5.1 BONDS

Delete the first sentence of Paragraph 5.1A and add the following:

The CONTRACTOR shall furnish a satisfactory Performance Bond in the amount of 100 percent of the Contract Price and a satisfactory Payment Bond in the amount of 100 percent of the Contract Price as security for the faithful performance and payment of all the CONTRACTOR'S obligations under the Contract Documents.

#### 5.1.D MAINTENANCE AND GUARANTY BOND

The CONTRACTOR shall provide a Maintenance and Guaranty Bond in the amount of 100 percent of the Contract Price to provide a guarantee against defects in the WORK occurring during the year following the one year correction period. The Bond shall meet all of the requirements listed in Paragraph 5.1 BONDS, shall be payable to the OWNER, and be at the sole cost of the CONTRACTOR.

#### SGC-5.2 INSURANCE

- A. The limits of liability for the insurance required by Paragraph 5.2 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations. Limits may be provided by a combination of primary and excess liability policies or through a single policy. If the limits are provided by a combination of primary and excess liability policies, then the excess or umbrella liability coverages shall include commercial general, comprehensive automobile, and employer's liability and shall provide coverage at least as broad as the underlying policies.

##### 1. Workers' Compensation:

State	Statutory
Applicable Federal (e.g. USL&H)	Statutory
Note: If the WORK called for in the Contract Documents involves work in or on any navigable waters, the CONTRACTOR shall provide Workers' Compensation coverage which shall include coverage under the Longshore and Harbor Workers' Compensation Act, the Jones Act, Maritime Law, and any other coverage required under Federal or State laws pertaining to workers in or on navigable waters.	
Employer's Liability	



Bodily Injury by Accident	\$ 2,000,000	each accident
Bodily Injury by Disease	\$ 2,000,000	policy limit
Bodily Injury by Disease	\$ 2,000,000	each employee

2. Comprehensive or Commercial General Liability

Combined Single Limit		
Premises/operations	\$ 2,000,000	each occurrence
Products/completed/ operations	\$ 2,000,000	each occurrence
	\$ 2,000,000	annual aggregate
Personal Injury	\$ 2,000,000	each occurrence

- a. Policies shall include premises/operations, products, completed operations, independent contractors, explosion, collapse, underground hazards, broad form contractual, personal injury with employment contractual exclusions deleted, and broad form property damage.
- b. If policies are written on a Commercial General liability form, the General Aggregate shall be at least two times the each occurrence limit or be written on a "per project" basis.
- c. If policies are written on a claims made form, the certificate should so specify and policies shall continue in force for 1 year after completion of the project. The retroactive date of the policy must be no later than the date of the Agreement.
- d. If policies are written for split limits, limits shall be equal for bodily injury and property damage liability.

3. Comprehensive Automobile Liability (including owned, hired, and nonowned vehicles):

Combined Single Limit		
Bodily Injury and Property Damage	\$ 2,000,000	each accident
If policies are written for split limits, limits shall be equal for bodily injury per person, bodily injury per accident, and property damage		

4. Builder's Risk Insurance:

- a. In an amount equal to the replacement cost of the completed value of the project.
- b. Any deductibles or self insured retentions shall be in accordance with Paragraph SGC-5.2F or as agreed to by the OWNER and CONTRACTOR.

- B. All policies shall provide that the CONTRACTOR agrees to waive all rights of subrogation against the OWNER, the ENGINEER, and their subconsultants, employees, officers and directors, for WORK performed under the Agreement. Endorsements shall be provided with certificates of insurance.
- C. All policies shall also specify that the insurance provided by the CONTRACTOR will be considered primary and not contributory to any other insurance available to the OWNER or ENGINEER.
- D. All policies except Workers' Compensation and Builders Risk shall name the OWNER, ENGINEER, their consultants, subconsultants, and their officers, directors, agents and employees as additional insureds. The Builders Risk insurance shall name the CONTRACTOR, OWNER, and ENGINEER as named insureds.
- E. All policies shall provide for 30 Days notice prior to any cancellation, reduction in coverage, or nonrenewal.
- F. The deductible or self insured retention on Comprehensive or Commercial General Liability shall not be greater than \$ 100,000. Deductibles on Builder's Risk coverage shall not be greater than \$25,000 for flood or \$100,000 or 5 percent of the Contract Price, whichever is greater, for earthquake coverage. All deductibles are the responsibility of the CONTRACTOR.

#### SGC-5.2C INSURANCE

NOT USED

#### SGC-6.6 SUBCONTRACT LIMITATIONS

Add the following as Paragraph 6.6B of the General Conditions:

- B. The CONTRACTOR shall perform not less than 20 percent of the WORK with its own forces (i.e., without subcontracting). The 20 percent requirement shall apply to the Contract Price less the values of OWNER-assigned contracts and allowances in the Bid for prenegotiated WORK.

#### SGC-6.7 PERMITS

- A. The CONTRACTOR shall be responsible for complying with the requirements of all permits acquired by the OWNER.
- B. Except for the permits specifically set forth in A above, the CONTRACTOR shall acquire all permits required by Laws or Regulations, including, without limitation, the following specific permits (if applicable):
  - 1. State permits to construct and/or operate sources of air pollution.
  - 2. Certificates and permits are required for sources such as, but not limited to:
    - a. Fuel burning equipment
    - b. Gasoline and petroleum distillate storage containers
    - c. Land disturbing activities
    - d. Processing equipment (sand, gravel, concrete batch plant, etc.)

- e. Roadway access and traffic control
  - f. Any trenchless utility installation in state highway right-of-way
3. Permits to construct and/or operating permits for construction should be obtained from:
- Salt Lake County, Utah Department of Transportation
4. Stormwater Permit.
5. Permit-Required Confined Space
- The workplace in which the WORK is to be performed may contain permit-required confined spaces (permit spaces) as defined 29 CFR 1910.146 and, if so, permit space entry is allowed only through compliance with a confined space entry program meeting the requirements of 29 CFR 1910.146.
6. Encroachment Permit.

#### SGC-6.17 INDEMNIFICATION

Replace Paragraph 6.17A of the General Conditions with the following:

To the fullest extent permitted by Laws and Regulations, the CONTRACTOR shall indemnify, defend, and hold harmless the OWNER, the ENGINEER, their consultants, subconsultants, and the officers, electe officials, appointed officials, directors, employees, and agents of each and any of them, against and from all claims and liability arising under, by reason of, related, or incidental to the Contract Documents or any performance of the WORK , in any and all situations, including situations involving the concurrent active or passive negligence of any indemnified party, but not from the sole negligence or willful misconduct of the OWNER and/or the ENGINEER. Such indemnification by the CONTRACTOR shall include, but not be limited to, the following:

The CONTRACTOR shall also indemnify, defend, and hold harmless Stantec Consulting Services, Inc. and its officers, directors, agents, and employees, against and from all claims and liability arising under or by reason of the Agreement or any performance of the WORK, but not from the sole negligence or willful misconduct of Stantec Consulting Services, Inc.

Replace Paragraph 6.17.A.9 of the General Conditions:

Liability or claims arising directly, or indirectly, or consequentially out of any action, legal or equitable, brought against the OWNER, the ENGINEER, their consultants, subconsultants, and the officers, elected officials, appointed officials, directors, employees and agents of each or any of them, to the extent caused by the CONTRACTOR'S and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them use of any premises acquired by permits, rights of way, or easements, the Site, or any land or areas contiguous thereto or its performance of the WORK thereon.

Add the following as Paragraph 6.18 of the General Conditions:

#### SGC-6.18 ASSIGNED CONTRACTS BY THE OWNER

- A. The OWNER will have executed a procurement contract with a Supplier for early procurement of the following described items to be installed in the WORK by the CONTRACTOR. Said procurement contract is hereby assigned to the CONTRACTOR as a part of the WORK of the Agreement. Said assignment of the procurement contract to the CONTRACTOR shall be a condition of the contract for the construction of Magna Westside Collection System Project 1B. As of the date of execution of the Agreement hereunder, all references in the procurement documents to the OWNER shall mean the CONTRACTOR hereunder.
- B. The CONTRACTOR shall be wholly responsible under the Agreement for administration of each of said procurement contract, including payment of the Supplier therefor and for all expediting, quality assurance, and delivery. All costs of site storage, erection, installation, safety, security, and protection both prior to and after erection or installation until after final acceptance of the WORK by the OWNER, shall be the responsibility of the CONTRACTOR. No separate payment will be allowed therefor, and all costs shall be included by the CONTRACTOR in the lump sum price Bid for the WORK.
- C. The assignment of said procurement contract shall act to relieve the OWNER from all further obligation and liability under the procurement contract, and all rights, duties, and obligations of the OWNER under said procurement contract shall become the rights, duties and obligations of the CONTRACTOR, including that of inspection at the point of manufacture or fabrication, as applicable.
- D. The CONTRACTOR shall be wholly responsible for all payments to the Supplier and for expediting, delivery, storage, and installation or erection under the Agreement. The CONTRACTOR shall be responsible for all safety, security, and protection of said procurement items both prior to and after installation until final acceptance by the OWNER.

#### SGC-7.2 COORDINATION

NOT USED

#### SGC-9.3 PROJECT REPRESENTATION

- A. The Resident Project Representative, who is the ENGINEER'S agent, will act as directed by and under the supervision of the ENGINEER and will confer with the ENGINEER regarding its actions. The Resident Project Representative's dealings in matters pertaining to the WORK shall, in general, be only with the ENGINEER and the CONTRACTOR, and dealings with Subcontractors shall only be through or with the full knowledge of the CONTRACTOR. Written communication with the OWNER will be only through or as directed by the ENGINEER.
- B. The Resident Project Representative shall have the duties and responsibilities set forth in this paragraph.

1. Review the progress schedule of Shop Drawing submittals and schedule of values prepared by the CONTRACTOR and consult with the ENGINEER concerning their acceptability.
2. Attend preconstruction conferences. Arrange a schedule of progress meetings and other job conferences as required in consultation with the ENGINEER and notify in advance those expected to attend. Attend meetings and maintain and circulate copies of minutes thereof.
3. Serve as the ENGINEER'S liaison with the CONTRACTOR, working principally through the CONTRACTOR'S superintendent and assist said superintendent in understanding the intent of the Contract Documents. Assist the ENGINEER in serving as the OWNER'S liaison with the CONTRACTOR.
4. Receive Shop Drawings and samples furnished by the CONTRACTOR.
5. Conduct on-Site observations of the WORK in progress to assist the ENGINEER in determining if the WORK is proceeding in accordance with the Contract Documents.
6. Verify that the tests, equipment, and systems startups and operating and maintenance instruction are conducted as required by the Contract Documents and in presence of the required personnel, and that the CONTRACTOR maintains adequate records thereof.
7. Transmit to the CONTRACTOR the ENGINEER'S clarifications and interpretations of the Contract Documents.
8. Consider and evaluate the CONTRACTOR'S suggestions for modifications in the Contract Documents and report them with recommendations to the ENGINEER.
9. Review applications for payment with the CONTRACTOR for compliance with the established procedure for their submittal and forward them with recommendations to the ENGINEER, noting particularly their relation to the schedule of values, WORK completed, and materials and equipment delivered at the Site but not incorporated in the WORK.
10. During the course of the WORK, verify that certificates, maintenance and operation manuals, and other data required to be assembled and furnished by the CONTRACTOR are applicable to the items actually installed.
11. Before the ENGINEER prepares a Notice of Completion, as applicable, submit to the CONTRACTOR a list of observed items requiring completion or correction.
12. Conduct final inspection in the company of the ENGINEER, the OWNER, and the CONTRACTOR, and prepare a punch list of items to be completed or corrected.
13. Verify that all items on the punch list have been completed or corrected and make recommendations to the ENGINEER concerning acceptance.

## SGC-12.2 WEATHER DELAYS

Modified as follows:

- A. The CONTRACTOR'S construction schedule shall anticipate delay due to unusually severe weather and include an allowance for 5 weather days.
- B. Contract Times may be extended by the ENGINEER because of delays in excess of the weather days listed above. The CONTRACTOR shall, within 10 Days of the beginning of any such delay, notify the ENGINEER in writing and request an extension of Contract Times. The ENGINEER will ascertain the facts and the extent of the delay and extend the Contract Times when, in its judgement, the findings of the fact justify such an extension.

#### SGC-14.3C AMOUNT OF RETENTION

Add the following to Paragraph 14.3C of the General Conditions:

Unless otherwise prescribed by law, the OWNER may retain a portion of the amount otherwise due to the CONTRACTOR, as follows:

- 1. Retention of 5 percent of each approved progress payment will be held until final payment, after completion of all the WORK identified on the final inspection of the project to the OWNER's satisfaction.

- END OF SUPPLEMENTARY GENERAL CONDITIONS -

## SECTION 01 10 00 - SUMMARY OF WORK

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The WORK to be performed under this Contract shall consist of furnishing pipe, tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the OWNER.
- B. Wherever the Contract Documents address a third party, i.e., subcontractor, manufacturer, etc., it is to be considered as the CONTRACTOR through the third party.
- C. Wherever a reference to number of days is noted, it shall be construed to mean calendar days (i.e. Saturday, Sunday and Holidays inclusive).

#### 1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. In general, the principal items of work under this Contract include, but are not necessarily limited to, the following:
  - 1. Construction of a new sewer line, sewer manholes, pipe trench excavation and backfill, trenchless installation of sewer across Highway 201, traffic control, pavement cutting, restoration as shown in the construction drawings and these specifications, and permitting.
  - 2. Site preparation within the boundaries shown on the Contract Drawings and specified herein including traffic control, permitting, pavement cutting, and restoration necessary to perform the WORK.
  - 3. Installation of sewer pipelines including excavation, backfill, bedding, compaction, fittings, adaptors, plugging of existing pipe, reconnection of existing pipes, and all other appurtenances as specified and/or shown on the Contract Drawings for a complete operable system.
  - 4. Excavation, bedding, backfilling and compacting. All unsuitable material shall be hauled off-site to an approved disposal site in accordance with Section 31 30 00.
  - 5. Utility or existing pipe crossings, where required, which shall include locating, potholing, temporary supports of exiting utilities, and concrete encasement and/or relocation, shall be the responsibility of the CONTRACTOR and shall be included in the BID PRICE.
  - 6. Trenchless installation of the sewer carrier pipe shown in the Contract Drawings across State Highway 201 per Utah Department of Transportation requirements and in accordance with Section 33 05 23 of the Contract Documents.

7. Any damage done to any of the utilities during construction shall be repaired by the CONTRACTOR or applicable SUBCONTRACTOR or UTILITY COMPANY and shall be paid for by the CONTRACTOR.
8. Provide all temporary services as necessary, including power, lighting, heating, security, and potable water.
9. Exploration by test holes via hand-digging or construction equipment as necessary.
10. Assure continuous operation of existing facilities during construction and not prevent or hinder access to active areas.
11. Daily cleanup of the site including the removal of rubbish, scrap and securing of materials/equipment.
12. Soil erosion and sediment control.
13. Federal, State, Local or other required permits and approvals as required. It is the responsibility of the CONTRACTOR that all work shall meet OSHA compliance and any additional safety requirements from the OWNER.
14. Concrete work as specified herein or on the CONTRACT DRAWINGS.
15. Removal and disposal of existing pipes as indicated on the CONTRACT DRAWINGS.
16. Working outside of normal business hours is only permitted with the written permission of the OWNER.
17. All other work required for a complete and satisfactory operating installation.

- B. The WORK is located in the roadway of 8000 West between 2100 South and the south end of the parking area at the southeast corner of 8000 West and State Highway 201 in Salt Lake County, just west of the OWNER's wastewater treatment plant.

### 1.3 CONTRACT METHOD

- A. The WORK hereunder will be constructed under a single lump sum contract.

### 1.4 WORK BY OTHERS

- A. Where 2 or more contracts are being performed at one time on the same Site or adjacent land in such manner that work under one contract may interfere with work under another, the OWNER will determine the sequence and order of the Work in either or both contracts. When the Site of one contract is the necessary or convenient means of access for performance of work under another, the OWNER may grant privilege of access or other reasonable privilege to the contractor so desiring, to the extent, amount, and in manner and at time that the OWNER may determine. No OWNER determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The CONTRACTOR shall conduct its operations so as to cause a minimum of interference with the work of such other contractors, and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.



- B. Interference With Work On Utilities: The CONTRACTOR shall cooperate fully with all utility forces of the OWNER or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the WORK, and shall schedule the WORK so as to minimize interference with said relocation, altering, or other rearranging of facilities.

#### 1.5 CONTRACTOR USE OF SITE

- A. The CONTRACTOR's use of the OWNER's wastewater treatment site for field office, staging and/or storage is permitted but requires coordination with OWNER's staff and strict compliance with site security requirements as per Section 01 55 00 – Site Access and Storage. Construction activities on and along 8000 West and State Highway 201 must comply with Salt Lake County and Utah Department of Transportation regulations.

#### 1.6 OUTAGE PLAN AND REQUESTS

- A. Unless the Contract Documents indicate otherwise, the CONTRACTOR shall not remove from service, de-energize, or modify settings for any existing pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the OWNER and ENGINEER.
- B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall submit a detailed outage plan and schedule for the ENGINEER'S approval a minimum of 2 weeks in advance of the time that such outage is planned.
- C. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.
- D. The CONTRACTOR shall provide written confirmation of the shutdown date and time 2 working days prior to the actual shutdown.

#### 1.7 PROJECT MEETINGS

##### A. Preconstruction Conference

1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR'S Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:
  - a. ENGINEER and the Resident Project Representative.
  - b. Representatives of OWNER.
  - c. Governmental representatives as appropriate.
  - d. Others as requested by CONTRACTOR, OWNER, or ENGINEER.
  - e. The CONTRACTOR shall bring the preconstruction conference submittals in accordance with Section 01 33 00 - Contractor Submittals.
2. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and

procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all the items listed below.

- a. Status of CONTRACTOR's insurance and bonds.
  - b. Status of Salt Lake County work permits.
  - c. Status of Utah Department of Transportation work permits.
  - d. CONTRACTOR's tentative schedules.
  - e. Transmittal, review, and distribution of CONTRACTOR's submittals.
  - f. Processing applications for payment.
  - g. Maintaining record documents.
  - h. Critical work sequencing.
  - i. Field decisions and Change Orders.
  - j. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.
  - k. Major equipment deliveries and priorities.
  - l. CONTRACTOR's assignments for safety and first aid.
3. The ENGINEER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.
  4. The CONTRACTOR and its subcontractors should plan on the conference taking no more than 4 hours. The conference will cover the items listed in paragraphs 2 and 3, and reviewing the Contract Drawings and Specifications, in extensive detail, with the ENGINEER and the OWNER.

**B. Progress Meetings**

1. The ENGINEER will schedule and hold regular on-Site progress meetings at least biweekly and at other times as requested by CONTRACTOR or as required by progress of the WORK. The CONTRACTOR, ENGINEER, and all subcontractors active on the Site shall attend each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.
2. The ENGINEER will preside at the progress meetings and arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the WORK, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the CONTRACTOR shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## **SECTION 01 14 00 – CONSTRUCTION CONSTRAINTS**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. WORK shall be scheduled, sequenced, and performed in a manner which minimizes disruption to 8000 West, 2100 South, State Highway 201, and the operation of the OWNER's wastewater treatment facilities.
- B. The CONTRACTOR shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under Section 01 32 16 – CPM Construction Schedule.

#### **1.2 EXISTING FACILITIES**

- A. The WORK shall be executed while the existing trunk sewer and wastewater treatment facility is in operation. Operation of the existing facility shall not be jeopardized nor shall the efficiency of wastewater treatment be reduced because of the execution of the WORK.
- B. Unless indicated otherwise, temporary pumping, piping, power, lighting, security devices, and safety devices shall be provided by the CONTRACTOR for completion of the WORK.
- C. The construction constraints in this Section do not include every item affecting the completion of the WORK but are intended to describe the sequence of critical events necessary to minimize disruption to the ongoing treatment plant processes and to ensure compliance with UPDES Permit requirements. It shall be understood and agreed by the CONTRACTOR that the critical events described are not inclusive and that additional items of WORK not included may be required to minimize disruption and ensure compliance. Deviation from or modification of these suggested sequences is permitted if techniques and methods known to the CONTRACTOR will result in reducing disruption to the facility operation and maintaining treatment efficiency, and if deviation is approved in advance by the ENGINEER.

#### **1.3 BYPASSING**

- A. Bypassing of untreated or partially treated sewage to surface waters or drainage courses is prohibited during construction. In the event accidental bypassing is caused by the CONTRACTOR's operations, the OWNER shall immediately be entitled to employ others to stop the bypassing and costs incurred therefore will be deducted from the CONTRACTOR's construction progress payments.

#### **1.4 COMPLIANCE WITH UPDES PERMIT**

- A. The plant is operating under the terms of a UPDES permit issued by the Utah Department of Environmental Quality. The UPDES permit specifies the water quality limits that the facility must meet prior to discharging its effluent. A copy of the UPDES permit is available for review by the CONTRACTOR. In scheduling and performing the WORK, the CONTRACTOR shall not, directly or indirectly, prevent the facility from achieving the discharge requirements. Penalties imposed on the OWNER as a result of any discharge violation caused by the actions of the CONTRACTOR or its employees, or subcontractors shall be borne in full by the CONTRACTOR, including fines, legal fees, and other expenses to the OWNER resulting directly or indirectly from such discharge

violations. The OWNER may recover such sums by deductions from the construction progress payments.

- B. The CONTRACTOR shall take necessary precautions to ensure that no damage occurs to the existing sewer line and treatment facilities, including piping, utilities, roads, and structures, that are to remain in operation and are not to be modified or replaced, in accordance with Section 01 50 10 – Protection of Existing Facilities. Any temporary facilities, access, materials, equipment, and labor required for the facility to continue to meet the terms of the UPDES permit during construction shall be provided by the CONTRACTOR as part of the WORK. At the completion of work, such temporary facilities, materials, and equipment shall be removed from the Site as part of the WORK.

## 1.5 OUTAGE REQUESTS

- A. Modifications to existing facilities, the construction of new facilities, and the connection of new to existing facilities may require the temporary outage or bypass of existing facilities. In such cases, the CONTRACTOR shall coordinate WORK with the ENGINEER as described below. The CONTRACTOR shall submit a detailed outage plan and time schedule for construction activities which will make it necessary to remove a, pipeline, , road, or other facilities from service.
- B. The outage plans shall be submitted to the ENGINEER for acceptance a minimum of 2 weeks in advance of the time that such outages are required. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of this Section. The outage plan shall describe the CONTRACTOR's method for preventing bypassing of facilities; the length of time required to complete the operation; any necessary temporary power, controls, instrumentation, or alarms required to maintain control, monitoring, and alarms for the conveyance of sewer water; and the manpower and equipment which the CONTRACTOR shall provide in order to ensure proper operation of associated facilities. Costs for preparing and implementing the outage plans shall be the responsibility of the CONTRACTOR as part of the WORK.
- C. The CONTRACTOR shall not begin an alteration affecting existing facilities until specific written approval has been granted by the ENGINEER in each case.
- D. The ENGINEER will coordinate the CONTRACTOR's planned procedure with the OWNER. The ENGINEER has the authority to modify any proposed shutdown procedures if such procedures would adversely impact collection system operations.
- E. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the WORK has changed or if revisions to the outage plan are required. The CONTRACTOR shall provide written confirmation of the shutdown date and time 2 Days prior to the actual shutdown.

## 1.6 CONSTRUCTION SEQUENCING

- A. Construction activities shall be scheduled and sequenced to ensure continuous operation of the existing facilities. The CONTRACTOR's scheduling shall develop construction sequencing so that the WORK will not adversely impact the existing facilities. The CONTRACTOR shall be responsible for development of the construction sequencing. The following general guidelines shall be used by the CONTRACTOR in planning the sequence of construction.

1. Safe working conditions for personnel shall be maintained during construction of the WORK. The foregoing includes at least proper trench excavation, traffic control, and covers over open manholes or trenches.
2. Temporary facilities shall be constructed in accordance with applicable codes and regulations to operate safely and properly.

#### 1.7 PERMITS

- A. The CONTRACTOR shall abide by the conditions of permits and shall obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the WORK by the OWNER.
- B. Conditions affecting the CONTRACTOR are found, but not limited to, in the following permits. Copies of permit conditions are attached at the end of this Section.
  1. Salt Lake County Construction and Traffic Control Permits
  2. Stormwater Pollution Prevention Plan
  3. Utah Department of Transportation Permits

#### 1.8 SCHEDULE CONSTRAINTS

- A. General: It is the CONTRACTOR's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall WORK.
- B. The listing of schedule constraints below does not mean that every constraint or special condition has been identified. The list does not substitute for the CONTRACTOR's coordination and planning for completion of the WORK within the Contract Times.
- C. The following constraints affect the construction schedule.
  1. Obtain all necessary permits
  2. Material/equipment lead times due to supply chain delays
  3. Bypass pumping

#### **PART 2 -- PRODUCTS (NOT USED)**

#### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## SECTION 01 29 00 - MEASUREMENT AND PAYMENT

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. Measurement and payment for all WORK shown or specified herein will be made on a unit or lump sum price basis in accordance with the prices set forth in the Bid for individual items of WORK. CONTRACTOR shall make a careful assessment when preparing the Bid.
- B. The items listed below refer to and are the same pay items listed in the Bid Schedule. They constitute all of the pay items for the completion of the WORK. No direct or separate payment will be made for providing miscellaneous temporary or accessory services or all other items not specifically named in specific bid item descriptions and needed for the prosecution of the WORK, and all other requirements of the Contract Documents. Compensation for all such services, things and materials shall be included in the prices stipulated for the lump sum and unit price pay items listed herein
- C. The prices stated in the Bid Schedule include all costs and expenses for taxes, labor, equipment, materials, commissions, transportation charges and expenses, patent fees and royalties, labor for handling materials during inspection, together with any and all other costs and expenses for performing and completing the WORK as shown on the Drawings and specified herein. The basis of payment for an item at the lump sum or unit price shown in the Bid Schedule shall be in accordance with the description of that item in this Section.

#### 1.2 ALTERATIONS

- A. The OWNER reserves the right to change the alignment, grade, form, length, dimensions, or materials of the WORK under the Contract, whenever any conditions or obstructions are met that render such changes desirable or necessary. All such alterations shall be paid for under the total lump sum bid or at a unit price bid for these items of WORK, except as follows:
  - 1. In case such alterations make the WORK less expensive to the CONTRACTOR, a proper deduction shall be made from the Contract Prices and the CONTRACTOR shall have no claim on this account for damages or for anticipated profits on the WORK that may be dispensed with.
  - 2. In case such alterations make the WORK more expensive, a proper addition shall be made to the Contract Prices.
  - 3. Any such deduction or addition shall be determined by the ENGINEER in accordance with the General Conditions.

#### 1.3 SUBMITTALS

- A. CONTRACTOR shall submit the following Informational Submittals in conformance with the General Conditions of the Contract:
  - 1. Schedule of Values: Section 01 29 73 – Schedule of Values.
  - 2. Schedule of Estimated Progress Payments: Section 01 29 73 – Schedule of Values

- a. Submit with initially acceptable Schedule of Values.
  - b. Submit adjustments thereto with Applications for Payment.
3. Applications for Payment.
4. Final Application for Payment.

#### 1.4 APPLICATION FOR PAYMENT

- A. Transmittal Summary Form: Attach one Summary Form with detailed Application for Payment and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of CONTRACTOR.
- B. Use detailed Application for Payment Form provided by ENGINEER.
- C. Include accepted Schedule of Values for each portion of WORK, the unit price breakdown for the WORK to be paid on unit price basis, a listing of equipment by OWNER-assigned contracts, a listing of OWNER-selected equipment, if applicable, and allowances, as appropriate.
- D. Preparation:
  1. List each Change Order executed prior to date of submission as separate line item. Totals to equal those shown on the Transmittal Summary Form as applicable.
  2. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand as applicable, and such supporting data as may be requested by ENGINEER.

#### 1.5 PAYMENT

- A. General:
  1. Progress payments will be made monthly.
  2. The date for CONTRACTOR's submission of monthly Application for Payment shall be established at the Preconstruction Conference.
- B. Payment for all the WORK shown or specified in Contract Documents is included in the Contract Price. No measurement or payment will be made for individual items.
- C. Payment for mobilization:
  1. The CONTRACTOR's attention is directed to the condition that 75 percent of total mobilization amount will be allowed at the first payment for mobilization and 25 percent will be retained at the final payment for demobilization.

#### 1.6 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

- A. Payment will not be made for following:
  1. Products wasted or disposed of in a manner that is not acceptable.

2. Products determined unacceptable before or after placement.
3. Products not completely unloaded from the transporting vehicle.
4. Products placed beyond the lines and levels of the required WORK.
5. Loading, hauling, and disposing of rejected Products.
6. Installation of rejected equipment or materials.
7. Defective WORK not accepted by the OWNER.
8. Material remaining on hand after completion of WORK.

#### 1.7 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

##### A. Major Equipment Delivered under the following conditions.

1. Shop drawings have been submitted and "Approved."
2. Operations and Maintenance Manuals have been approved.
3. Up to 80 percent of the equipment value.
4. Provide manufacturer's invoice for the equipment.
5. Provide secure location for equipment to the satisfaction of the Owner.
6. Store and maintain equipment according to the manufacturer's written instruction. Failure to properly store and maintain the equipment will be grounds for deducting any previous payments for the equipment.

#### 1.8 FINAL PAYMENT

- ##### A.
- Final payment will be made only for products incorporated in WORK; remaining products, for which partial payments have been made, shall revert to CONTRACTOR unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## SECTION 01 29 73 - SCHEDULE OF VALUES

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. This Section defines the process whereby the Schedule of Values (lump sum price breakdown) shall be developed and incorporated into the cost loading function of the CPM Schedule in accordance with the requirements of Section 01 32 16 – CPM Construction Schedule.
- B. Monthly progress payment amounts will be determined from the monthly progress updates of the CPM Schedule activities.
- C. Develop the Schedule of Values independent of but simultaneous with the development of the CPM Schedule activities and logic.

#### 1.2 PRELIMINARY SCHEDULE OF VALUES

- A. Submit a preliminary Schedule of Values for the major components of the WORK at the Preconstruction Conference in accordance with the requirements of Section 01 10 00 – Summary of Work.
- B. At a minimum, submit proposed values for the following major WORK components:
  - 1. Mobilization: Maximum 5 percent of Contract Price;
  - 2. the total value of trench excavation, dewatering, shoring, bedding, backfill and testing WORK;
  - 3. the total value of pipe material and installation WORK;
  - 4. the total value of manhole material, protective coatings, and installation WORK;
  - 5. the total value of the trenchless installation of the sewer main across State Highway 201 WORK;
  - 6. the total value of site civil WORK, inclusive of pavement saw cutting, paving, and grade rings and concrete collars finish work for manholes, and;
  - 7. the total value of other WORK not specifically included in the above items.
- C. Review and Revisions
  - 1. The CONTRACTOR and ENGINEER shall meet and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the ENGINEER, these are necessary to establish fair and reasonable allocation of values for the major WORK components.
  - 2. Front-end loading will not be accepted.
  - 3. The ENGINEER may require reallocation of major WORK components from items in the above listing if in the opinion of the ENGINEER such reallocation is necessary.

4. This review and any necessary revisions shall be completed within 15 Days from the date of Notice to Proceed.

### 1.3 DETAILED SCHEDULE OF VALUES

- A. Prepare and submit a detailed Schedule of Values to the ENGINEER within 20 Days from the date of Notice to Proceed.
- B. Base the detailed Schedule of Values on the accepted preliminary Schedule of Values for major WORK components.
- C. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the CPM Schedule activities, furnish a sufficiently detailed breakdown in order to meet this requirement.
- D. The ENGINEER will be the sole judge of acceptable numbers, details and description of values established.
- E. If, in the opinion of the ENGINEER, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified by the ENGINEER.

### 1.4 CHANGES TO SCHEDULE OF VALUES

- A. Changes to the CPM Schedule which additional activities not included in the original schedule but included in the original WORK (schedule omissions) shall have values assigned as approved by the ENGINEER.
- B. Reduce other activity values in order to provide equal value adjustment increases for added activities, as approved by the ENGINEER.
- C. In the event that the CONTRACTOR and ENGINEER agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

## **PART 2 -- PRODUCTS (NOT USED)**

## **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## SECTION 01 32 16 - CPM CONSTRUCTION SCHEDULE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall schedule the WORK in accordance with this Section.
- B. Development of the schedule, the cost loading of the schedule, monthly payment requisitions and project status reporting requirements of the Contract shall employ Critical Path Method (CPM) scheduling. The CPM Schedule shall be cost loaded based on the schedule of values as approved by the ENGINEER in accordance with Section 01 29 73 – Schedule of Values.
- C. The CPM schedule and related reports should be prepared electronically.

#### 1.2 DEFINITIONS

- A. CPM Scheduling: The term shall be interpreted to be generally as outlined in the Association of General Contractors (AGC) publication, "The Use of CPM in Construction." except that either "i-j" arrow diagrams or precedence diagramming format may be utilized. In the case of conflicts between this Section and the AGC document, this Section shall govern.
- B. Float: Unless otherwise indicated herein, float and total float are synonymous. Total float is the period of time measured by the number of Days each non-critical path activity may be delayed before it and its succeeding activities become part of the critical path. If a non-critical path activity is delayed beyond its float period, then that activity becomes part of the critical path and controls the end date of the WORK. Thus, delay of a non-critical path activity beyond its float period will cause delay to the project itself.

#### 1.3 CPM SCHEDULE SUBMITTALS

- A. Original CPM Schedule Submittal: Within 30 Days after the commencement date stated in the Notice to Proceed, the CONTRACTOR shall submit for review by the ENGINEER an electronic CPM schedule (PDF or Excel). This submittal shall have already been reviewed and approved by the CONTRACTOR's Project Manager, superintendent, and estimator prior to submission. The CPM schedule shall describe the activities to be accomplished and their logical relationships and shall show the critical path. Each installation and sitework activity shall be cost loaded.
- B. Original CPM Schedule Review Meeting: The CONTRACTOR shall, within 30 Days from the commencement date stated in the Notice to Proceed, meet with the ENGINEER to review the original CPM schedule submittal. The ENGINEER's review will be limited to conformance with the Contract Documents. However, the review may also include:
  - 1. Clarifications of the design intent.
  - 2. Directions to include activities and information missing from the submittal.
  - 3. Requests to the CONTRACTOR to clarify and revise the schedule.
- C. Revisions to the Original CPM Schedule: Within 30 Days after the commencement date stated in the Notice to Proceed, the CONTRACTOR shall revise the original CPM schedule submittal to address review comments from the original CPM schedule review

meeting and resubmit for the ENGINEER's review. The ENGINEER, within 14 Days from the date that the CONTRACTOR submitted the revised schedule will either (1) accept the schedule as submitted, or (2) advise the CONTRACTOR in writing to review any part or parts of the schedule which either do not meet the requirements or are unsatisfactory for the ENGINEER to monitor the progress and status of WORK or evaluate monthly payment requests by the CONTRACTOR. The ENGINEER may accept the schedule conditional upon the first monthly CPM schedule update correcting deficiencies identified. When the schedule is accepted, it shall be considered as the "Original CPM Construction Schedule" until an updated schedule has been submitted. The ENGINEER reserves the right to require that the CONTRACTOR adjust, add to, or clarify any portion of the schedule which may later be discovered to be insufficient for the monitoring of WORK or approval of partial payment requests. No additional compensation will be provided for such adjustments, additions, or clarifications.

#### D. Acceptance

1. Acceptance of the CONTRACTOR's schedule by the ENGINEER and OWNER will be based solely upon compliance with the requirements. By way of the CONTRACTOR assigning activity durations and proposing the sequence of the WORK, the CONTRACTOR agrees to utilize sufficient and necessary management and other resources to perform WORK in accordance with the schedule. Upon submittal of a schedule update, the updated schedule shall be considered the "current" project schedule.
2. Submission of the CONTRACTOR's progress schedule to the ENGINEER shall not relieve the CONTRACTOR of total responsibility for scheduling, sequencing, and pursuing the WORK to comply with the requirements of the Contract Documents, including adverse effects such as delays resulting from ill-timed WORK.

#### E. Monthly Updates and Periodic CPM Schedule Submittals

1. Following acceptance of the CONTRACTOR's original CPM schedule, the CONTRACTOR shall monitor the progress of the WORK and adjust the schedule each month to reflect actual progress and any changes in planned future activities. Each schedule update submittal shall be complete including information requested in the original schedule submittal and be in the schedule report format indicated below. Each update shall continue to show WORK activities including those already completed. Completed activities shall accurately depict "as built" information by indicating when the WORK was actually started and completed.
2. Neither the submission nor the updating of the CONTRACTOR's original schedule submittal nor the submission, updating, change, or revision of any other report, curve, schedule, or narrative submitted by the CONTRACTOR, nor the ENGINEER's review or acceptance of any such report, curve, schedule, or narrative shall have the effect of amending or modifying in any way the Contract Times or milestone dates or of modifying or limiting in any way the CONTRACTOR's obligations under the Contract. Only a signed, fully executed Change Order can modify contractual obligations.

### 1.4 CHANGE ORDERS

- A. Upon approval of a Change Order or upon receipt by the CONTRACTOR of authorization to proceed with additional WORK, the change shall be reflected in the monthly updates of the CPM Schedule. Whenever the CONTRACTOR believes that a Change Order will extend the Contract Times, the sub-network analysis herein shall be submitted with the



price proposal for the change. If the CONTRACTOR does not submit the sub-network demonstrating that the change affects the Contract Times, then no subsequent claim for additional time due to the change will be accepted.

## 1.5 CPM STANDARDS

- A. Construction and procurement activities shall be presented in a time-scaled format with a calendar timeline along the entire sheet length. Each activity arrow or node shall be plotted so that the beginning and completion dates of each activity are accurately represented along the calendar timeline. Every activity shall use symbols that clearly distinguish between critical path activities, non-critical activities, and free float for each non-critical activity.

## 1.6 PROJECT STATUS REPORTING

- A. The CONTRACTOR shall prepare monthly written narrative reports of the status of the project for submission to the ENGINEER. Status reports shall include:
  - 1. The status of major project components (percent complete, amount of time ahead or behind schedule) and an explanation of how the project will be brought back on schedule if delays have occurred.
  - 2. The progress made on critical activities indicated on the CPM schedule.
  - 3. Explanations for any lack of WORK on critical path activities planned for the last month.
  - 4. Explanations for any schedule changes, including changes to the logic and to activity durations.
  - 5. A list of the critical activities scheduled to be performed in the next 2 months.
  - 6. The status of major material and equipment procurement.
  - 7. The value of materials and equipment properly stored at the Site but not yet incorporated into the WORK.
  - 8. Any delays encountered during the reporting period.
  - 9. An assessment of inclement weather delays and impacts to the progress of the WORK.
- B. The CONTRACTOR may include any other information pertinent to the status of the WORK. The CONTRACTOR shall include additional status information requested by the ENGINEER.

## 1.7 INCLEMENT WEATHER PROVISIONS OF THE SCHEDULE

- A. The CONTRACTOR's schedule shall include at least the number of Days of delay due to unusually severe weather as required by the Supplementary General Conditions.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## **SECTION 01 33 00 - CONTRACTOR SUBMITTALS**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. Wherever submittals are required by the Contract Documents, submit them to the ENGINEER.
  - 1. Provide submittals electronically in PDF format as directed ENGINEER. ENGINEER may create a SharePoint site or require email delivery. Submittal process to be determined and agreed upon at the PRE-CONSTRUCTION MEETING.
- B. Within 10 Days after the date of commencement as stated in the Notice to Proceed, submit the following items for review:
  - 1. Submittal Schedule
    - a. Submit a preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("or equal") submittals listed in the Bid.
    - b. Base the schedule of submittals on CONTRACTOR's priority, planned construction sequence and schedule, long-lead items, and size of submittal package.
    - c. Allow time for resubmittals.
  - 2. Submit a list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

#### **1.2 PRECONSTRUCTION CONFERENCE SUBMITTALS**

- A. At the preconstruction conference of Section 01 10 00 – Summary of Work, submit the following items to the ENGINEER for review:
  - 1. Key Personnel contact sheet;
  - 2. Revised schedule of Shop Drawings, Samples, and proposed Substitution ("or-equal") submittals listed in the Bid;
  - 3. List of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit;
  - 4. Preliminary schedule of values in accordance with Section 01 29 73 – Schedule of Values.

#### **1.3 SHOP DRAWINGS**

- A. Wherever called for in the Contract Documents or where required by the ENGINEER, provide Shop Drawings in PDF format.
- B. Shop Drawings as specified in individual work sections include, but are not necessarily limited to, data such as fabrication and drawings, scheduled information,

setting diagrams, actual shopwork manufacturing instructions, custom templates, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the Work.

- C. All Shop Drawings submitted by subcontractors for approval shall be sent directly to the Contractor for preliminary checking. The CONTRACTOR shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
- D. The CONTRACTOR shall check all subcontractor's Shop Drawings regarding measurements, size of members, materials, and details to satisfy themselves that they conform to the intent of the Contract Drawings and Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors for correction before submission thereof.
- E. All details on Shop Drawings submitted for approval shall show clearly the elevations of the various parts to the main members and lines of the structure (s) and where correct fabrications of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted for approval.
- F. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items.
- G. Whenever the CONTRACTOR is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in the State of Utah. The CONTRACTOR shall prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work sections of the Specifications, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required), coordination with other submittals, testing, purchasing, fabricating, delivery and similar sequenced activities. No extension of time will be authorized because of the CONTRACTOR's failure to transmit submittals sufficiently in advance of the work.
- H. Organization
  - 1. Use a single submittal for each technical specification section or item or class of material or equipment for which a submittal is required.
  - 2. A single submittal covering multiple sections will not be accepted, unless the primary specification references other Sections for components: For example, if a pump section references other sections for the motor, shop-applied protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be accepted, whereas a single submittal covering vertical turbine pumps and horizontal split-case pumps would not be accepted.
  - 3. Index the components of the submittal and insert tabs in the submittal to match the components.
  - 4. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, or schedule title.
  - 5. Unless otherwise indicated, match terminology and equipment names and numbers used in the submittals with those used in the Contract Documents.

#### H. Format

1. Number every page in a submittal in sequence.
2. Where product data from a manufacturer is submitted, clearly mark which model or product is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports.
3. Present a sufficient level of detail for assessment of compliance with the Contract Documents.
4. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.

#### I. ENGINEER's Review

1. Except as otherwise indicated, the ENGINEER will return comments on each submittal to the CONTRACTOR with comments noted thereon, within 21 Days following receipt by the ENGINEER.
2. It is considered reasonable that the CONTRACTOR shall make a complete and acceptable submittal to the ENGINEER by the first resubmittal on an item.
3. The OWNER reserves the right to withhold monies due to the CONTRACTOR to cover additional costs of the ENGINEER's review beyond the first resubmittal.
4. The ENGINEER'S maximum review period for each submittal or resubmittal will be 30 Days; thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 90 Days.

J. If a submittal is returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.

K. If a submittal is returned marked "MAKE CORRECTIONS NOTED," the CONTRACTOR shall make the corrections on the submittal, but formal revision and resubmission will not be required.

#### L. Resubmittals

1. If a submittal is returned marked "AMEND-RESUBMIT," the CONTRACTOR shall revise the submittal and resubmit the required number of copies.
2. Resubmittal of portions of multi-page or multi-drawing submittals will not be accepted: For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "AMEND-RESUBMIT," the submittal as a whole is deemed "AMEND-RESUBMIT," and 10 drawings are required to be resubmitted.
3. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

#### M. Rejected Submittals

1. If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed, or is a substitution request not submitted

in accordance with Section 01 60 00 – Products, Materials, Equipment, and Substitutions.

2. In the first 2 cases, the CONTRACTOR shall prepare a new submittal.
  3. In the latter case, the CONTRACTOR shall submit the substitution request according to the requirements of Section 01 60 00 – Products, Materials, Equipment, and Substitutions.
  4. The resubmittal of rejected portions of a previous submittal will not be accepted.
- N. The fabrication of an item may commence only after the ENGINEER has reviewed the pertinent submittals and returned copies to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."
- O. Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.
- P. Review by CONTRACTOR
1. Submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR prior to submission to the ENGINEER.
  2. Each submittal shall be dated and signed by the CONTRACTOR as being correct and in strict conformance with the Contract Documents.
  3. In the case of Shop Drawings, each sheet shall be so dated and signed.
  4. Any deviations from the Contract Documents shall be noted on the transmittal sheet.
  5. The ENGINEER will only review submittals that have been so verified by the CONTRACTOR.
  6. Non-verified submittals will be returned to the CONTRACTOR without action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.
- Q. Conformance
1. Corrections or comments made on the CONTRACTOR's Shop Drawings during review shall not relieve the CONTRACTOR from compliance with Contract Drawings and Specifications.
  2. A lack of comments made on the CONTRACTOR's Shop Drawings during review shall not relieve the CONTRACTOR from compliance with Contract Drawings and Specifications.
  3. Review is for conformance to the design concept and general compliance with the Contract Documents only.
  4. The CONTRACTOR shall be responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating WORK with the trades, and satisfactory and safe performance of the WORK.

## 1.4 SAMPLES

### A. Quantity

1. The CONTRACTOR shall submit the number of samples indicated by the Specifications.
2. If the number is not indicated, submit not less than 3 samples.
3. Where the quantity of each sample is not indicated, submit such quantity as necessary for proper examination and testing by the methods indicated.

### B. Identification and Distribution

1. Individually and indelibly label or tag each sample, indicating the salient physical characteristics and the manufacturer's name.
2. Upon acceptance by the ENGINEER, one set of the samples will be stamped and dated by the ENGINEER and returned to the CONTRACTOR, one set of samples will be retained by the ENGINEER, and one set shall remain at the Site in the ENGINEER's field office until completion of the WORK.

### C. Selection

1. Unless otherwise indicated, the ENGINEER will select colors and textures from the manufacturer's standard colors and standard materials, products, or equipment lines.
2. If certain samples represent non-standard colors, materials, products, or equipment lines that will require an increase in Contract Times or Price, the CONTRACTOR shall clearly state so on the transmittal page of the submittal.

### D. The CONTRACTOR shall schedule sample submittals such that:

1. Sample submittals for color and texture selection are complete so the ENGINEER has 45 Days to assemble color panels and select color- and texture-dependent products and materials without delay to the construction schedule; and,
2. After the ENGINEER selects colors and textures, the CONTRACTOR has sufficient time to provide the products or materials without delay to the construction schedule.
3. The Contract Times will not be extended for the CONTRACTOR's failure to allow enough review and approval or selection time, failure to submit complete samples requiring color or texture selection, or failure to submit complete or approvable samples.

## 1.5 TECHNICAL MANUAL

- A. The CONTRACTOR shall submit technical operation and maintenance information electronically for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual.
- B. The manual shall be written such that it can be used and understood by the OWNER
- C. Categories

1. The Technical Manual shall be subdivided first by Specification Section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):
  - a. Category 1 - Equipment Summary
    - 1) Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.
    - 2) Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.
  - b. Category 2 - Operational Procedures
    - 1) Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:
      - Installation
      - Adjustment
      - Startup
      - Location of controls, special tools, equipment required, or related instrumentation needed for operation
      - Operation procedures
      - Load changes
      - Calibration
      - Shutdown
      - Troubleshooting
      - Disassembly
      - Reassembly
      - Realignment
      - Testing to determine performance efficiency
      - Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices
      - List of all electrical relay settings including alarm and contact settings
  - c. Category 3 - Preventive Maintenance Procedures
    - 1) Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.
    - 2) Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.
  - d. Category 4 - Parts List
    - 1) Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.



- 2) Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.
- e. Category 5 - Wiring Diagrams
  - 1) Diagrams: Category 5 shall include complete internal and connection wiring diagrams for electrical equipment items.
- f. Category 6 - Shop Drawings
  - 1) Drawings: This category includes approved shop or fabrication drawings with ENGINEER comments and corrections incorporated, complete with dimensions.
- g. Category 7 - Safety
  - 1) Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.
- h. Category 8 - Documentation:
  - 1) Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

#### D. Format

1. Bind each Technical Manual in standard size 3-ring hardcover binders, labeled on the spine and cover with Project name, OWNER's project number, Specification Section number, equipment name, and equipment identification number
2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.
3. Documents in binders shall be 3-hole punched, with no text punched out, and pages larger than 8-1/2 by 11 shall be folded to 8-1/2 by 11 size.
4. Provide a CD with electronic files with each final set of Technical Manuals.
  - a. Adobe Acrobat portable document format (PDF) or other software required by the Specifications; and,
  - b. Manufacturer literature in Adobe Acrobat portable document format (PDF).

#### E. Review Process

1. Furnish draft Technical Manuals electronically for each Specification Section that requires a manual.
2. OWNER and ENGINEER will review and provide comments back to the CONTRACTOR electronically.

3. CONTRACTOR shall incorporate comments into the draft and submit 3 identical hard copies and an electronic copy (CD with manual in PDF format) of the final manual for acceptance.

F. Schedule

G. Submittal and Corrections

1. The WORK under this Contract involves start-up and commissioning of equipment in multiple areas of the facility at independent times within the Project Schedule.
2. The manuals shall be completed for each piece of equipment prior to final acceptance of the equipment by the OWNER.
3. Except as otherwise indicated, submit the manuals for review in final form a minimum of 30 Days prior to the start of performance testing for each piece of equipment.
4. Discrepancies found by the ENGINEER shall be corrected within 30 Days from the Date of written notification by the ENGINEER.

- H. Manuals that are incomplete or unacceptable at the schedule criterion above will constitute sufficient justification for the OWNER to retain the amount in Paragraph "Technical Manual Submittals" of Section 01 77 00 – Project Closeout, from any monies due the CONTRACTOR.

1.6 SPARE PARTS LIST - CONSULT INDIVIDUAL TECHNICAL SECTIONS

1.7 AS-BUILT DRAWINGS

A. On-Site Drawings Set

1. Maintain one set of Drawings at the Site for the preparation of as-built drawings.
2. On this set, mark every project condition, location, configuration, and any other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction.
3. Give special attention to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.
4. Supplement the as-built drawings by any detailed sketches as necessary or as directed, in order to fully indicate the WORK as actually constructed.
5. The as-built drawings are the CONTRACTOR's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up-to-date during the progress of the WORK.
6. Use red ink for alterations and notes.
7. Notes shall identify relevant Change Orders by number and date.

B. Submittal

1. Submit one final set of as-built drawings at the end of the project.
  - C. In the case of those drawings that depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, update the as-built drawings by indicating those portions which are superseded by Change Order drawings or final Shop Drawings, and by including appropriate reference information describing the Change Orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.
  - D. Unacceptable Drawings
    1. Disorganized or incomplete as-built drawings will not be accepted.
    2. The CONTRACTOR shall revise them and resubmit within 10 Days.
  - E. As-built drawings shall be accessible to the ENGINEER during the construction period.
  - F. Final Payment
    1. Final payment will not be acted upon until the as-built drawings have been completed and delivered to the ENGINEER.
  - G. Information submitted by the CONTRACTOR will be assumed to be correct, and the CONTRACTOR shall be responsible for the accuracy of such information
- 1.8 QUALITY CONTROL (QC) SUBMITTALS
- A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the ENGINEER that the CONTRACTOR has satisfied certain requirements of the Contract Documents.
  - B. Unless otherwise indicated, QC submittals shall be submitted:
    1. Before delivery and unloading, for the following types of submittals:
      - a. Manufacturers' installation instructions
      - b. Manufacturers' and Installers' experience qualifications
      - c. Ready mix concrete delivery tickets
      - d. Design calculations
      - e. Affidavits and manufacturers' certification of compliance with indicated product requirements
      - f. Laboratory analysis results
      - g. Factory test reports
    2. Within 30 Days of the event documented for the following types of submittals:
      - a. Manufacturers' field representative certification of proper installation
      - b. Field measurement

- c. Field test reports
  - d. Receipt of permit
  - e. Receipt of regulatory approval
- C. The ENGINEER will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

#### 1.9 INFORMATIONAL SUBMITTALS

- A. Informational submittals formalize the flow of information between the CONTRACTOR and the ENGINEER.
- B. Electronic forms shall be used for such purpose.

#### **PART 2 -- PRODUCTS (NOT USED)**

#### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## **SECTION 01 35 53 – SITE SECURITY**

### **PART 1 -- GENERAL**

#### **1.1 GENERAL**

- A. OWNER's fenced wastewater treatment facility (SITE) is located northeast of the site of the WORK. OWNER is willing to allow storage, staging, and field operations to be located within the fence for security purposes. Access must be requested and coordinated at the PRE-CONSTRUCTION meeting and follow the OWNER'S security program and requirements listed below.

#### **1.2 SECURITY PROGRAM**

- A. The CONTRACTOR shall:
  - 1. Protect WORK, existing premises, and OWNER'S operations from theft, vandalism, and unauthorized entry.
  - 2. Initiate program in coordination with OWNER'S existing security system at mobilization.
  - 3. Maintain program throughout construction period.

#### **1.3 ENTRY CONTROL**

- A. The CONTRACTOR shall:
  - 1. Restrict entry of persons and vehicles into Site and existing facilities.
  - 2. Allow entry only to authorized persons with proper identification.
  - 3. Maintain log of workers and visitors and make log available to OWNER on request.
  - 4. Coordinate access of OWNER'S personnel to Site in coordination with OWNER'S security forces.
- B. The OWNER will control the entrance of persons and vehicles to those related to the OWNER'S operations.

#### **1.4 PERSONNEL IDENTIFICATION (NOT USED)**

#### **1.5 SECURITY SERVICE (NOT USED)**

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## SECTION 01 42 13 - REFERENCE STANDARDS

### PART 1 -- GENERAL

#### 1.1 GENERAL

- A. Wherever in these Specifications references are made to published standards, codes, specifications, or other published data it shall mean the latest standards codified as of the date of advertisement of bids by the various international, national, regional, or local organizations. Such organizations may be referred to by their acronym or abbreviation only. As partial list of applicable acronyms or abbreviations which may appear shall have the meanings indicated herein

#### 1.2 ABBREVIATIONS

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABMA	American Bearing Manufacturer's Association – ABMA
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AF&PA	American Forest and Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	The Asphalt Institute
AIA	American Institute of Architects
AIHA	American Industrial Hygiene Association
AIIM	Association for Information and Image Management
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMA	Acoustical Material Association
AMCA	Air Movement and Control Association International, Inc
ANS	American Nuclear Society
ANSI	American National Standards Institute, Inc.
APA	The Engineered Wood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society of Nondestructive Testing
ASQ	American Society for Quality
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWCI	American Wire Cloth Institute
AWI	Architectural Woodwork Institute

AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BBC	Basic Building Code, Building Officials and Code Administrators International
BHMA	Builders Hardware Manufacturer's Association
CABO	Council of American Building Officials
CDA	Copper Development Association
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CLPCA	California Lathing and Plastering Contractors Association
CMAA	A division/section of the Material Handling Industry of America
CPG	Compressed Gas Association
CRSI	Concrete Reinforcing Steel Institute
DCDMA	Diamond Core Drilling Manufacturer's Association
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EI	Energy Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
ETL	Electrical Test Laboratories
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
FEMA	Federal Emergency Management Association
FHWA	Federal Highway Administration
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute, Hydraulic Institute
HSWA	Federal Hazardous and Solid Waste Amendments
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
ICC-ES	International Code Council Evaluation Service
ICCEC	Electrical Code
ICEA	Insulated Cable Engineers Association
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code, Association Connecting Electronic Industries
IRC	International Residential Code
ISA	Instrument Society of Automation
ISDI	Insulated Steel Door Institute
ISEA	Industrial Safety Equipment Association
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
ITU-T	Telecommunications Standardization Sector of the International Telecommunications Union



LPI	Lightning Protection Institute
LRQA	Lloyd's Register Quality Assurance
MBMA	Metal Building Manufacturer's Association
MIL	Military Standards (DoD)
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers
DASMA	Door and Access Systems Manufacturers Association International
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NCCLS	National Committee for Clinical Laboratory Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association or National Fluid Power Association
NISO	National Information Standards Organization
NIST	National Institute of Standards and Technology
NLGI	National Lubricating Grease Institute
NRCA	National Roofing Contractors Association
NSF	National Sanitation Foundation
NWWDA	National Wood Window and Door Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PPI	Plastic Pipe Institute
RCRA	Resource Conservation and Recovery Act
RIS	Redwood Inspection Service, a division of the California Redwood Association, CRA
RMA	Rubber Manufacturers Association
RVIA	Recreational Vehicle Industry Association
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SDI	Steel Door Institute, Steel Deck Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricator's Association
SPIB	Southern Pine Inspection Bureau
SSBC	Southern Standard Building Code, Southern Building Code Congress
SSPC	Society for Protective Coating
SSPWC	Standard Specifications for Public Works Construction
STLE	Society of Tribologists and Lubricating Engineers
TAPPI	Technical Association of the Worldwide Pulp, Paper, and Converting Industry
TFI	The Fertilizer Institute
TIA	Telecommunications Industries Association
TPI	Truss Plate Institute
UBC	Uniform Building Code
UDEQ	Utah Department of Environmental Quality
UDOT	Utah Department of Transportation
UL	Underwriters Laboratories, Inc.

USEPA	United States of America Environmental Protection Agency
WCLIB	West Coast Lumber Inspection Bureau
WDMA	National Window and Door Manufacturers Association
WEF	Water Environment Federation
WI	Woodwork Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## SECTION 01 42 19 - REFERENCE STANDARDS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Titles of Sections and Paragraphs: Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.
- B. Applicable Publications: Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.
- C. Specialists, Assignments: In certain instances, specification text requires (or implies) that specific WORK is to be assigned to specialists or expert entities who must be engaged to perform that WORK. Such assignments shall be recognized as special requirements over which the CONTRACTOR has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the WORK; also, they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of WORK is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the CONTRACTOR.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. The CONTRACTOR shall construct the WORK in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.
- B. References to "Building Code" or "Uniform Building Code" shall mean Uniform Building Code of the International Conference of Building Officials (ICBO). References to "Building Code" or "Standard Building Code" shall mean the Standard Building Code of the Southern Building Code Congress International. References to "Building Code" or "National Building Code" shall mean the National Building Code of Building Officials and Code Administrators International (BOCA). References to "Building Code" or "International Building Code" shall mean International Building Code of the International Code Council (ICC) as amended by the local jurisdiction. Similarly, references to "Mechanical Code" or "Uniform Mechanical Code," "Plumbing Code" or "Uniform Plumbing Code," "Fire Code" or "Uniform Fire Code," shall mean Uniform Mechanical Code, Uniform Plumbing Code and Uniform Fire Code of the International Association of Plumbing and Mechanical Officials (IAPMO) as amended by the local jurisdiction. "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of the codes as approved by the Municipal Code and used by the local agency as of the date that the

WORK is advertised for Bids shall apply to the WORK herein, including all addenda, modifications, amendments, or other lawful changes thereto.

- C. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the ENGINEER for clarification and direction prior to ordering or providing any materials or furnishing labor. The CONTRACTOR shall bid for the most stringent requirements.
- D. References to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
- E. References to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
- F. Applicable Standard Specifications: References in the Contract Documents to "Standard Specifications" or SSPWC shall mean the Standard Specifications for Public Works Construction.

### 1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

- A. The CONTRACTOR shall be responsible that all WORK included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.
- B. Where no specific regulations exist and the OWNER has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## **SECTION 01 45 00 - QUALITY CONTROL**

### **PART 1 -- GENERAL**

#### **1.1 DEFINITION**

- A. Specific quality control requirements for the WORK are indicated throughout the Contract Documents. The requirements of this Section are primarily related to performance of the WORK beyond furnishing of manufactured products. The term "Quality Control" includes inspection, sampling and testing, and associated requirements.
- B. The CONTRACTOR shall be responsible for and shall supervise the work of all subcontractors, providing direction to each when their work does not conform to the requirements of this section or the CONTRACT DOCUMENTS.
- C. CONTRACTOR is responsible for Quality Control. CONSTRUCTION MANAGER is responsible for Quality Assurance.

#### **1.2 SAMPLING AND TESTING**

- A. Unless otherwise indicated, all sampling and testing will be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered; however, the OWNER reserves the right to use any generally-accepted system of sampling and testing which, in the opinion of the ENGINEER will assure the OWNER that the quality of the workmanship is in full accord with the CONTRACT DOCUMENTS.
- B. Any waiver by the OWNER of any specific testing or other quality assurance measures, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the testing or other quality assurance requirements originally indicated, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial WORK, shall not be construed as a waiver of any requirements of the Contract Documents.
- C. Notwithstanding the existence of such waiver, the ENGINEER reserves the right to make independent investigations and tests, and failure of any portion of the WORK to meet any of the requirements of the Contract Documents, shall be reasonable cause for the ENGINEER to require the removal or correction and reconstruction of any such WORK in accordance with the Contract.

#### **1.3 INSPECTION AND TESTING SERVICE**

- A. Inspection and testing laboratory service shall comply with the following:
  - 1. Unless indicated otherwise by the Technical Specifications, the CONTRACTOR shall employ and pay for services of an independent firm to perform inspection and testing specified in the CONTRACT DOCUMENTS including those required by any permits, codes, or applicable regulations.
  - 2. The OWNER or OWNER'S DESIGNEE will perform inspections, testing, and other services as required by the ENGINEER under Paragraph 1.2C above.

3. Reports of testing, regardless of whether the testing was the OWNER'S or the CONTRACTOR'S responsibility, will be submitted to the ENGINEER electronically in PDF format as directed by the ENGINEER, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
4. The CONTRACTOR shall cooperate with the OWNER or independent firm and furnish samples of materials, design mix, equipment, tools, storage, and assistance as requested.
5. The CONTRACTOR shall notify ENGINEER 72 hours prior to the expected time for operations requiring inspection and laboratory testing services.
6. Retesting required because of non-conformance to requirements shall be performed by the same independent firm on instructions by the ENGINEER. The CONTRACTOR shall bear all costs from such retesting.
7. For samples and tests required for CONTRACTOR'S use, the CONTRACTOR shall make arrangements with an independent firm for payment and scheduling of testing. The cost of sampling and testing for the CONTRACTOR'S use shall be the CONTRACTOR'S responsibility.

#### 1.4 RIGHT OF REJECTION

- A. The OWNER shall have the right to reject any articles or materials to be furnished hereunder which, in any respect, fail to meet the requirements of the CONTRACT DOCUMENTS, regardless of whether the defects are detected at the point of manufacture or after completion of WORK. If the OWNER or ENGINEER, through oversight or otherwise, has accepted materials or WORK which is defective or which is contrary to the CONTRACT DOCUMENTS or deemed unsatisfactory by an authorized approving authority, no matter in what stage or condition of manufacture, delivery, or erection may be subsequently rejected by the OWNER.
- B. The CONTRACTOR shall be responsible for promptly removing rejected items or material from the site after notification of rejection by OWNER or ENGINEER. All cost of removal and replacement of rejected article or materials shall be the responsibility of the CONTRACTOR.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### 3.1 INSTALLATION

- A. Inspection: The CONTRACTOR shall inspect materials or equipment upon the arrival on the job site and immediately prior to installation and reject damaged and defective items.
- B. Measurements: The CONTRACTOR shall verify measurements and dimensions of the WORK, as an integral step of starting each installation. CONTRACTOR shall be responsible to coordinate dimensions of all Work.
- C. Manufacturer's Instructions: Where installations include manufactured products, the CONTRACTOR shall comply with manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in Contract Documents.

### 3.2 Buoyancy

- A. The CONTRACTOR shall be solely responsible for any tanks, pipelines, manholes, foundations, or similar improvements that may become buoyant during construction due to groundwater levels. Should there be any possibility of buoyancy, the CONTRACTOR shall take necessary steps to prevent damage due to floating or flooding and shall repair or replace said improvements at the direction of the ENGINEER or OWNER at no additional cost.

END OF SECTION

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## **SECTION 01 50 00 - MOBILIZATION**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. CONTRACTOR shall mobilize as required for the proper performance and completion of the WORK and in accordance with the Contract Documents.
- B. Mobilization shall include at least the following items:
  - 1. Obtaining required permits.
  - 2. Moving onto the Site with equipment necessary for the first month of operations.
  - 3. Constructing and implementing security features and requirements complying with Section 01 35 53 – Site Security.
  - 4. Having OSHA required notices and establishing safety programs.
  - 5. Submitting initial submittals.
  - 6. If using the OWNER's wastewater treatment facility for staging, storage, etc., start coordination of said use with the OWNER at the preconstruction conference.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## SECTION 01 50 10 - PROTECTION OF EXISTING FACILITIES

### PART 1 -- GENERAL

#### 1.1 GENERAL

- A. The CONTRACTOR shall be responsible for the preservation and protection of property adjacent to the WORK areas against damages or injury as a result of the WORK. Any damage or injury occurring on account of any act, omission, or neglect on the part of the CONTRACTOR shall be restored in a proper and satisfactory manner or replaced by and at the expense of the CONTRACTOR.
- B. In the event of any claims for damage or alleged damage to property during or as a result of the WORK, the CONTRACTOR shall be solely responsible for all costs in connection with the settlement of or defense against such claims. Prior to the commencement of work in the vicinity to the work areas, the CONTRACTOR may, at their own expense, take surveys and document as necessary to sufficiently establish existing conditions.
- C. The CONTRACTOR shall protect all existing utilities and improvements not designated for removal and shall restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than prior to such damage or temporary relocation, all in accordance with the CONTRACT DOCUMENTS.

#### 1.2 RIGHTS-OF-WAY

- A. The CONTRACTOR shall not do any WORK that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, nor shall the CONTRACTOR enter upon the rights-of-way involved until notified that the OWNER has secured authority therefor from the proper party.
- B. After authority has been obtained, the CONTRACTOR shall give said party due notice of its intention to begin work, if required by said party, and shall remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace the same.

#### 1.3 PROTECTION OF STREET OR ROADWAY MARKERS

- A. The CONTRACTOR shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the CONTRACTOR shall be accurately restored after street or roadway resurfacing has been completed.

#### 1.4 RESTORATION OF PAVEMENT

- A. General: All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the CONTRACT DOCUMENTS or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Temporary and permanent pavement shall conform to the requirements

of the affected pavement owner. Pavements which are subject to partial removal shall be neatly saw cut in straight lines.

- B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction, the CONTRACTOR shall place temporary surfacing promptly after backfilling and shall maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.
- C. Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, the CONTRACTOR shall saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.
- D. Restoration of Sidewalks or Driveways: Wherever sidewalks or interior roads or driveways have been removed for purposes of construction, the CONTRACTOR shall place suitable temporary sidewalks or roadways promptly after backfilling and shall maintain them in satisfactory condition for the period of time fixed by the authorities having jurisdiction over the affected portions. If no such period of time is so fixed, the CONTRACTOR shall maintain said temporary sidewalks or roadways until the final restoration thereof has been made.

#### 1.5 EXISTING UTILITIES AND IMPROVEMENTS

- A. General: The CONTRACTOR shall protect underground Utilities and other improvements which may be impaired during construction operations, regardless of whether or not the Utilities are indicated on the Contract Drawings. The CONTRACTOR shall take all possible precautions for the protection of unforeseen Utility lines to provide for uninterrupted service and provide such special protection as may be necessary.
- B. Except where the Construction Drawings indicate Utilities have been field located during design or certain Utility locations shall be exposed as part of the WORK, the CONTRACTOR shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of Utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the CONTRACTOR's progress. When such exploratory excavations show the Utility location as shown on the Drawings to be in error, the CONTRACTOR shall notify the ENGINEER, in writing, of the following location differences promptly upon their discovery (but in no event later than 2 Days after their discovery) and before they are disturbed.
- C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the Utility.
- D. Utilities to be Moved: In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the CONTRACTOR, be notified by the OWNER to move such property within a specified reasonable time. When utility lines that are to be moved are encountered within the area of operations, the CONTRACTOR shall notify the ENGINEER a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

- E. Utilities to be Removed: Where the proper completion of the WORK requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, the CONTRACTOR shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to the ENGINEER and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished by the CONTRACTOR in a manner that will restore or replace the Utility or improvement as nearly as possible to its former locations and to as good or better condition than found prior to removal.
- F. OWNER's Right of Access: The right is reserved to the OWNER and to the owners of public utilities and franchises to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the WORK of this Contract.
- G. Underground Utilities Indicated: Existing Utility lines that are indicated or the locations of which are made known to the CONTRACTOR prior to excavation and that are to be retained, and all Utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced by the CONTRACTOR, unless otherwise repaired by the owner of the damaged Utility. If the owner of the damaged facility performs its own repairs, the CONTRACTOR shall reimburse said owner for the costs of repair.
- H. Underground Utilities Not Indicated: In the event that the CONTRACTOR damages existing Utility lines that are not indicated or the locations of which are not made known to the CONTRACTOR prior to excavation, a verbal report of such damage shall be made immediately to the ENGINEER and a written report thereof shall be made promptly thereafter. The ENGINEER will immediately notify the owner of the damaged Utility. If the ENGINEER is not immediately available, the CONTRACTOR shall notify the Utility owner of the damage.
- I. Approval of Repairs: All repairs to a damaged Utility or improvement are subject to inspection and approval by an authorized representative of the Utility or improvement owner before being concealed by backfill or other work.
- J. Maintaining in Service: Unless indicated otherwise, oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the WORK shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the ENGINEER are made with the owner of said utilities. The CONTRACTOR shall be responsible for and repair all damage due to its operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

#### 1.6 TREES OR SHRUBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS

- A. Trees or shrubs within the street rights-of-way and project limits shall be protected during construction or replaced to match the pre-construction condition to the satisfaction of the Salt Lake County, Utah Department of Transportation, and the OWNER.

#### 1.7 LAWN AREAS

- A. Lawn or landscaped areas damaged during construction shall be repaired to match the preconstruction condition to the satisfaction of the landowner and the OWNER.

#### 1.8 NOTIFICATION BY THE CONTRACTOR

- A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the CONTRACTOR shall provide 48-hour notice to the associated Utility owners.

#### **PART 2 -- PRODUCTS (NOT USED)**

#### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## **SECTION 01 51 00 – TEMPORARY UTILITIES**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. The types of utility services required for general temporary use at the Site include the following:

Sanitary sewer

### **PART 2 -- PRODUCTS**

#### **2.1 MATERIALS**

- A. The CONTRACTOR shall provide either new or used materials and equipment, that are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided by utility company, the CONTRACTOR shall provide the remaining portion with matching and compatible materials and equipment and shall comply with recommendations of the utility company.

### **PART 3 -- EXECUTION**

#### **3.1 INSTALLATION OF TEMPORARY UTILITY SERVICES (NOT USED)**

#### **3.2 TEMPORARY POWER**

- A. Power: The CONTRACTOR shall provide power required for its operations under the Contract and shall provide and maintain temporary power lines required to perform the WORK in a safe and satisfactory manner. If temporary power lines are not applicable to the WORK site, power shall be supplied via other means such as portable generators.

#### **3.3 INSTALLATION OF LIGHTING**

- A. Construction Lighting: WORK conducted at night or under conditions of deficient daylight shall be suitably lighted to insure proper performance and to afford adequate facilities for inspection and safe working conditions.

#### **3.4 WATER SUPPLY**

- A. Water for construction purposes is available at the Owner's wastewater treatment plant or nearby hydrants. The CONTRACTOR shall not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission from OWNER.
- B. CONTRACTOR shall be responsible for providing drinking water for their crews.

#### **3.5 INSTALLATION OF SANITARY FACILITIES**

- A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of CONTRACTOR's employees. Toilets at construction sites shall conform

to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction.

- B. Sanitary and Other Organic Wastes: The CONTRACTOR shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations shall be disposed of away from the Site in accordance with laws and regulations pertaining thereto.

### 3.6 INSTALLATION OF FIRE PROTECTION (NOT USED)

### 3.7 INSTALLATION OF GAS SERVICE (NOT USED)

### 3.8 OPERATIONS AND TERMINATIONS

- A. Inspections: Prior to placing temporary utility services into use, the CONTRACTOR shall inspect and test each service and arrange for governing authorities' required inspection and tests and obtain required certifications and permits for use thereof.
- B. Protection: The CONTRACTOR shall maintain distinct markers for underground lines and protect from damage during excavating operations.
- C. Termination and Removal: When need for a temporary utility service or a substantial portion thereof has ended, or when its service has been replaced by use of permanent services, or not later than time of substantial completion, the CONTRACTOR shall promptly remove installation unless requested by ENGINEER to retain it for a longer period. The CONTRACTOR shall complete and restore WORK which may have been delayed or affected by installation and use of temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces.
- D. Removal of Water Connections: Before final acceptance of the WORK on the project, temporary connections and piping installed by the CONTRACTOR shall be entirely removed and affected improvements shall be restored to original condition or better, to the satisfaction of the ENGINEER and to the agency owning the affected utility.

END OF SECTION



## SECTION 01 55 00 – SITE ACCESS AND STORAGE

### PART 1 -- GENERAL

#### 1.1 HIGHWAY LIMITATIONS

- A. The CONTRACTOR shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the WORK. It shall be the CONTRACTOR's responsibility to construct and maintain any haul roads required for its construction operations.

#### 1.2 CONTRACTOR'S WORK AND STORAGE AREA

- A. The OWNER will designate and arrange for the CONTRACTOR's use, a portion of their wastewater treatment facility, adjacent to the WORK for its exclusive use during the term of the Contract as storage and shop area for its construction operations on the WORK. At completion of WORK, the CONTRACTOR shall return this area to its original condition, including grading and landscaping.
- B. The CONTRACTOR shall make its own arrangements for any necessary off-Site storage or shop areas necessary for the proper execution of the WORK.
- C. The CONTRACTOR shall construct and use a separate storage area for hazardous materials used in constructing the WORK.
- D. For the purpose of this paragraph, hazardous materials to be stored in the separate area are products labeled with any of the following terms: Warning, Caution, Poisonous, Toxic, Flammable, Corrosive, Reactive, or Explosive. In addition, whether or not so labeled, the following materials shall be stored in the separate area: diesel fuel, gasoline, new and used motor oil, hydraulic fluid, cement, paints and paint thinners, 2 part epoxy coatings, sealants, asphaltic products, glues, solvents, wood preservatives, sand blast materials, and spill absorbent.
- E. Hazardous materials shall be stored in groupings according to the Material Safety Data Sheets.
- F. The CONTRACTOR shall develop and submit to the ENGINEER a plan for storing and disposing of the materials above.
- G. The separate storage area shall meet the requirements of authorities having jurisdiction over the storage of hazardous materials.
- H. Hazardous materials that are delivered in containers shall be stored in the original containers until use. Hazardous materials delivered in bulk shall be stored in containers which meet the requirements of authorities having jurisdiction.

#### 1.3 PARKING

- A. The CONTRACTOR shall:
  - 1. Direct its employees to park in areas requested by the OWNER.

2. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. The CONTRACTOR shall repair breaks, potholes, low areas which collect standing water, and other deficiencies.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## SECTION 01 57 19 – TEMPORARY ENVIRONMENTAL

### CONTROLS PART 1 -- GENERAL

#### 1.1 DUST ABATEMENT

- A. The CONTRACTOR shall prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity of the Site. The CONTRACTOR shall be responsible for any damage resulting from dust originating from its operations. Dust abatement measures shall be continued until the CONTRACTOR is relieved of further responsibility by the ENGINEER.
- B. Storage Piles: Enclose, cover, water (as needed), or apply non-toxic soil binders according to manufacturer's specifications on material piles (i.e. gravel, sand, dirt) with a silt content of 5 percent or greater.
- C. Active Areas of Site: Water active construction areas and unpaved roads as needed and as requested by ENGINEER.
- D. Inactive Areas of Site: Apply non-toxic soil stabilizers according to manufacturer's specifications to inactive construction areas, or water as needed to maintain adequate dust control.
- E. Vehicle Loads: Cover or maintain at least 2-feet of freeboard vertical distance between the top of the load and the top of the trailer sides on trucks hauling dirt, sand, soil, or other loose materials off of the Site.
- F. Roads: When there is visible track-out onto a paved public road, install wheel washers where the vehicles exit and enter onto the paved roads and wash the undercarriage of trucks and any equipment leaving the Site on each trip. Sweep the paved street at the end of each shift with a Mobil Athey or similar water spray pick-up broom-type street sweeper as necessary or as directed.

#### 1.2 EROSION/SEDIMENTATION CONTROL AND ABATEMENT

- A. The CONTRACTOR shall be responsible for collecting, storing, hauling, and disposing of spoil, silt, and waste materials in compliance with applicable federal, state, and local rules and regulations and the Contract Documents.
- B. Install and maintain erosion and sediment control measures, such as swales, grade stabilization structures, berms, dikes, waterways, filter fabric fences, and sediment basins.
- C. Filter fabric barrier systems, if used, shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.
- D. Remove and dispose of sediment deposits at the designated spoil area. If a spoil area is not indicated, dispose of sediment off-Site at a location not in or adjacent to a stream or floodplain. Sediment to be placed at the spoil area should be spread evenly, compacted, and stabilized. Sediment shall not be allowed to flush into a stream or drainage way.

- E. The CONTRACTOR shall not permit any runoff water from disturbed surfaces, water from dewatering operations that becomes contaminated with silt, much or other deleterious matter, fuels, oils, bitumens, chemicals or other polluting materials.
- F. Maintain erosion and sediment control measures until final acceptance or until requested by the ENGINEER to remove it.

### 1.3 STORMWATER POLLUTION PREVENTION

- A. The CONTRACTOR shall prepare and comply with the requirements of a Stormwater Pollution Prevention Plan as required by the Utah Division of Water Quality to prevent discharge to the storm water collection and conveyance system. (This includes catch basin filters, washdown materials, etc.)

### 1.4 RUBBISH CONTROL

- A. During the progress of the WORK, the CONTRACTOR shall keep the Site and other areas for which it is responsible in a neat and clean condition and free from any accumulation of rubbish. The CONTRACTOR shall dispose of rubbish and waste materials of any nature and shall establish regular intervals of collection and disposal of such materials and waste. The CONTRACTOR shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal and in conformance with applicable safety laws and the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

### 1.3 CHEMICALS

- A. Chemicals used on the WORK or furnished for facility operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer. In addition, see the requirements set forth in paragraph 6.11 of the General Conditions.

### 1.4 CULTURAL RESOURCES

- A. The CONTRACTOR's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archaeological, or cultural resources (hereinafter called "cultural resources").
- B. In the event potential cultural resources are discovered during subsurface excavations at the Site, the following procedures shall be instituted:
  - 1. The OWNER will issue a temporary Notice to Suspend Work directing the CONTRACTOR to cease construction operations at the location of such potential cultural resources find.
  - 2. The suspension Notice will contain the following:
    - a. A clear description of the WORK to be suspended

- b. Instructions regarding issuance of further orders by the CONTRACTOR for material services
  - c. Guidance as to the action to be taken on subcontracts
  - d. Suggestions to the CONTRACTOR to minimize incurred costs
  - e. Estimated duration of the temporary suspension.
- 3. Such suspension shall be effective until such time as a qualified archeologist can assess the value of the potential cultural resources and make recommendations to authority having jurisdiction.
  - 4. The OWNER will implement appropriate actions as directed by the State of Utah. The CONTRACTOR shall cease WORK in the area of a discovery until appropriate actions have been determined in accordance with this paragraph.
  - 5. If human remains are discovered, WORK in the immediate vicinity of the find shall stop. The County Coroner shall be notified.
- C. If the archeologist determines that the potential find is a bonafide cultural resource, at the direction of the State of Utah, the OWNER will extend the duration of the suspension.
  - D. Changes to the Contract Price and Contract Times for suspension due to discovery of a potential cultural resource shall be determined with the OWNER.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## **SECTION 01 60 00 – PRODUCTS, MATERIALS, EQUIPMENT, AND SUBSTITUTIONS**

### **PART 1 – GENERAL**

#### **1.1 DEFINITIONS**

- A. The word "Products," as used in the Contract Documents, is defined to include purchased items for incorporation into the WORK, regardless of whether specifically purchased for the project or taken from CONTRACTOR's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form WORK. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," "special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.
- B. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying, and erection of the WORK.

#### **1.2 QUALITY ASSURANCE**

- A. Source Limitations: To the greatest extent possible for each unit of WORK, the CONTRACTOR shall provide products, materials, and equipment of a singular generic kind from a single source.
- B. Compatibility of Options: Where more than one choice is available as options for CONTRACTOR's selection of a product, material, or equipment, the CONTRACTOR shall select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material, and equipment selections.

#### **1.3 PRODUCT DELIVERY AND STORAGE**

- A. The CONTRACTOR shall deliver and store the WORK in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the CONTRACTOR shall ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

#### **1.4 TRANSPORTATION AND HANDLING**

- A. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.
- B. The CONTRACTOR shall provide equipment and personnel to handle products, materials, and equipment, including those furnished by OWNER, by methods to Prevent soiling and damage.

- C. The CONTRACTOR shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

#### 1.5 STORAGE AND PROTECTION

- A. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate-controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.
- B. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.
- C. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
- D. Storage shall be arranged to provide access for inspection. The CONTRACTOR shall periodically inspect to assure products are undamaged and are maintained under required conditions.
- E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.
- F. If the CONTRACTOR will be using the OWNER's wastewater treatment facility for storage, products shall be stored in a location and manner requested by the OWNER.

#### 1.6 PROPOSED SUBSTITUTIONS OR "OR-EQUAL" ITEM

- A. Whenever materials or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular manufacturer, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of other manufacturers may be accepted if sufficient information is submitted by the CONTRACTOR to allow the ENGINEER to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:
  - 1. The burden of proof as to the type, function, and quality of any such substitution product, material or equipment shall be upon the CONTRACTOR.
  - 2. The ENGINEER will be the sole judge as to the type, function, and quality of any such substitution and the ENGINEER's decision shall be final.
  - 3. The ENGINEER may require the CONTRACTOR to furnish additional data about the proposed substitution.
  - 4. The OWNER may require the CONTRACTOR to furnish a special performance guarantee or other surety with respect to any substitution.
  - 5. Acceptance by the ENGINEER of a substitution item proposed by the CONTRACTOR shall not relieve the CONTRACTOR of the responsibility for full compliance with the Contract Documents and for adequacy of the substitution.



6. The CONTRACTOR shall pay all costs of implementing accepted substitutions, including redesign and changes to WORK necessary to accommodate the substitution.
- B. The procedure for review by the ENGINEER will include the following:
1. If the CONTRACTOR wishes to provide a substitution item, the CONTRACTOR shall make written application to the ENGINEER on the "Substitution Request Form."
  2. Unless otherwise provided by law or authorized in writing by the ENGINEER, the "Substitution Request Form(s)" shall be submitted within the 30-day period after award of the Contract.
  3. Wherever a proposed substitution item has not been submitted within said 30-day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by the ENGINEER, the CONTRACTOR shall provide the material or equipment indicated in the Contract Documents.
  4. The CONTRACTOR shall certify by signing the form that the list of paragraphs on the form are correct for the proposed substitution.
  5. The ENGINEER will evaluate each proposed substitution within a reasonable period of time.
  6. As applicable, no shop drawing submittals shall be made for a substitution item nor shall any substitution item be ordered, installed, or utilized without the ENGINEER'S prior written acceptance of the CONTRACTOR'S "Substitution Request Form."
  7. The ENGINEER will record the time required by the ENGINEER in evaluating substitutions proposed by the CONTRACTOR and in making changes by the CONTRACTOR in the Contract Documents occasioned thereby.
- C. The CONTRACTOR's application shall address the following factors which will be considered by the ENGINEER in evaluating the proposed substitution:
1. Whether the evaluation and acceptance of the proposed substitution will prejudice the CONTRACTOR's achievement of Substantial Completion on time.
  2. Whether acceptance of the substitution for use in the WORK will require a change in any of the Contract Documents to adapt the design to the proposed substitution.
  3. Whether incorporation or use of the substitution in connection with the WORK is subject to payment of any license fee or royalty.
  4. Whether all variations of the proposed substitution from the items originally specified are identified.
  5. Whether an itemized estimate is included of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and

claims of other contractors affected by the resulting change.

6. Whether the proposed substitute item meets or exceeds the experience and/or equivalency requirements listed in the appropriate technical specifications.
- D. Without any increase in cost to the OWNER, the CONTRACTOR shall be responsible for and pay all costs in connection with proposed substitutions and of inspections and testing of equipment or materials submitted for review prior to the CONTRACTOR's purchase thereof for incorporation in the WORK, whether or not the ENGINEER accepts the proposed substitution or proposed equipment or material. The CONTRACTOR shall reimburse the OWNER for the charges of the ENGINEER for evaluating each proposed substitution.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## **SECTION 01 74 20 – GRAVITY PIPELINE TESTING**

### **PART 1 – GENERAL**

#### **1.1 THE SUMMARY**

1.2 The CONTRACTOR shall test sanitary system pipelines in accordance with the Contract Documents. The CONTRACTOR shall perform all pipeline flushing and testing, complete, for gravity pipelines as specified herein and in accordance with the requirements of the Contract Documents.

1.3 The CONTRACTOR shall be responsible for conveying test water from the OWNER-designated source to the point of usage and also for disposal, as required, or water used in the testing operations.

#### **1.4 CONTRACTOR SUBMITTALS**

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Furnish:

1. A testing plan and schedule including methods for water conveyance, control, leak testing, and water disposal shall be submitted in writing for approval.
2. The CONTRACTOR shall also submit minimum 48-hour advance written notice of any gravity pipeline test to the ENGINEER prior to commencing.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

A. All gravity pipelines shall be tested.

B. Gravity sewer pipes and service laterals shall be tested for exfiltration or infiltration and deflection as indicated. Manholes shall be tested for leakage prior to backfill placement, whereas pipes shall be backfilled prior to testing. The maximum length of pipe tested shall be the 4 reaches between 5 manholes. Leakage tests shall be completed and approved prior to placing of permanent resurfacing of pavement. When leakage or infiltration exceeds the allowed amount, the CONTRACTOR shall locate the leaks and make the necessary repairs or replacements to reduce the leakage or infiltration to the allowable limits. Individually detectable leaks shall be repaired, regardless of whether the test results are acceptable or not.

C. Unless otherwise indicated, water for testing will be furnished by the OWNER; however, the CONTRACTOR shall convey the water from the OWNER-designated source to the points of use.

D. No materials shall be used which would be injurious to pipeline structure and future function. Air test gauges shall be laboratory-calibrated test gauges, and if required by the ENGINEER, shall be recalibrated by a certified laboratory prior to the leakage test. Air test gauges shall have a size and pressure range appropriate for the pipe being tested.

- E. Testing operations shall be performed in the presence of the ENGINEER.

### 3.2 TESTING SCHEDULE

#### A. Leakage Tests

1. Perform the type of leakage tests determined from the table below, based on pipe size, slope between manholes (Criterion 1), and difference in water levels (Criterion 2).

	Criterion 1		Criterion 2	
Nominal Pipe Size	Manhole Delta H, feet		Test Water vs Ground Water Delta H, feet	
	Less than or equal to 10 ft	greater than 10 ft	greater than or equal to 4 ft	less than 4 ft
less than or equal to 24 inches	See Criterion 2	Infiltration or Air See Note 1	Exfiltration	Infiltration or Air
greater than 24 inches	See Criterion 2	See Criterion 2	Exfiltration	Infiltration

#### Notes:

1. If ground water is present, perform an infiltration test or air test at the option of the CONTRACTOR; if no ground water is present, perform an air test.
2. Definitions
  - a. Delta H is the difference between 2 elevations, expressed in feet.
  - b. Manhole Delta H is the invert elevation difference in 2 adjacent manholes.
  - c. Test Water vs Ground Water Delta H is the required elevation of water surface for testing minus the average elevation of ground water adjacent to the pipe to be tested. Units are feet.
- B. Deflection Tests: Flexible pipe 30-inches and smaller shall be tested for deflection by the mandrel test. Larger flexible pipe shall be tested by a method approved by the ENGINEER. Excessively deflected pipe shall be removed and replaced.

### 3.3 WATER EXFILTRATION TEST

- A. Each section of sewer shall be tested between successive manholes by closing the lower end and the inlet sewers of the upper manhole with stoppers or inflatable plugs. The pipe and manhole shall be filled with water to a point 4-feet above the centerline of the sewer at the center of the upper manhole; or if ground water is present, 4-feet above the average adjacent ground water level, whichever is higher.

- B. Water shall remain in the pipe for at least one hour or until the water level stabilizes, whichever is longer, before the test begins. The minimum test duration shall be 4 hours. Unless indicated otherwise, the CONTRACTOR shall measure exfiltration. Measure the amount of water added to the upstream manhole to maintain the water level at the elevation set above. Compare the amount added to the allowable leakage calculated below, and if the amount added is equal to or less than the allowable amount, the tested section of the pipe has passed.
- C. The allowable leakage will be computed by the formula:

$$E = 0.000012 LD (H)^{1/2}$$

Where:

E = Allowable leakage in gallons per minute of sewer tested.

L = Length of sewer and house connections tested, in feet.

D = Internal diameter of the pipe in inches.

H = Elevation difference in feet between the water surface in the upper manhole and the centerline of the pipe at the lower manhole; or if ground water is present above the centerline of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the ground water at the lower manhole.

### 3.4 WATER INFILTRATION TEST

- A. The end of the sewer at the upper structure shall be closed to prevent the entrance of water, and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.
- B. The infiltration into each individual reach of sewer between adjoining manholes shall not exceed that allowed by the formula above, where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream manhole.
- C. Unless otherwise indicated, infiltration shall be measured by the CONTRACTOR.

### 3.5 AIR PRESSURE TEST

- A. The CONTRACTOR shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the ENGINEER.
- B. The CONTRACTOR may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of the service laterals. Such tests will be considered to be for the CONTRACTOR's convenience and need not be performed in the presence of the ENGINEER.
- C. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the pipe and the upper ends of all service laterals. Prior to insertion in the sewer, each plug shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released and the leaks

eliminated or the plug replaced.

- D. The test of the pipe and service laterals shall be conducted in the presence of the ENGINEER. Testing of pipe, regardless of the pipe material, shall be performed in accordance with ASTM F 1417 - Standard Test Method for Installation of Plastic Gravity Sewer Line Using Low Pressure Air.
- E. Air pressure in the sewer line shall be increased to 4.0 psi above groundwater pressure (1.0 psi for each 2.3 feet of water elevation above the highest point of the pipe). Do not allow the pressure at any point in the pipe to reach 9 psi under any circumstances. Allow the pressure to stabilize for 5 minutes, then reduce the pressure to 3.5 psi above groundwater pressure and start the test. Stop the air release and record the decrease in pressure over time.
- F. Pass/Fail Criterion: The time taken for the pressure to decrease from 3.5 to 2.5 psi above groundwater pressure shall be equal to or greater than the time below.

<b>Nominal Pipe Diameter, inches</b>	<b>Minimum Time, min:sec</b>	<b>Length for Minimum Time, ft</b>	<b>Increased Time for Longer Lengths, seconds per foot</b>
4	3:46	597	.0380
6	5:40	398	0.854
8	7:34	298	1.520
10	9:26	239	2.374
12	11:20	199	3.418
18	17:00	133	7.692
24	22:40	99	13.674
30	28:20	80	21.366
36	34:00	66	30.768

- G. Testing criteria of pipe 12-inches and larger may be adjusted if the ENGINEER approves. The air pressure decrease may be 0.5 psi instead of 1.0 psi, and the corresponding minimum times will be one-half of the tabulated times.
- H. For pipe larger than 24-inches, air pressure tests may be performed on each joint. The time for the pressure to fall from 3.5 to 2.5 psi, both above groundwater pressure, shall not be less than 10 seconds regardless of pipe diameter.
- I. If the time is less than the allowable time, the pipe will be considered defective and shall be repaired and retested.

### 3.6 DEFLECTION TEST

- A. All PVC pipe larger than 4-inch diameter shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the ENGINEER as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the CONTRACTOR.

END OF SECTION

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## **SECTION 01 75 00 – EQUIPMENT TESTING AND STARTUP**

### **PART 1 – GENERAL**

#### **1.1 THE SUMMARY**

- A. Equipment testing and startup is prerequisite to satisfactory completion of the contract requirements and shall be completed within the Contract Times.
- B. Conduct all test, check out, startup, and related requirements indicated in the Contract Documents and provide documentation of same to the ENGINEER prior to requesting Substantial Completion from the ENGINEER. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup.
- C. All testing shall be witnessed by the ENGINEER or OWNER to be considered valid.
- D. General requirements for startup activities are included in this Section. More specific requirements may also be included in other portions of the Contract Documents.
- E. Temporary facilities may be necessary. If so, CONTRACTOR shall design, provide, operate, and later decommission them.
- F. The CONTRACTOR shall furnish all personnel, necessary equipment, facilities, and services required for conducting the tests.
- G. The CONTRACTOR shall commence and complete all testing during the normal working hours and workweek. Testing shall not occur on holidays.

#### **1.2 DEFINITIONS**

- A. Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion.

#### **1.3 SUBMITTALS**

- A. Schedule: The schedule for startup shall be submitted under Section 01 32 16 – CPM Construction Schedule.
- B. Startup Plan: Not less than 60 Days prior to startup, submit for review a detailed Startup Plan. The CONTRACTOR shall revise the Plan as necessary based on review comments. The Plan shall include:
  - 1. Safety, startup, and testing procedures and proposed inspection and certification forms and records.
  - 2. Trenchless installation of sewer main across State Highway 201. Schedule and plan shall indicate permitting, coordination with impacted owners, and all major milestones in the trenchless installation process (site preparation, utility relocation, micro-tunneling, carrier pipe installation, monitoring, annular space filling, corrosion protection, etc.).
  - 3. Interconnection of new to existing facilities

- a. Date and time frame of proposed shutdown or interconnection, including sequence of events and activities to be conducted.
  - b. A detailed description of sequences and activities for the planned shutdown and interconnection.
  - c. Staff, equipment, and materials that will be at the Site before commencing the shutdown.
- 4. Hydrostatic testing of water-holding structures and pipelines and other potable water equipment. Schedule and plan shall indicate source of water, testing and disinfection sequence, disinfection procedures, and the disposal of the water following disinfection.
- C. System Outage Requests: Request for shutdown of existing systems as necessary to test or start up new facilities.
- D. Records and Documentation
  - 1. Where required by the specifications, submit equipment installation certifications and testing under those Sections.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## **SECTION 01 77 00 – PROJECT CLOSEOUT**

### **PART 1 -- GENERAL**

#### **1.1 ACCEPTANCE**

- A. WORK shall be accepted only after the Contractor receives written notice from the Engineer that the work installed complies with and satisfies the intent of the Contract Documents.
- B. The CONTRACTOR shall promptly remove from the vicinity of the completed WORK, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the WORK by the OWNER will be withheld until the CONTRACTOR has satisfactorily performed the final cleanup of the Site.

#### **1.2 CONDITIONS PRIOR TO CLOSEOUT**

The CONTRACTOR shall fulfill all the requirements of the General Conditions of the Contract which apply and form a part of these specifications. These requirements shall include, but not be limited to the following:

- Clean-up;
- Guarantee;
- Bonds;
- Affidavits;
- Record drawings;
- Final inspection requirements;
- Manufacturer's certification of proper installation;
- Testing;
- Restoration of damages;
- Removal of Contractor-Owned items;
- Manufacturer's equipment or product warranty; and,
- Operation and Maintenance Manuals.

#### **1.3 CLOSEOUT PROCEDURES**

- A. The CONTRACTOR shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the OWNER, the ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.
- B. The CONTRACTOR shall perform all closeout procedures in the presence of the ENGINEER and a representative of the Owner.
- C. The CONTRACTOR shall sequence closeout procedures properly so that work will not be endangered or damaged, and so that every required performance will be fully tested and demonstrated.
- D. The CONTRACTOR shall check each item in each system to determine that it is

set for proper operation. With the ENGINEER and the OWNER's representative present, the CONTRACTOR shall demonstrate that all equipment and appurtenances are properly installed during a test of appropriate duration as specified elsewhere.

- E. The OWNER and/or OWNER'S DESIGNEE shall make a final inspection when the CONTRACTOR notifies the OWNER that WORK is ready for inspection. Any work not found acceptable and requiring repair, replacement or other corrective measures will be documented on a final punch list.
- F. Once the CONTRACTOR has completed items from the final punch list, the OWNER and/or OWNER'S DESIGNEE shall inspect those items again. If WORK still requires changes, the CONTRACTOR shall proceed with addressing said item(s) until the OWNER and/or OWNER'S DESIGNEE is satisfied that the WORK in entirety is properly and satisfactorily constructed and operational in accordance with the requirements of the CONTRACT DOCUMENTS.
- G. WORK subject to final inspection and accepted by the OWNER and/or OWNER'S DESIGNEE shall be maintained by the CONTRACTOR until OWNER'S final acceptance of all WORK.

#### 1.4 CLOSEOUT SUBMITTALS

- A. The CONTRACTOR, prior to requesting final payment, shall obtain and submit the following items to the ENGINEER for transmittal to the OWNER:
  - 1. Written guarantee of the work performed indicating the Contractor's responsibility to replace any defective material or damage of the work to the satisfaction of the ENGINEER at no cost to the OWNER.
  - 2. Copies of the manufacturer's certification of installation for all major items in the project.
  - 3. All manufacturer's warranties.
  - 4. Technical Manuals and instructions.
  - 5. Maintenance stock items; spare parts; special tools.
  - 6. Completed record drawings.
  - 7. Certificates of inspection and acceptance by local governing agencies having jurisdiction.
  - 8. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.
  - 9. Surety Corporation Maintenance Bond and/or other Bonds or Sureties as otherwise provided in the CONTRACT and such Bond or Sureties shall remain in full force and effect for a period of one (1) year from the date of acceptance of the WORK unless otherwise provided in the CONTRACT.
- B. The CONTRACTOR shall submit two (2) applications for payment upon completion of WORK.

1. The first application shall indicate 100% completion for all work under this CONTRACT but shall not include any retainage. The second application shall indicate an application for the retainage amount of the CONTRACT.

1.5 FINAL CLEANUP

- A. The CONTRACTOR shall promptly remove from the vicinity of the completed WORK, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the WORK by the OWNER will be withheld until the CONTRACTOR has satisfactorily performed the final cleanup of the Site.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## SECTION 01 95 00 – BID ALLOWANCES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. Listing of allowance items to be included in the Contractor's bid as outlined in Section 00 41 00 - Bid Forms.
  - 1. The allowance amount is shown in the event that unforeseen utility conflicts arise and additional coordination, relocation, and other related ancillary tasks are needed for completion of the WORK.

#### 1.2 ALLOWANCE AMOUNTS

- A. Contractor shall include the following allowance amount in the contract for addressing unforeseen utility conflicts needed for the completion of the WORK: \$ 25,000.00

#### 1.3 COSTS INCLUDED AND EXCLUDED IN ALLOWANCES

- A. Costs included in allowances:
  - 1. Relocation of unforeseen utilities in conflict with the sewer main or trenchless installation infrastructure that are not already identified in the Contract Documents.
- B. Costs to be included in Contractor's Bid Price, but not included in allowances:
  - 1. Relocation of utilities already identified in the Contract Documents.
  - 2. Potholing and other existing utility investigations.
  - 3. Other expenses required to complete the WORK.

#### 1.4 DUTIES OF CONTRACTOR IN PROVIDING UTILITY RELOCATION BY ALLOWANCE

- A. Advise Engineer immediately of utility conflicts not identified in the Contract Documents to avoid impacts to Progress Schedule.
- B. If the Engineer and Contractor are unable to resolve the utility conflict with sewer design adjustments, notify conflicting utility owner immediately and begin coordination efforts for resolving the conflicting utility issue.
- C. Advise the Engineer and Owner of the proposed solution to the utility conflict(s) and proposed cost of the solution.
- D. Proceed with resolving the utility conflict per agreed upon solution once notified by the Owner. Agreed upon cost of solution shall be billed against the allowance amount.
- E. If the project work is completed without unforeseen utility relocations, the allowance amount shall be deducted from the contract price by change order.

#### 1.5 ADJUSTMENT OF COSTS

- A. When the actual cost is more or less than the amount of allowance, Contract Price will be adjusted by Change Order.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION



## SECTION 01 95 10 – BID ALTERNATES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. Identification and description of Bid Alternate Items as shown on the Bid Form in Section 00 41 00.

#### 1.2 PROCEDURES

- A. Alternates will be exercised at OWNER's option.
- B. Coordinate related work and modify surrounding work as required to complete the WORK, including changes under Alternates accepted by OWNER in Notice of Award.

#### 1.3 ALTERNATES

- A. Bid Alternate A – Relocate Mountain, LTD fiber optic line for trenchless reception shaft installation:
  - 1. Coordinate fiber optic line relocation with Mountain, LTD
  - 2. Perform all duties of utility relocation required to install the trenchless reception shaft.
  - 3. Related drawings:
    - a. The following drawings are related to the WORK described in this Section. The drawings listed are to show the potential conflict between the trenchless reception shaft and fiber optic line.
      - C-7
      - C-8
    - b. This list of related drawings is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed WORK complies accurately with the Contract Documents.
- B. Bid Alternate B – Relocate Rocky Mountain Power, a division of PacifiCorp (RMP), underground primary wire:
  - 1. The Contractor shall:
    - a. Provide all necessary trenching and backfilling per agreed upon conduit routing between RMP, the ENGINEER, and the OWNER per Section 31 30 00 Earthwork.
    - b. Provide asphalt repairs per Section 32 11 13 A.C. Pavement and Base.
    - c. Furnish and install all distribution transformer pads, conduit, and ducts required by RMP.
    - d. Establish final grade for routing of circuits, placement of transformer pads, vaults, junction boxes and other underground facilities as required by RMP.
    - e. Install and maintain property lines and survey stakes.

- f. Make no permanent surface improvements, except curb and gutters, before RMP completes installation of its facilities.
  - g. Provide legal rights-of-way to RMP, at no cost to RMP, using RMP's standard forms.
- 2. Related drawings:
  - a. The following drawings are related to the WORK described in this Section. The drawing listed is to show the potential conflict between RMP utilities and the proposed SSMH-11.
    - C-7
  - b. This list of related drawings is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed WORK complies accurately with the Contract Documents.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

## **SECTION 02 22 00 - SITE CONDITION SURVEYS**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. The CONTRACTOR shall conduct thorough pre-construction and post-construction Site Condition Survey of the entire Project. Site Condition Survey shall consist of photographs, videotape recordings, and topographic mapping.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Photographs, and other data of the preconstruction conditions shall be submitted to the ENGINEER for record purposes prior to, but not more than three weeks before, commencement of any construction activities.
- B. Except as otherwise indicated, post-construction topographic mapping shall be submitted to the ENGINEER within 60 days of completing WORK.
- C. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the OWNER and ENGINEER.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### **3.1 PHOTOGRAPHS**

- A. CONTRACTOR, as a minimum, shall document pre- and post-construction conditions by taking photograph surveys of the following:
  - 1. Roadways used to access the Site or haul materials and equipment to the Site.
  - 2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, designated tunnel launch and reception shaft locations, and staging areas.
  - 3. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.
  - 4. Driveways, sidewalks, curbs/gutters, roadway signage and above ground infrastructure, and buildings which might be affected by the WORK.
  - 5. Utility markings by owners of utilities prior to beginning construction.
- B. Supplement photograph surveys with spot elevation surveys as required to thoroughly document the original condition and location of existing features and facilities.

### 3.2 TOPOGRAPHIC MAPPING

- A. Topographic mapping shall be developed using the Project coordinates, shall be referenced to the Project base lines and benchmarks, and shall be adequate to ascertain pre-construction and post-construction elevations of all public and private property within and adjacent to the construction limits
- B. Topographic mapping shall be conducted to document the post-construction topography of the Site.
- C. Spot elevation surveys used to document the elevation on abutting roadways, drives, and walks shall be taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the WORK.
- D. All pre- and post-construction topographic mapping and other data, including spot elevations, shall be prepared and sealed by a Professional Land Surveyor.
- E. All pre- and post-construction survey data shall be furnished as follows:
  - 1. Site mapping shall be submitted as a separate electronic drawing in AutoCAD Release 17, or later.
  - 2. Each AutoCAD site map shall also be submitted in hard copy plot format (six copies).
  - 3. ENGINEER will review hardcopy plots for accuracy relative to the indicated requirements.
  - 4. CONTRACTOR shall amend mapping files as required, based on ENGINEER's comments.
  - 5. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of 1"=20' horizontal and 1-foot contour intervals as specified for National Map Accuracy Standards.
  - 6. Electronic mapping files shall be three-dimensional.
  - 7. Submit points lists for all topographic surveys in ASCII text file format.
  - 8. All files shall be copied to one or more compact discs in a format acceptable by CONSTRUCTION MANAGER.
  - 9. Submit six copies of the compact discs.

END OF SECTION

## **SECTION 03 31 50 – CAST-IN-PLACE CONCRETE**

### **PART 1 -- GENERAL**

#### **1.1 THE REQUIREMENT**

- A. The WORK of this Section includes sub-grade preparation and construction of concrete collars, bases, and thrust blocking of the kind and design specified, at the locations shown in the Plans or where designated by the ENGINEER in accordance with these Specifications and in conformity to the lines and grades as staked. Work on this project shall conform to requirements of the Utah APWA Manual of Standard Specifications, 2017 Edition, except as modified by these Contract Documents.

#### **1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Specifications:

- 1. Section 31 30 00 – Earthwork

- B. Referenced Standards: This Section incorporates by reference the Utah APWA Manual of Standard Specifications, 2017 Edition. They are part of this Section. In case of conflict between the requirements of this Section and the APWA Standard Specifications, the CONTRACTOR shall point out the conflict to the Project Representative; lacking a definitive answer otherwise, the requirements of the Contract Specifications shall prevail.

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with requirements of Section 01 33 00 – CONTRACTOR Submittals and the following:
  - 1. Written list identifying the supplier(s) from which the materials are to be obtained.
  - 2. Certificates, signed by the materials producer and the paving subcontractor, stating that materials meet or exceed the specified requirements.
  - 3. The mixing plant shall submit available past compressive strength test data on the proposed mix design on proposed mix design.
  - 4. Ready-mix delivery ticket for each truck.

### **PART 2 -- PRODUCTS**

#### **2.1 MATERIALS**

- A. Portland Cement, aggregates, pre-molded joint filler, and curing materials and admixtures shall meet the requirements of Utah APWA Manual of Standard Specifications Section 03 30 04 Concrete.

### **PART 3 -- EXECUTION (NOT USED)**

END OF SECTION

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## **SECTION 03 60 00 - GROUTING**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents.
- B. The following types of grout are covered in this Section:
  - 1. Cement Grout
  - 2. Non-Shrink Grout - Class I (cement-based)
  - 3. Non-Shrink Grout - Class II (cement-based)
  - 4. Epoxy Anchor Grout for Adhesive Anchors
  - 5. Topping Grout and Concrete/Grout Fill

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
  - 1. Certified testing lab reports for tests indicated herein.
  - 2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.
  - 3. Certifications that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
  - 4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. The current ICC-ES or IAPMO-UES report shall be submitted for all epoxy anchor grouts for adhesive anchors.
  - 5. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.
  - 6. Submit manufacturer's written warranty as indicated herein.
  - 7. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

#### **1.3 QUALITY ASSURANCE**

- A. Field Tests
  - 1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.

2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink), at intervals during construction selected by the ENGINEER. As a minimum, a set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 31 50 - Cast-in-Place Concrete, at intervals during construction selected by the ENGINEER.
4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C 579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes, Method B, at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.
5. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.
6. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03 31 50 unless indicated otherwise.

## PART 2 -- PRODUCTS

### 2.1 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Anchor bolts, anchor rods and reinforcing steel required to be set in grout that is not in high temperature or high fire risk areas.	Epoxy Anchor Grout
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink - Class I (Class II where placement time exceeds 20 min.)
Toppings and concrete/grout fill less than 3-inches thick	Topping Grout
Toppings and concrete/grout fill greater than 3-inches thick	Structural Concrete per 03 31 50
Surface repairs	Cement Grout



Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material	Non-Shrink - Class I or
Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials	Non-Shrink - Class II
Any application not listed above, where grout is indicated	Non-Shrink Class I, unless specifically indicated otherwise

## 2.2 CEMENT GROUT

- A. Cement grout shall be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4000 psi.
- B. Cement grout materials shall be as indicated in Section 03 31 50.

## 2.3 NON-SHRINK GROUTS (cement-based)

### A. General

1. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.
2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
3. Grout shall not contain chlorides or additives that may contribute to corrosion.
4. Grout shall be formulated to be used at any consistency from fluid to plastic.
5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:
  - a. Minimum tensile splitting strength of 500 psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
  - b. Minimum flexural strength of 1000 psi per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
  - c. Minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
  - d. Grout shall be certified for use in freeze/thaw environments.

B. Non-Shrink Grout – Class I

1. Non-Shrink Grout – Class I shall have a minimum 28 Day compressive strength of 5000 psi when mixed at a fluid consistency.
2. Non-Shrink Grout – Class I shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.
3. Non-Shrink Grout – Class I shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures. The grout when tested shall not bleed or segregate at maximum allowed water.
4. Non-Shrink Grout – Class I shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090 – Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
5. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.
6. Non-Shrink Grout – Class I shall be **Masterflow 713 Plus** by **MBT/Degussa Building Systems**, **Five Star Grout** by **Five Star Products**, **Sikagrout 212** by **Sika Corporation**, **Premier** by **L&M Construction Chemicals**; **High-Flow Grout** by **Euclid Chemical Company**, **CG 200 PC** by **Hilti**, or equal.

C. Non-Shrink Grout – Class II

1. Non-Shrink Grout – Class II shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7500 psi, when mixed at a fluid consistency.
2. Non-Shrink Grout – Class II shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827.
3. Non-Shrink Grout – Class II shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.
4. Non-Shrink Grout – Class II shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.
5. Non-Shrink Grout – Class II shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
6. The grout when tested shall not bleed or segregate at maximum allowed water content.
7. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.

8. Non-Shrink Grout – Class II shall be **Masterflow 928** by **MBT/Degussa Building Systems**, **Five Star Fluid Grout 100** by **Five Star Products**, **Crystex** by **L&M Construction Chemicals**, or equal.

#### 2.4 EPOXY ANCHOR GROUT

- A. Epoxy anchor grout shall conform to ASTM C 881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete, Type IV, Class A, B and C, Grade 3 with the exception of gel time.
- B. Heat deflection temperature per ASTM D 648 – Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position shall be a minimum 120 degrees F.
- C. Manufacturer shall certify that the epoxy anchor grout will maintain 90 percent of its strength up to a temperature of 125 degrees F.
- D. Grout shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.
- E. Epoxy anchor grout shall be capable of being used in submerged applications once cured.
- F. Compressive strength per ASTM D 695 – Standard Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.
- G. If the average working or operating temperature will be over 100 degrees F or in a high fire risk area, use cement based non-shrink grout and oversized holes.
- H. Overhead anchors and anchors in fire-resistive construction shall be cast-in anchors.
- I. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.
- J. Epoxy anchor grout shall be **Epcon C6** by **ITW Ramset/Red Head**; **Power-Fast Epoxy Injection Gel** by **Powers Fasteners**; **RE 500** by **Hilti**, **Sikadur AnchorFix-4**, or equal.

#### 2.5 TOPPING GROUT AND CONCRETE/GROUT FILL

- A. Where fill thickness is 3 inches or greater, structural concrete as indicated in Section 03 31 50 – Cast-in-Place Concrete, may be used when accepted by the ENGINEER. Fiber reinforcing shall be as indicated below.
- B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and be mixed as indicated. Materials and procedures indicated for structural concrete in Section 03 31 50 – Cast-in-Place Concrete, shall apply unless indicated otherwise.
- C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45.
- D. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent By Weight Passing
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

- E. Final mix design shall be as determined by trial mix design as indicated in Section 03 31 50, except that drying shrinkage tests are not required.
- F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 31 50.
- G. **Strength:** Minimum compressive strength of topping grout and concrete/grout fill at 28 Days shall be 4000 psi.

## 2.6 CURING MATERIALS

- A. Curing materials shall be in accordance with Section 03 31 50 and as recommended by the manufacturer of prepackaged grouts.

## 2.7 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.
- B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4 inches.

## 2.8 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

# PART 3 -- EXECUTION

## 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Grout shall be stored in accordance with manufacturer's recommendations.

### 3.2 GENERAL

- A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.
- B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.
- C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.
- D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 31 50. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.
- G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

### 3.3 GROUTING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.
  - 1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.
  - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted by the CONTRACTOR for acceptance by the ENGINEER.
  - 3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.
- C. Drilled Anchors and Reinforcing Bars

## 1. General

- a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the manufacturer's instructions.
- b. The CONTRACTOR shall identify the position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in drilling to avoid damaging existing reinforcing or embedded items. The location of drilled holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

## 2. Epoxy Adhesive Anchors

- a. Grout shall be proportioned and mixed per the manufacturer's instructions.
- b. Holes shall be dry.

## 3. Cement Based Non-Shrink Grout

- a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using cement based non-shrink grout, Class I.
- b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.
- c. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one-inch, the hole diameter should be at least twice the bolt diameter.
- d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
- e. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

## D. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively where accepted by the ENGINEER, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall

expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.

2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping and fill. No topping concrete shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.
4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.
6. As soon as topping or fill finishing is completed, coat surface with curing compound.

#### 3.4 CONSOLIDATION

- A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

#### 3.5 CURING

- A. Cement based grouts shall be cured per 03 31 50 and per the manufacturer's recommendations.

END OF SECTION

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## **SECTION 31 23 19 - DEWATERING**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. The CONTRACTOR shall dewater trench and structure excavations, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section of the Specifications.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations. The detailed plan shall include mitigation measures to prevent settlement of nearby structures and a contingency plan for restoring nearby structures if settlement is observed as a result of the CONTRACTOR's dewatering operations. The CONTRACTOR may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The CONTRACTOR's dewatering plan is subject to review by the ENGINEER.

#### **1.3 QUALITY CONTROL**

- A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.
- B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.

### **PART 2 -- PRODUCTS**

#### **2.1 EQUIPMENT**

- A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL REQUIREMENTS**

- A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

- B. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.
- C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.
- D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.
- F. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.
- G. Flotation shall be prevented by the CONTRACTOR by maintaining a positive and continuous removal of water. The CONTRACTOR shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.
- H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the CONTRACTOR shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.
- I. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.
- J. If any evidence of contamination in the water, based on olfactory or visual indications, cease excavation work until potential risks are evaluated. During evaluation, handle water as a contaminated material.
- K. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.
- L. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the WORK and all costs thereof shall be included in the various contract prices in the Bid Forms, unless a separate bid item has been established for dewatering. The CONTRACTOR shall pay for damages resulting from dewatering operations.

END OF SECTION

## SECTION 31 30 00 - EARTHWORK

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

#### 1.2 REFERENCES

Utah APWA Manual of Standard Specifications, 2017 Edition

Report dated July 15, 2022, prepared by Intermountain GeoEnvironmental Services, Inc., entitled "Geotechnical Investigation: Proposed Sewer Line Installation MWD Sewer Influent Line Project 1B" consisting of 62 pages.

#### 1.3 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit a copy of the Excavation Permit issued by the Salt Lake County Public Works Engineering Department.
- B. Imported backfill materials
  - 1. The CONTRACTOR shall submit mix design for trench zone backfill and bedding material (untreated base course). Provide the following. Allow ENGINEER 10 days to evaluate the submittal.
    - a. Date of mix design. If older than 365 days from date of submission, recertify mix design.
    - b. Name of supplier and aggregate source.
    - c. Target gradation for each sieve size.
    - d. Percent composition of reclaimed asphalt or concrete included in the mix.
    - e. Unit weight, CBR, relative density, and relative moisture content.
    - f. Aggregate physical properties (APWA (Utah) Section 32 11 23 Aggregate Base Courses, Article 2.1). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from date of submission.
- C. Geotextile Fabrics
  - 1. The CONTRACTOR shall submit Manufacturer's certificate that the geotextile fabric complies with requirements of APWA (Utah) Section 31 05 19 Geotextiles.
- D. Shoring
  - 1. The CONTRACTOR shall follow all standards and meet all requirements as specified in APWA (Utah) Section 31 41 00 Shoring.

2. The CONTRACTOR shall submit a trench shoring Protective System plan signed and stamped by a professional engineer registered in the State of Utah.
3. A two (2) Protective System is required. The use of a Trench Box shall be classified as one Protective System.

#### 1.4 QUALITY ASSURANCE

- A. Use a laboratory that complies with ASTM D3740 and Section 01 45 00 requirements.
- B. Reject fill products that do not meet requirements of this section.
- C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.

#### 1.5 ACCEPTANCE

- A. General
  1. Acceptance is by Lot. One (1) lot is one (1) day production.
  2. Dispute resolution, Section 01 35 10.
- B. Roadway Backfill: Sub-lot size is 5,000 tons.

#### 1.6 CODES, ORDINANCES, AND STATUTES

- A. CONTRACTORS shall familiarize themselves with, and comply with, all applicable codes, ordinances, statutes, and bear sole responsibility for the penalties imposed for noncompliance.

#### 1.7 TOLERANCES

- A. All material limits shall be constructed within a tolerance of 0.1 foot except where dimensions or grades are shown or specified as minimum. All grading shall be performed to maintain slopes and drainage as shown. No reverse slopes will be permitted.

#### 1.8 DEWATERING

- A. All excavations shall be properly dewatered in accordance with Section 31 23 19 Dewatering.

### **PART 2 -- PRODUCTS**

#### 2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

- A. The CONTRACTOR shall follow all requirements as specified in APWA (Utah) Section 33 05 20 Backfilling Trenches.
- B. General

1. Fill, backfill, and embankment materials shall be selected or shall be processed with clean fine earth, rock, gravel, or sand, be free from grass, roots, brush, other vegetation and organic matter.
2. Fill and backfill materials that are to be placed within 12 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

C. Trench Zone Backfill Material

1. Trench zone backfill material shall be new untreated base course. Do not use gravel as a base course without Engineer's permission.
2. The CONTRACTOR shall meet all requirements as specified in APWA (Utah) Section 32 11 23 Aggregate Base Courses.

D. Pipe Zone Backfill Material

1. Pipe zone backfill material shall be  $\frac{3}{4}$ " drain rock per Magna Water District standards.

E. Pipe Bedding Material

1. Pipe bedding material shall be new untreated base course unless specified otherwise by pipe manufacturer.
2. The CONTRACTOR shall follow all requirements as specified in APWA (Utah) Section 32 11 23 Aggregate Base Courses.

## 2.2 GEOTEXTILE FABRICS

- A. The CONTRACTOR shall follow all requirements as specified in APWA (Utah) Section 31 05 19 Geotextiles.
- B. The Contractor shall use stabilization-separation geotextiles to wrap around the pipe bedding and pipe zone area.

## 2.3 IDENTIFICATION TAPE

- A. Permanent, bright colored, continuous printed magnetic plastic marker tape shall be placed above buried pipelines.
- B. Identification tape shall be no less than 6-inches wide by 4-mils thick, and green in color.
- C. Tape shall be labeled with CAUTION – BURIED INSTALLATION BELOW.

# PART 3 -- EXECUTION

## 3.1 EXCAVATION AND BACKFILLING - GENERAL

- A. The CONTRACTOR shall follow all requirements as specified in APWA (Utah) Section 31 23 16 Excavation.
- B. General

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions, that would interfere with the proper execution and completion of the WORK.
2. The removal of such materials shall conform to the lines and grades indicated or ordered.
3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.
4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.
5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.
7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the State of Utah.

C. Removal and Exclusion of Water

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavations.
2. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed.

3.2 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.
- B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.
- C. Material shall be disposed of at an approved on-Site disposal area or off-Site at a location arranged by the CONTRACTOR in accordance with laws and regulations regarding the disposal of such material.

3.3 BACKFILL

A. General

1. Backfill shall not be dropped directly upon any structure or pipe.
2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.

3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.
- B. Except for drain rock materials being placed in over-excavated areas or trenches, backfill shall be placed after water is removed from the excavation.
- C. Pre-Placement Conditions
1. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.
  2. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.
- D. Layering
1. Backfill materials shall be placed and spread evenly in layers.
  2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 8 inches in thickness when using riding compaction equipment or 6 inches in thickness when using hand held compaction equipment.
- E. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.
- F. Moisture Content
1. All backfill materials shall be maintained within plus or minus two (2) percent of optimum moisture content at the time of compaction in accordance with ASTM D1557.
  2. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
  3. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

### 3.4 ROADWAY EXCAVATION AND BACKFILL

A. Excavation Beneath Paved Areas

1. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness.
2. After the required excavation has been completed, the top 12 inches of exposed surface shall be stabilized with geotextile.
3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement.
4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

B. Notification of ENGINEER

1. The CONTRACTOR shall notify the ENGINEER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is stabilized or is covered with backfill or with any construction materials.

C. Compaction of Backfill Materials

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.
2. Equipment and methods that are consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.
3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

D. Flooding, ponding, and jetting shall NOT be used for aggregate base materials.

E. Heavy Equipment

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.
2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations. Where hand-operated equipment is required, loose lift thickness of backfill shall be reduced to facilitate adequate compaction of each lift.

F. Layering

1. Fill material shall be placed and spread evenly in approximately horizontal layers.
2. Each layer shall be moistened and aerated as necessary.
3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.
4. The embankment and fill shall be compacted in conformance with Paragraph G, below.

G. Compaction Requirements

1. The CONTRACTOR shall meet all requirements of APWA (Utah) Section 31 23 26 Compaction.
2. Compact the entire area to 96 percent of laboratory determined maximum dry density and eliminate unstable zones.



### 3.5 PIPELINE TRENCH EXCAVATION AND BACKFILL

#### A. Exploratory (Utility Pothole) Excavations

1. The CONTRACTOR shall excavate and expose buried points of connection to existing utilities as indicated.
2. Excavation shall be performed prior to the preparation of Shop Drawings for connections and before the fabrication of the pipe
3. The data obtained from exploratory excavations shall be used in preparing the Shop Drawings.
4. Data, including dates, locations excavated, and dimensioned sketches, shall be submitted to the ENGINEER within one week of excavation.
5. Damage to utilities from excavation activities shall be repaired by the CONTRACTOR in accordance with the General Conditions.

#### B. General

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as shown in the drawings and recommended by the pipe manufacturer. Width is measure at the pipe spring line and includes any necessary sheathing. Follow manufacture's recommendations when using trench boxes.

#### C. Trench Bottom

1. The bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.
2. Foundation stabilization: Get Engineer's permission before installing common fill. Prior to placing backfill, installation of stabilization-separation geotextile will be required to separate backfill material and native subgrade materials if common fill cannot provide a working surface or prevent soils migration.
3. Bedding: Follow APWA (Utah) Section 33 05 20 requirements and the following provisions:
  - a. Maximum loose lift thickness is 8-inches.
  - b. Bedding immediately under the pipe should not be compacted, but loosely placed.
4. Compacted density shall be 96 percent or greater relative to maximum dry density as determined in laboratory by modified proctor test, APWA (Utah) Section 31 23 26.
5. Excavations for pipe bells and welding shall be made as required.
6. Over-Excavation: When ordered or authorized by the ENGINEER, whether indicated on the drawings or not, trenches shall be over-excavated beyond the depth and/or

width shown. Such over-excavation shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Over-excavation less than six (6) inches below the limits on the Drawings shall be done at no increase in cost to the OWNER. When the over-excavation authorized or ordered by the ENGINEER is six (6) inches or greater below the limits shown, or wider, additional payment may be made to the CONTRACTOR. Said additional payment will be made under separate unit price bid items for over-excavation.

#### D. Open Trenches

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.
2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.
3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

#### E. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.
2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.
3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.
4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.
5. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.
6. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

#### F. Placing and Spreading of Backfill Materials

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor approved by the ENGINEER.

2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of:
    - a. one-half the diameter of the pipe; or
    - b. 24 inches, measured in the uncompacted state.
  3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24 inches or not.
  4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.
  5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.
  6. The material shall be placed in lifts that will not exceed 6 inches when compacted to the required density.
- G. Flooding, ponding, and jetting shall NOT be used for consolidation of any backfill materials.
- H. Mechanical Compaction
1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.
  2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.
- I. Pipe and Utility Trench Backfill
1. Pipe Zone Backfill
    - a. Definitions
      - 1) The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.
      - 2) The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.
      - 3) The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.
    - b. Final Trim
      - 1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when

first laid will be continually in contact with the bedding along the extreme bottom of the pipe.

2) Excavation for pipe bells and welding shall be made as required.

- c. The pipe zone shall be backfilled with the indicated backfill material.
- d. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.
- e. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
- f. Maximum lift thickness is 8-inches before compaction when using riding compaction equipment. Compaction is 96 percent or greater relative to a modified proctor density, APWA (Utah) Section 31 23 26, unless pipe manufacturer requires more stringent installation.
- g. Submission of quality control compaction test results data developed for the haunch zone may be requested by Engineer at any time. Contractor is to provide results of test immediately upon request.
- h. Water jetting is NOT allowed.

## 2. Trench Zone Backfill

- a. Follow all requirements indicated in APWA Section 33 05 20 and the following provisions:
- b. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.
- c. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.
- d. Maximum lift thickness is 8-inches before compaction when using riding compaction equipment. Compaction is 96 percent or greater relative to a standard proctor density, APWA (Utah) Section 31 23 26.
- e. Water jetting is NOT allowed.

## J. Identification Tape

- 1. Install identification tape as indicated in Paragraph 2.2 above.
- 2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.

## K. Compaction Requirements

1. The CONTRACTOR shall meet all requirements of APWA (Utah) Section 31 23 26 Compaction.
2. Compact the entire area to 96 percent of laboratory determined maximum dry density and eliminate unstable zones.

### 3.6 GEOTEXTILE FABRIC PLACEMENTS

- A. Remove all organic material larger than 1 inch in diameter from the subgrade and grade to elevations required for overlaying backfill.
- B. Compact subgrade to the extent allowed by substrate condition.
- C. Roll fabric onto subgrade so subgrade remains smooth. Do not drag.
- D. Fold or overlap geotextile in direction of drainage. A Minimum of 6" overlap is required at the top of the pipe zone.
- E. Place granular material on top of fabric and spread carefully to insure no puncture. Minimum backfill lift on fabric, six inches.
- F. Cover fabric with 12 inches of sand before placing rock larger than four inches diameter over the fabric.
- G. Compact backfill soils over fabric to 96 percent or greater relative to a standard proctor density, APWA (Utah) Section 31 23 16 Compaction.
- H. Repair any puncture by covering with new fabric using a minimum of 6" overlap.

### 3.7 FIELD TESTING

- A. General:
  1. Field soils testing will be performed by a testing laboratory of the OWNER's choice at the OWNER's expense, except as indicated below.
- B. Density
  1. Where soil material is required to be compacted to a percentage of maximum dry density, the maximum dry density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.
  2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.
  3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.
- C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.
2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. CONTRACTOR's Responsibilities

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.
2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.
3. Lawn areas destroyed by test trenching and excavation shall be regraded and relandscaped with sod.

END OF SECTION

## SECTION 32 11 13 - A.C. PAVEMENT AND BASE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide A.C. pavement and base, complete and in place, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Utah APWA Manual of Standard Specifications, 2017 Edition
- B. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf per cu ft)
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

#### 1.3 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the ENGINEER.

- B. Suitability Tests of Proposed Materials: Tests for conformance with APWA Section 32 12 05 Bituminous Concrete, 32 11 23 Aggregate Base Courses and 32 12 13.13 Tack Coat shall be performed prior to start of the WORK. Results of all tests shall be submitted to the ENGINEER for approval. Materials to be tested shall include untreated base course, bituminous concrete and tack coat.
- C. The CONTRACTOR shall submit mix design for aggregate base material (untreated base course). Provide the following. Allow ENGINEER 10 days to evaluate the submittal.
1. Date of mix design. If older than 365 days from date of submission, recertify mix design.
  2. Name of supplier and aggregate source.
  3. Target gradation for each sieve size.
  4. Percent composition of reclaimed asphalt or concrete included in the mix.
  5. Unit weight, CBR, relative density, and relative moisture content.
  6. Aggregate physical properties (APWA (Utah) Section 32 11 23 Aggregate Base Courses, Article 2.1). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from date of submission.
- D. The CONTRACTOR shall provide the following submittals for tack coat:
1. Certificate showing asphaltic material complies with APWA (Utah) Section 32 12 03 Asphalt Binder:
    - a. Identify water/asphalt dilution ratio
    - b. Identify tack coat application rate
  2. Identify asphalt material recommended by fabric manufacturer.
- E. The CONTRACTOR shall provide the following submittals for bituminous concrete:
1. General:
    - a. Pre-approved Mix Design: Submit name and address of Supplier.
    - b. Allow ENGINEER 10 days to evaluate mix design submittals.
    - c. Once a mix design is accepted, a new mix design submittal is required if the following occurs.
      - 1) Asphalt binder grade is changed.
      - 2) Aggregate source is changed. When this occurs, submit a physical properties report on the proposed aggregates.
  2. Quality Assurance:



- a. Independent Laboratory: Submit names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM D3666 and follows Section 01 45 00 requirements.
  - b. Mix Production Equipment: Submit verification by an individual acceptable to ENGINEER, that plant equipment complies with requirements of ASTM D995.
  - c. Testing Report: If requested by ENGINEER, submit a report of source and field quality control testing performed by CONTRACTOR and Suppliers.
3. Mix Design: Submit the following.
- a. Date of mix design. If the date exceeds the following times, the mix design is invalid and must be redesigned.
    - 1) One year for non-commercial plants.
    - 2) Two years for commercial plants if there is no change in the aggregate source. A new mix design will be required if aggregate source is changed.
  - b. Binder source, type and grade. Disclose if RAP or ROSP is used in the mix.
  - c. Optimum compaction temperature at the project site.
  - d. Theoretical maximum specific gravity.
  - e. Compaction density at design target air voids.
  - f. Target Grading Curve for aggregate.
  - g. Binder target percentage, dust to binder ratio, and the following as applicable.
    - 1) For Superpave mix design provide 1) voids in the mineral aggregate (VMA), and 2) voids filled with Bituminous Binder also known as VFA, and 3) Hamburg Wheel Tracker results.
    - 2) For Marshall mix design provide 1) tensile strength ratio (moisture sensitivity), 2) voids in the mineral aggregate (VMA), 3) stability, 4) flow and 5) voids in the bituminous mix, and 6) voids filled with Bituminous Binder also known as VFA.
  - h. Percentage of 1) mineral filler, 2) anti-strip, 3) reclaimed bituminous pavement (RAP or ROSP), 4) recycle agent in the mix, and 5) virgin aggregate.
  - i. Aggregate physical properties (APWA (Utah) Section 32 12 05 Bituminous Concrete, article 2.2). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than two calendar years from the date of submission.
- F. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the ENGINEER shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the CONTRACTOR for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the CONTRACTOR, and approved by the

ENGINEER. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than 2 laboratory trial batch tests will be paid by the OWNER but the CONTRACTOR shall be responsible for the materials. Performing and paying for any additional trial batch testing shall be the CONTRACTOR's responsibility.

## **PART 2 -- PRODUCTS**

### **2.1 AGGREGATE BASE**

- A. Materials for aggregate base shall be new untreated base course material, APWA (Utah) Section 32 11 23 Aggregate Base Courses.

### **2.2 TACK COAT**

- A. Tack coat shall be Grade SS-1, APWA (Utah) Section 32 12 13.13 Tack Coat.

### **2.3 BITUMINOUS CONCRETE**

- A. Bituminous concrete pavement shall be Permanent Warm Weather Bituminous Concrete: PG64-22, DM-1/2, 50 blow, APWA (Utah) Section 32 12 05 Bituminous Concrete.

## **PART 3 -- EXECUTION**

### **3.1 SUBGRADE PREPARATION**

- A. Implement traffic control plan requirements.
- B. The subgrade shall be prepared in accordance with Section 31 30 00 Earthwork as applicable to roadways. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.
- C. Cutting pavements: cut full depth and straight, APWA (Utah) Section 02 41 14 Pavement Removal. Remove all bonding inhibitors.

### **3.2 AGGREGATE BASE**

- A. Aggregate base shall be provided per MWD standard detail 25 on Sheet GC-1 to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided, and the base shall be free of pockets of coarse or fine material.
- B. Maximum lift thickness before compaction is 8-inches when using riding equipment or 6-inches when using handheld equipment. Compaction is 95 percent or greater relative to a modified proctor density, APWA (Utah) Section 31 23 26 Compaction.

### **3.3 TACK COAT**

- A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold

pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement.

- B. The CONTRACTOR shall follow all requirements as outlined in APWA (Utah) Section 32 12 13.13 Tack Coat.

### 3.4 BITUMINOUS CONCRETE

- A. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.
- B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.
- C. The thickness of the pavement shall match existing pavement thickness or be six inches, whichever is greater.
- D. Clean all vertical surfaces that butt against new patchwork. Provide full coverage spray tack coat. Do not spray tack coat on surfaces exposed to public view. Do not apply tack coat by brush.
- E. Place bituminous pavement in lifts not less than 3 inches after compaction. Compact to 94 percent of ASTM D2041 (Rice density) plus or minus 2 percent.
- F. Match adjacent surface slopes.
- G. Use lay-down machine for final lift if trench is in direction of traffic flow.

### 3.5 TOLERANCE

- A. 1/4-inch vertical deviation from design elevation in 10 feet.

END OF SECTION

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## SECTION 33 01 29 - SPRAY-APPLIED MANHOLE COATING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The WORK of this Section includes providing a spray-applied epoxy or polyurethane coating such that concrete manholes become structurally sound and impervious to ground water, soil, and debris, and become resistant to hydrogen sulfide (sulfuric acid) corrosion.
- B. The CONTRACTOR is cautioned that sewage will continue to flow to the manhole during installation of SSMH-1 and that the work must be performed under permit required confined space entry conditions.

#### 1.2 SPECIFICATIONS AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

ASTM D 4541      Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM D 4787      Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates

#### 1.3 SHOP DRAWINGS AND SAMPLES

- A. The following shall be submitted in compliance with Section 01 33 00 – Contractor Submittals:
  - 1. Coating manufacturer's data sheet for each product used, including statement on suitability of the material for the intended use and compliance with the requirements of this Section.
  - 2. Coating manufacturer's instructions and recommendations on surface preparation, application, and repair of discontinuities.
  - 3. Material Safety Data Sheet for each product to be used.

#### 1.4 Applicator's qualifications and certificate.

#### 1.5 Spark test certification for each manhole.

### PART 2 -- PRODUCTS

#### 2.1 WALL CLEANING MATERIALS

- A. Water Abrasive or Wet Abrasive Blast: Type and size of abrasive shall be selected to produce a surface profile that meets the applicator's recommendations.
- B. High Pressure Water: Water at 3500 psi minimum pressure.

- C. Cleaners: Cleaners shall be per applicator's recommendations.

## 2.2 WALL REPAIR MATERIALS

- A. Hydraulic Plug: Quick-setting material recommended by the manufacturer for sealing active leaks in manhole structures. Material shall be compatible with coating material.
- B. Quick-Set Mortar: Material to repair wide cracks, holes, and disintegrated mortar.

## 2.3 COATING MATERIAL

- A. Manhole coating material shall be epoxy (Raven 405 by Raven Lining Systems) or polyurethane (SprayWall by Sprayrog Inc)..
- B. Contractor shall choose from the following 2 manufacturers:
  - 1. **Raven 705CA Cementitious Trowel Coat, Raven 155 Primer and Raven 405 Epoxy by Raven Lining Systems.** A thickness of 150 mils is required on new manholes.
  - 2. **SprayWall self-priming polyurethane lining by Sprayrog Inc.**

## PART 3 -- EXECUTION

### 3.1 CLEANING AND SURFACE PREPARATION

- A. Remove dirt, grease, and debris from floor and walls of manhole using high pressure water, abrasive, and cleaners as necessary to prepare a roughened, bondable surface as recommended by the applicator.

### 3.2 REPAIRS

- A. Active leaks, if present, shall be sealed by application of material selected by the applicator.
- B. Repair wide cracks, holes, or disintegrated mortar with quick-set mortar, following the manufacturer's application instructions.

### 3.3 COATING

- A. Prepare and spray the coatings according to the Manufacturer's instructions and recommendations. Refer to appendix B or C.

### 3.4 FIELD TESTING

- A. Inspect the coated surfaces for cracks, voids, holes, uncured spots, dry spots, delaminations, and any defect which might affect the coating performance.
- B. Test the entire coated surface for holidays at 100 volts/mil in accordance with the procedures of ASTM D 4787.
- C. Spark test.

1. Perform spark testing on fully installed coating system in accordance with ASTM D 4787 on all coated surfaces of each manhole.
2. OWNER and/or ENGINEER will be present to observe and approve each spark test.
3. Provide equipment and materials required for spark testing.
  - a. Provide certification that spark tester equipment has a current calibration.
4. Testing process:
  - a. Properly clean and prepare manhole.
  - b. ENGINEER will identify bolt installation location around circumferential perimeter of the manhole approximately 12 inches below point where manhole cone and manhole riser meet.
  - c. Drill a hole no larger than 1/2-inch diameter that penetrates a minimum of 2 inches into the concrete (or other manhole wall surface type). An adhesion test hole can also serve as a location to install the bolt.
  - d. Install 3/8-inch diameter stainless steel expansion bolt into the hole.
    - 1) Bolt penetration minimum: 2 inches into manhole wall.
    - 2) Bolt exposure minimum length: 1 inch.
    - 3) Bolt exposure maximum length: 2 inches.
    - 4) Bolt exposed end: Hex-head end.
    - 5) The various layers of the coating system shall be installed securely up to and around the base of the bolt to seal the bolt penetration off as a pathway for corrosion.
    - 6) Bolt will be used during the spark testing to provide grounding.
  - e. Do not test with squeegee-type test wand or wet sponge.
  - f. Test with wire brush-type test wand with a minimum test voltage of 100 volts per mil (where 1 mil = 1/1000 inch) of finished surface coat thickness.
    - 1) For example, use minimum 12,500 volts for surface coat thickness of 1/8 inch (125 mils).
    - 2) Use installed stainless steel bolt as a grounding rod for the spark testing equipment.
  - g. Perform quality control test to assure proper functioning of spark testing equipment, if required by ENGINEER.
    - 1) Frequency: 1 test may be required for each manhole.

- 2) Drill a hole through the coating system into the underlying concrete substrate to demonstrate that the spark testing equipment can "find" the hole.
  - 3) Patch and repair the hole as recommended by the coating manufacturer.
  - 4) Unless otherwise determined by the ENGINEER, any adjustments to the spark testing methodology (e.g., adjusting the grounding method, increasing the test voltage, etc.) required to "find" the known holiday (hole) shall remain in effect for the remainder of the spark testing of that manhole.
- h. Spark test entire coated surface of the manhole.
- i. Treatment of imperfections found in the coating system using spark testing at no additional cost to OWNER.
- 1) The CONTRACTOR shall grind down defects and holidays at least 2-inches in all directions from the defect and make repairs according to the manufacturer's recommendations.
  - 2) Do not use acetone, MEK or other chemical solvents to dissolve the underlayment or coating system as a substitute for mechanical grinding down of the imperfection.
  - 3) Re-test repaired areas until all portions of manhole pass the spark test as specified in this Section.
- j. Provide certification for each manhole stating that the coating is free of holes or other imperfections.

END OF SECTION



## SECTION 33 05 16 - PRECAST CONCRETE MANHOLES

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide precast concrete manholes, complete and in place, in accordance with the Contract Documents. Each manhole shall be sprayed with protective coating per Section 33 01 29 Spray-Applied Manhole Coating.

#### 1.2 SPECIFICATIONS, CODES AND STANDARDS

ASTM A 48	Gray Iron Castings
ASTM C 76	Standard Specification for Reinforced Concrete Culvert, Storm drain, and Sewer Pipe
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 890	Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

- A. Referenced Standards: This Section incorporates by reference the Utah APWA Manual of Standard Specifications, 2017 Edition. They are part of this Section. In case of conflict between the requirements of this Section and the APWA Specification, the CONTRACTOR shall point out the conflict to the Project Representative; lacking a definitive answer otherwise, the requirements of the Contract Specifications shall prevail.

#### 1.3 CONTRACTOR SUBMITTALS

- A. **General:** Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings
  - 1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
  - 2. Structural design calculations for manholes, signed by a registered engineer.
  - 3. Buoyancy design calculations signed by a registered engineer.
  - 4. Manhole frames and covers.

- C. **Manufacturer's Certification for Manholes:** Written certification that the manhole complies with the requirements of this Section.

#### 1.4 QUALITY ASSURANCE

- A. **Inspection:** After installation, the CONTRACTOR shall demonstrate that manholes have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

### PART 2 -- PRODUCTS

#### 2.1 MANHOLES

- A. The CONTRACTOR shall provide precast manholes designed for the indicated applications and of the sizes indicated.
- B. The minimum wall thickness for manholes shall be 4 3/4-inches. Cement shall be Type V portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by the manhole manufacturer.
- C. **Design Loading:** Manholes shall be designed for H-20 traffic loading. Lateral loads on manholes in all areas shall be calculated from:

$$L = 90 h, \text{ plus surcharge of } 240 \text{ psf in areas of vehicular traffic}$$

$$\text{Where } L = \text{loading in psf}$$

$$h = \text{depth of fill in feet}$$

- D. Joints in sections shall be bituminous mastic gasket-type sealant or otherwise approved by the Engineer. Where joints are designed in pre-cast concrete manholes, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.
- E. **Frame and Cover:**
  - 1. Scoriated, asphalt coated, heavy duty, ductile iron, APWA (Utah) Section 05 56 00 Metal Castings, with flat top design meeting load rating HS-20 and appropriate utility lettering. Shape, size and lifting device as necessary.
- F. Where penetration(s) of the pre-cast concrete manhole are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. Manholes need not be designed to resist thrust from piping passing through the vault.
- G. Weight of vault shall resist buoyant forces caused by total submersion in water. Soil friction shall be neglected in buoyancy design calculations.
- H. **Manufacturer, or Equal:**

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

- A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the CONTRACTOR shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.
- B. Buried pre-cast concrete manholes shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete manholes shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.
- C. Prior to backfilling, all cracks and voids in pre-cast concrete manholes shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant. With the authorization of the ENGINEER, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.
- D. All new pre-cast concrete manholes shall be sprayed with protective coating per Section 33 01 29.

END OF SECTION

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## SECTION 33 05 23.05 – SHAFT EXCAVATION AND SUPPORT

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. This Section presents requirements for shafts required to complete the microtunneling drive.

#### 1.2 REQUIREMENTS

- A. This is a performance specification. The Contractor shall design the shafts, shaft support systems, and bases within the limitations presented herein.
- B. The shafts shall use walls that are installed into the ground to full depth required for groundwater cutoff prior to excavating the inside of the shaft.
- C. The walls shall be sheet piles or approved equivalent.
- D. The shafts shall have seals at the break-outs and break-ins (Eyes) to control the ground during the trenchless drive.
- E. External dewatering is strictly limited during shaft construction as specified herein.
- F. The CONTRACTOR shall be responsible for coordination of construction activities and all communications with all governmental agencies and other third parties that may be affected by the work.
- G. The CONTRACTOR shall abide by the requirements of all permits required to complete the work.

#### 1.3 QUALIFICATIONS

- A. The shaft CONTRACTOR shall meet all of the following experience requirements:
  - 1. At least 5 years of experience and successfully completed at least three excavation and support projects to a depth of at least 15 feet.
- B. The sheet pile subcontractor shall meet all of the following experience requirements:
  - 1. At least 5 years of experience with the construction of interlocking steel sheet piles.
  - 2. Successfully completed at least three excavation and support projects including at least one to a depth of at least 15 feet.
- C. The Project Manager shall meet all of the following experience requirements:
  - 1. At least 10 years of experience in heavy civil construction experience with at least 3 years of experience in large excavations with sheet pile ground support in similar scope and complexity to this work.
  - 2. Have successfully completed at least three similar projects within the last seven years and have been in responsible charge of at least one of those projects.

- D. The Site Safety Officer(s) shall have at least 5 years of experience in excavations for civil construction.

#### 1.4 SYSTEM DESCRIPTION

##### A. Design Requirements

1. Select dimensions and depth that are compatible with proposed construction methods and equipment, and which allow for construction and installation of the permanent structures as indicated on the Contract Drawings.
2. Perform shaft excavation in a manner that limits loss of ground, limits lateral movement and settlement of the ground, structures, and utilities in the vicinity of the shaft excavation. Take all measures necessary to protect existing structures, utilities, and facilities from damage, including field verification. As a minimum abide by the ground movement limits and criteria presented in 33 05 23.45–Settlement Monitoring for Trenchless Utility Installations.
3. Design temporary shoring system to provide a minimum factor of safety of 1.5 against bottom heave.
4. Design shaft sides and invert to support CONTRACTOR's construction equipment and means and methods.
5. External dewatering is not allowed for the shaft construction. All shafts shall be watertight. Internal sump dewatering is allowed.
6. The CONTRACTOR shall determine details and design of the watertight shoring configuration subject to the limitations specified herein and elsewhere in the Contract Documents. The design shall use a groundwater level consistent with the ground surface for all scenarios.
7. It is the responsibility of the CONTRACTOR to safely construct the shaft excavations and provide the finished product within the limitations specified herein and elsewhere in the Contract Documents.
8. The CONTRACTOR shall develop a Contingency Action Plan as specified herein to address unexpected conditions and situations during prosecution of the work

#### 1.5 SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00.

- B. Pre-Construction Submittals:

1. Submit the following a minimum of six weeks before the scheduled start of the applicable activity.
2. Written documentation summarizing the qualifications and experience for the Project Manager and Site Safety Officer.
3. Detailed Shaft Staging Plans including layout of the access shafts, all major equipment and staging areas. Include at a minimum, the layout of the shaft

equipment, crane, required area for handling shaft and tunnel spoils, and any staging areas.

4. CONTRACTOR's Shaft Safety and Accident Prevention Program for all shaft work including the safety of workers and the public. Submittal shall be for record purposes only.
5. Permits. List required permits and third-party approvals to perform the work.
6. Hauling and disposal of spoils from the shaft excavations. The plan shall include: disposal site, haul route, truck frequency, confirmation from disposal site that they will accept tunnel and shaft spoils, and hours of spoil haulage.
7. Detailed shaft work plans, one for both the entrance and receiving shafts, including:
  - a. Design with calculations for the walls, bracing, and bottom plug or slab.
  - b. Method of excavation.
  - c. Design of the break-out and break-in from the shafts with drawings, diagrams, and properties illustrating the system and how it will work to control the ground and groundwater.
  - d. Schedule of activities including walls, bracing, dewatering if any, excavation, bottom plug or slab, and beginning of tunneling.
  - e. Provisions for controlling nuisance water in the shafts.
8. Shoring Design
  - a. Walls and Bracing. The submittal shall include the layout, wall thickness, reinforcing, sizes, and materials. Include the layout and design of the eyes for trenchless entrance and receiving shafts. The submittal shall include full structural calculations signed by a professional civil or structural engineer registered in Utah.
  - b. Base Design and Construction. The submittal shall present the CONTRACTOR's proposed approach to stabilizing the bottom of the shaft including design, construction sequence, sizes, and materials for shaft base. If used, include details of plans for excavating shaft within the wet and dewatering of shaft such that bottom stability is maintained. The submittal shall include full structural calculations signed by a professional civil or structural engineer registered in Utah.
  - c. Design assumptions, analyses, calculations, and information on CONTRACTOR's proposed method of installation and removal of all shoring. The design and calculations shall be performed by, sealed and signed by a professional engineer registered in Utah and experienced in the design of earth retaining structures.
  - d. The maximum design load to be carried by the various members of the support system.

- e. Loads on support system for various stages of excavation, bracing removal and concrete placement.
  - f. Expected equipment loads including the crane, pipe storage, and temporary dead and live loads.
  - g. Maximum design load carried by various members of support system, and preload values.
  - h. Detailed excavation support drawings, showing all pertinent dimensions, spacing, and relationships among the components of the shoring, as well as construction sequence and scheduling.
  - i. Details, arrangement and method of assembly and disassembly of proposed system and sequence of construction.
  - j. The method of preload bracing and bracing during excavation.
  - k. The full excavation depth and depth(s) below the main excavation to which the support system will be installed.
  - l. Detailed sequence of construction and bracing removal and backfilling.
  - m. Methods of resolving difficulties arising from misalignment of sheet piles exposed during excavation, and criteria for implementing procedures.
  - n. Detailed drawings and descriptions of the method to be used by the CONTRACTOR to monitor shoring and adjacent ground/structure movements.
  - o. Demonstrate coordination with interior dewatering work (sump pumps).
9. Shaft Backfill Plan: Plans showing the sequence of shaft backfilling including removal of bracing, and materials used for the backfill with placement requirements. The submittal shall also include measures to restore conditions at the ground surface.

C. Construction Submittals

- 1. Written Daily Logs. The Written Daily Logs shall have as a minimum the information specified below in this Section.

D. Post-Construction Submittals.

- 1. Record drawings showing the final configuration of the shafts including location, size and depth of components remaining in the ground, and surface restoration.

## 1.6 QUALITY CONTROL AND QUALITY ASSURANCE

A. In addition to the provision of operational data referred to elsewhere in this specification, the CONTRACTOR shall comply with the following:

- 1. The CONTRACTOR shall establish and maintain quality control for all to assure compliance with the contract requirements, and maintain records of quality control



for materials, equipment, and construction operations.

2. The CONTRACTOR shall keep and maintain at the construction site a complete set of field drawings for recording as-built conditions. It shall have marked or noted thereon all field information, properly dated, recording as-built conditions. This set of field drawings shall be kept up-to-date during the course of the project.

- B. The CONTRACTOR shall establish a quality assurance and quality control (QA/QC) plan for all materials used in shaft construction. The QA/QC plan shall detail tests, testing frequency, and acceptance criteria. The CONTRACTOR shall maintain QA/QC records for materials, equipment, and construction operations.

## **PART 2 -- PRODUCTS**

### **2.1 INTERCONNECTING STEEL SHEET PILE SHAFTS**

- A. The CONTRACTOR shall use interconnecting steel sheet piles as the primary element in shaft walls. The CONTRACTOR shall design the walls. The sheet piles may be supplemented with ground improvement at the option of the CONTRACTOR to achieve watertightness for the break-in, break-out or shaft plug.

### **2.2 BRACING**

- A. The CONTRACTOR shall determine and design bracing needed to support the walls of the excavation.
- B. All bracing shall be internal to the shaft. Tiebacks and bracing extending beyond the walls or beyond the limits of shaft construction shown on the Contract Drawings is not allowed.

### **2.3 SHAFT BACKFILL**

- A. The Launch Shaft and the Receiving Shaft shall be backfilled per the requirements of Section 31 30 00 – Earthwork.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

- A. Do not begin Work until:
  1. Required submittals have been made and reviewed.
  2. All monitoring and instrumentation have been installed and initial measurements have been obtained.
  3. A pre-construction method and means conference has been conducted. Arrange this conference and inform the OWNER of the time and place of the conference at least seven days in advance.
  4. All pre-construction surveys have been completed.
  5. Survey control has been established and verified by the OWNER.
- B. Maintain clean working conditions at all times inside the shafts. All excavated soil,

slush, grout spills, water, and any other material not required shall be removed from the excavation in a timely manner.

- C. Provide access for the OWNER at all times during active Work. Access shall be for, but not limited to, the following: inspect and observe the work; and perform independent surveys, including geologic mapping, monitoring of instrumentation, and installation of additional instrumentation. Access shall include use of transportation facilities used by the CONTRACTOR's personnel within the shafts.
- D. Complete excavation to provide adequate support at all times to adjacent conduits, structures, or roads and so as to offer no hazard to truck or automobile operations. Bracing and shoring shall be substantial and safe, and all work shall be done in full conformity and subject to the inspection of all affected parties. If and when required and to the degree necessary, the CONTRACTOR shall provide additional support as may be necessary at no additional cost.
- E. Take every precaution to prevent the entry of water, mud and foreign matter into the excavation at all times. It is the intention of these Specifications that all construction work described herein shall be carried out under dry conditions. The CONTRACTOR shall promptly and continuously control water inflow and dispose of all water from any source that may accumulate in the excavation via sump pumping only. This shall include all necessary pumping, bailing, draining and sedimentation prior to discharge.
- F. Any and all excess excavation or over-excavation performed by the CONTRACTOR for any purpose or reason, except as may be ordered in writing by the OWNER, shall be at the expense of the CONTRACTOR. Any damage done to the work by the CONTRACTOR's operations shall be repaired by and at the expense of the CONTRACTOR and in a manner approved by the OWNER.

### 3.2 GROUND MOVEMENTS

- A. Protect or repair utilities damaged by operations of this Section. Protect adjacent structures and property from damage and disfiguration.
- B. In the event that the ground movement criteria are exceeded, immediately make adjustments in work procedures and perform necessary ground improvements to reduce settlement to within specified limits.
- C. The CONTRACTOR shall be responsible for and bear the cost for all damages to all facilities caused by underground construction including but not limited to tunnels, shafts, grouting, and associated phenomena including but not limited to settlement, heave, grout contamination and hydrofracturing. The liability for damages shall include but not be limited to direct costs of repair or replacement and loss of use.

### 3.3 WATER AND GROUNDWATER CONTROL

- A. Control and eliminate the inflow of water into the shafts. Ground water inflow into the shaft exceeding 15 gpm is not acceptable and remedial action shall be taken to reduce the groundwater flow. Remove nuisance water from the shafts as necessary for safety and efficient work conditions.

### 3.4 WALL AND BRACING DESIGN

- A. Design the walls and bracing subject to the requirements and limitations specified

herein. Design shall include as a minimum resistance from all loads including but not limited to soil, surcharge, nearby footings, and groundwater.

### 3.5 BASE DESIGN

- A. Design the base of the shafts to be stable in all conditions. Design shall include as a minimum factor of safety for resistance from soil heave and groundwater uplift. The CONTRACTOR may at the CONTRACTOR's option incorporate the following components or a combination of the following components and features into the base: walls extended well below the shaft floor, mass of concrete or jet grouting, or structural slab.

### 3.6 SHAFT BREAK-IN AND BREAK-OUT (TUNNELING EYES)

- A. The shafts shall include specially configured eyes for launching and receiving the Casing Pipe. The break-out from the Launch Shaft shall include a flexible gasket or collar surrounding the jacked Casing Pipe and prevents the intrusion of soil and groundwater into the shaft. The break-in at the Receiving Shaft shall be either a flexible gasket or collar, or improved ground as determined by the CONTRACTOR. The improved ground shall be weakly-grouted ground of suitable properties and sufficient size to prevent the inflow of ground and water into the shaft from the trenchless drive penetration.

### 3.7 WRITTEN DAILY LOGS.

- A. Maintain Written Daily Logs recorded at intervals of five feet of vertical excavation or less and signed by the CONTRACTOR's Shoring Superintendent. As a minimum, the Written Daily Logs shall include the following:
  - 1. The activities on site including excavation, ground support and grouting;
  - 2. The crews for each activity with number of people on the crew by craft;
  - 3. The date, starting time, and finish time for each activity and crew;
  - 4. Description of the soils encountered, position of different soils layers, and description of ground behavior;
  - 5. Any unusual conditions, breakdowns, and delays.

### 3.8 CLEANUP AND RESTORATION

- A. Following each work item, remove all equipment, unused materials, and debris from the site.
- B. Repair all damages and deficient conditions.

### 3.9 REMOVAL OF SUPPORT SYSTEM/SITE RESTORATION

- A. After all equipment and excavated materials for the microtunneling operations have been removed from the jacking shaft, the CONTRACTOR shall prepare the bottom of the shaft in the same manner as a pipe foundation or on top of the mud mat if applicable. The CONTRACTOR shall remove all loose and disturbed materials.

The CONTRACTOR shall remove all support of excavation materials from the shaft /pit area once microtunneling and installation is complete. The CONTRACTOR shall remove all materials with the exception of the approved backfill materials. The removal of the ground support system shall be performed in a manner that avoids ground settlement and damage to adjacent facilities. The OWNER may instruct additional remediation due to the settlement at no additional cost to the OWNER if settlement occurs during or after installation/removal of the ground support system. The OWNER may elect to leave the shoring in place if the CONTRACTOR cannot remove the support without creating settlement within acceptable limits.

- B. Site restoration shall be completed at all shaft locations restoring site to its original preconstruction condition in its entirety.

END OF SECTION

## SECTION 33 05 23.19 – MICROTUNNELING

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The work of this section includes construction of the Magna Project 1B – Trenchless Crossing to install a 48-inch diameter steel casing using microtunneling as shown in the Contract Drawings.
- B. This section presents requirements for using a Closed-Face MTBM to excavate and advance the Casing Pipe.
- C. Within this section, the terms “Tunnel” and “Tunneling” refer to the trenchless installation by Microtunneling with a closed face machine.

#### 1.2 REQUIREMENTS

- A. The CONTRACTOR shall use a Closed-Face Microtunnel Machine using a steel jacked casing pipe in accordance with Section 33 05 23.31– Steel Casing Pipe. Microtunneling requirements are presented herein.
- B. The CONTRACTOR shall perform operations in accordance with ASCE/CI 36-15 Standard Design and Construction Guidelines for Microtunneling.
- C. The CONTRACTOR shall use an MTBM suitable for tunneling in soft soils with low bearing capacities and shall control the line and grade of the drive to meet the tolerances specified herein.
- D. The CONTRACTOR shall use break-outs and break-ins from the shafts in accordance with Section 33 05 23.05 - Shaft Excavation and Support.
- E. Perform tunnel excavation in a manner that limits loss of ground and limits lateral movement and settlement of the ground, structures, and utilities in the vicinity of the tunnel alignment. Take all measures necessary to protect existing structures, utilities, and facilities, including performing field verification. As a minimum abide by the ground movement limits and criteria presented in 33 05 23.45 - Settlement Monitoring for Trenchless Utility Installations.
- F. Dewatering is not allowed for the trenchless drive.
- G. The annulus and voids outside the casing pipe shall be contact grouted in accordance with Section 33 05 23.43 Carrier Pipe Installation and Backfill and 33 05 23.41 Contact Grouting.
- H. An instrumentation program shall be implemented in accordance with the Contract Drawings and Section 33 05 23.45 - Settlement Monitoring for Trenchless Utility Installations.
- I. The CONTRACTOR shall determine details and design of the MTBM equipment subject to the limitations specified herein and elsewhere in the Contract Documents.
- J. A system of guidance and support is required for the trenchless drive as specified herein.

- K. Upsizing the casing is allowed within limits specified herein in Part 3 – Execution.
- L. It is the responsibility of the CONTRACTOR to safely construct the trenchless drive and provide the finished product within the limitations specified herein and elsewhere in the Contract Documents.
- M. The CONTRACTOR shall develop a Contingency Action Plan as specified herein to address unexpected conditions and situations during prosecution of the work.

### 1.3 DEFINITIONS

- A. Microtunnel Boring Machine (MTBM): Remote-controlled, guided and steerable, slurry shield that provides continuous support to the excavation face. The MTBM is operated from a control system located on the ground surface. Soil excavation is achieved by a rotating cutterwheel. Excavated soil enters a slurry chamber where it is mixed with drilling fluid to form a slurry. Pumps cycle the slurry to the surface where a separation plant removes the soil solids from the slurry. The recycled fluid is then returned to the face in a closed system of pumps, pipes, and hoses. Drilling fluid used to convey spoil may be water; however, it may also contain acceptable additives such as bentonite that allow it to carry more soil solids, provide gel strength, and reduce permeability into the soils at the heading. The guidance system consists of a laser or theodolite and electronic distance measurement (EDM) device mounted in the jacking shaft communicating a reference line to a target mounted in the MTBM's articulated steering head. The target in an MTBM provides the operator with information about machine attitude and pitch, and allows for accurate steering control.
- B. Carrier Pipe: Permanent pipe for operational use that is used to convey flows. Carrier pipes are installed inside a casing pipe jacked into place behind the MTBM..
- C. Hydrofracture: Release of drilling fluid or lubrication to the ground surface due to pressures exceeding the maximum allowable limits of the formation and/or preferential paths for fluid migration.
- D. Jacking Pipe: Pipe jacked behind the MTBM. The jacking pipe shall be the casing pipe, specifically designed to be installed by pipejacking using microtunneling equipment.
- E. Launch/Retrieval Seal or Entry/Exit Seal: A mechanical seal, usually comprised of one or more rubber flanges attached to a steel housing that is mounted to the wall of the jacking/receiving shaft. The microtunneling machine distends the flange seal as it passes through, reducing water, slurry, or lubricant inflows into the shaft during microtunneling operations.
- F. Lubrication/Grout Port: A port located within the MTBM, or in the jacking pipes, fitted with a one-way valve for injection of lubricant and grout into the annular space between the jacking pipe and the ground.
- G. Obstruction: Objects located completely or partially within the cross-section of the tunnel that prevent continued forward progress of the MTBM or jacking pipes along the design path, and within allowable tolerances, after all diligent efforts to advance past the object by the CONTRACTOR have failed.

### 1.4 PERFORMANCE REQUIREMENTS

A. Job Conditions

1. Refer to the Geotechnical Report in Appendix A for anticipated subsurface conditions.

1.5 QUALIFICATIONS

A. The project manager shall meet all of the following experience requirements:

1. At least ten years of microtunneling construction experience and has been in responsible charge of these construction projects for at least three years.
2. Have successfully completed at least three similar projects within the last seven years and has been in responsible charge of at least one of those projects.
3. Successfully completed, as the foreman or supervisor, at least one soft ground project using a similar closed-face MTBM system proposed for this project and having a size of at least 36 inches and 150 ft long.

B. The trenchless superintendent shall meet all of the following experience requirements:

1. At least five years of microtunneling construction experience and has been in responsible charge of these construction projects for at least two years.
2. Have successfully completed at least two similar projects within the last seven years and has been in responsible charge of at least one of those projects.
3. Successfully completed, as the foreman or supervisor, at least one soft ground project using a similar closed-face MTBM system proposed for this project and having a size of at least 36 inches and 150 ft long.

C. The underground site safety officer shall meet all of the following experience requirements:

1. At least seven years of site safety experience on heavy civil projects.
2. At least five years of site safety experience for excavations and underground work.
3. Specific training, certifications, and licenses as applicable for the work and in accordance with all regulations and standards.

1.6 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00.

B. Pre-Construction Submittals:

1. Written documentation summarizing the qualifications and experience of the Project Manager, Trenchless Superintendent, and Underground Site Safety Officer.
2. Detailed Staging Plan including layout of the access shafts, all major equipment and staging areas. Include at a minimum, the layout of the shaft equipment, crane, operators cabin, generators, casing pipe stacks, loading and unloading areas, required area for handling shaft and tunneling spoils, and any

staging areas.

3. CONTRACTOR's underground work safety and accident prevention program for all underground work including for the safety of workers and the public. Submittal shall be for record purposes only.
4. Underground personnel plan. The plan shall include provisions for ventilation, temperature control, lighting, electrical safeguards, safety of the public, monitoring, and warning systems.
5. Permits. List of required permits and third-party approvals to perform the work.
6. Hauling and disposal of spoils from the shafts and tunneling. The plan shall include disposal site, haul route, truck frequency, confirmation that disposal site will accept the spoils, and hours of spoil haulage.
7. Detailed Microtunneling work plan with description and shop drawings of the complete system illustrating the design, layout, and operation of each system component including:
  - a. Method of maintaining face stability including removing spoils while maintaining face stability.
  - b. Procedures for measuring excavation quantities versus forward progress per length of pipe advanced and comparison of excavated volume versus theoretical volume. Include a calculation of the bulking factor for soil removed.
  - c. Method of spoil transportation and removal from the face of the excavation and from the shaft.
  - d. Methods and materials used to manage sticky clays including at the face, transport system and separation plant.
  - e. Monitoring. Instrumentation, methods, procedures, and frequencies for surveying the alignment and grade of the drive.
  - f. Datalogger collection system to collect MTBM parameters. The computer recorded data shall be referenced to time and distance and shall be recorded at time intervals of 30 seconds or less.
  - g. Guidance and Control. Equipment and procedures for guiding and controlling the alignment and grade of the bore. The submittal shall include the methods and equipment for tracking of the MTBM along the alignment
  - h. Methods for personnel access and layout of utilities inside of the tunnel.
  - i. Equipment spreads, crew make-ups, and anticipated cycle times.
  - j. Equipment and methods for controlling friction outside the pipe including overcut, annulus, and slurry outside the casing.
  - k. Lubrication system including port locations, fluid design and properties, supply pipe size and injection frequency.



- I. Provisions for controlling groundwater.
8. Detailed description and shop drawings for the microtunnel machine and system to be used. The Submittal shall include:
  - a. The make and model number of the equipment along with any modifications.
  - b. Drawings and design for the equipment.
  - c. Cutterhead configuration and type of cutterhead.
  - d. Size of the overcut outside the casing.
  - e. Method of controlling line and grade of the casing and MTBM in soft clay materials with low blow counts.
  - f. Details of the CONTRACTOR's proposed survey system including control points, equipment, methods, and frequencies.
  - g. Details of entry and exit seals to be used at the launch and reception shafts.
9. Jacking Frame Description: Capacity, number, and arrangement of main jacks including details of the thrust ring, thrust block, jacking frame, jacking controls, pressure gages, and jack calibration data (pressure vs. force relationship for each stage of the jacks).
10. Method of supporting and preventing the MTBM from sinking in the soft soils. The submittal shall include calculations showing: 1) the weight of the MTBM relative to allowable bearing capacity of the surrounding soil, 2) how the weight of the machine is carried on the support system or in-situ soil. Calculations shall be stamped and signed by a Professional Engineer registered in the State of Utah.
11. Plan for personnel entry into the Casing Pipe including provisions for ventilation, temperature control, lighting, electrical safeguards, monitoring, and warning systems. Include ventilation design, calculations and drawings stamped and signed by a Professional Engineer registered in the State of Utah.
12. Joint and coupling details. Descriptions and details of pipe joints and method of joining pipes.
13. Maximum and minimum face pressures to be used to stabilize tunnel face without causing hydrofracture of earth considering groundwater levels, active earth pressures, and passive earth pressures.
14. Descriptions and details of pipe ports for contact grouting including shop drawings showing locations, size, and plugs for abandonment.
15. Jacking System Design. The submittal shall include design of the entire pipe jacking system including the pipe, jacking frame, and thrust restraint. Include capacity, number, and arrangement of main jacks including details of the thrust ring, thrust block, jacking frame, jacking controls, pressure gages, and jack calibration data (pressure vs. force relationship for each stage of the jacks).

16. The submittal drawings and calculations shall be stamped and signed by a Professional Engineer registered in the State of Utah.
17. Equipment and procedures for monitoring the jacking operation including jacking loads and loads on the Jacking Pipe.
18. CONTRACTOR 's calculation of estimated and proposed allowable jacking force on the pipe. Calculations of anticipated jacking forces including graphical plot of distance vs. jacking force for the drive.
19. Lubrication System. Design of the system to reduce pipe friction including injection locations and frequency, pumping pressures, slurry design, and method for maintaining slurry in the annulus.
20. Contingency Action Plan: The Contingency Action Plan shall include all the information specified herein.
21. Surface Spill and Inadvertent Drilling Fluid Return (IR) Contingency Plan addressing measures to be taken in the event of lubrication or slurry release to the ground surface, waterway, utility, or any other features along the alignment.

C. Construction Submittals

1. Written Daily Logs. The Written Daily Logs shall have as a minimum the information specified below in this Section.
2. Steel casing certificates of compliance.
3. Survey records of all Underground Work including deviations from design line-and- grade. Provide copies to the OWNER on a daily basis.
4. Results of all material tests specified herein. Test results shall be submitted within one week after completion of each test.
5. MTBM recorded data parameters recorded in 30 second intervals including:
  - a. The main control system is used to remotely control the microtunneling operation and should provide the following information to the operator at the minimum required intervals and critical to the successful operation of the MTBM:
    - 1) Deviation of the MTBM from the required line and grade of the pipeline, normally by reference to a laser beam
    - 2) Grade and roll of the MTBM
    - 3) Pipe Number and corresponding total tunnel length
    - 4) Face pressure or method of calculating face pressure with other parameters
    - 5) Jacking load
    - 6) Torque and RPM of the cutter head
    - 7) Instantaneous jacking rate (rate of advance) and total distance jacked

- 8) Indication of steering direction
- 6. For slurry systems, the following is also required:
  - 1) Volume of slurry flow in both the supply and return sides of the slurry loop  
Indication of slurry bypass valve position
  - 2) Indication of pressure of the slurry in the slurry chamber
- 7. Slurry Additives: Provide records of all slurry additives including any bentonite and polymers. The time and volume, or weight, of the additive shall be noted. Measurements of mud weights, specific gravity and viscosity shall be made at the beginning, middle, and end of each shift, and submitted with the daily logs. Measurements shall be made on slurry samples taken from the slurry tanks and noted accordingly.
- D. Post-Construction Submittals. Submit the following:
  - 1. Survey of the line and grade of the completed casing, manholes and other permanent facilities.

#### 1.7 TOLERANCES

- A. The Microtunnel alignment shall be within one inch of the planned line and grade requirements shown on the Contract Drawings. The pipe alignment shall not change by more than one inch per 50 ft.
- B. If the jacked pipe is off-line and/or grade by more than the specified tolerances, the CONTRACTOR shall make adjustments, repairs and changes as necessary to achieve the specified tolerances. Should the jacking pipe be outside the above tolerance requirements, then the leading edge of the pipe, shall be returned to the plane line and/or grade at a rate of not more than 1 inch per 25 ft of advance.
- C. If the jacked pipe is sufficiently far off-line and/or grade to require redesign of structures, acquisition of easements, or backfilling and re-excavation, the CONTRACTOR shall be responsible for doing all additional work and costs. If the jacked pipe is off-line and/or grade by an amount that requires, in the opinion of the ENGINEER, re-design of any structure, the CONTRACTOR shall be responsible for all redesign costs.
- D. Steering corrections made to the jacking pipe shall be carried out in such a manner that the joint angle of any two adjacent pipes or segments does not exceed allowable limits.
- E. Tolerances for installation of the Carrier Pipes shall be as shown on the Contract Drawings and as specified in Section 33 05 23.43 – Carrier Pipe Installation and Backfill.

#### 1.8 QUALITY CONTROL AND QUALITY ASSURANCE

- A. In addition to the provision of operational data referred to elsewhere in this specification, the CONTRACTOR shall comply with the following:
  - 1. The CONTRACTOR shall establish and maintain quality control for all

Underground Work to assure compliance with the contract requirements and maintain records of quality control for materials, equipment, and construction operations.

- B. The CONTRACTOR shall keep and maintain at the construction site a complete set of field drawings for recording as-built conditions. It shall have marked or noted thereon all field information, properly dated, recording as-built conditions. This set of field drawings shall be kept up to date during the course of the project. The CONTRACTOR shall establish a quality assurance and quality control (QA/QC) plan for all materials used in tunneling. The QA/QC plan shall detail tests, testing frequency, and acceptance criteria. The CONTRACTOR shall maintain QA/QC records for materials, equipment, and construction operations.
- C. In addition to the tests required to be performed by the CONTRACTOR, the CONTRACTOR shall take samples for the OWNER and/or allow access for the OWNER to obtain samples of the grout and grout materials, as determined by the OWNER.

## 1.9 CONSTRUCTION IRREGULARITIES

- A. The CONTRACTOR shall stop work, stabilize the excavation and notify the OWNER in the event that construction activities result in any of the following conditions:
  - 1. Potentially dangerous,
  - 2. May damage existing facilities and structures, or
  - 3. Obstructions or ground conditions that substantially impede the construction.
    - a. Following initial activities to stabilize the excavation, the CONTRACTOR shall perform explorations as necessary to determine the extent and nature of the conditions. The explorations shall be submitted to the OWNER for review prior to starting the work.
    - b. Following the explorations, the CONTRACTOR shall develop an action plan to continue work in a safe and controlled manner while protecting existing facilities and structures. The action plan shall be submitted to the OWNER for review prior to starting the work.

## PART 2 -- PRODUCTS

### 2.1 MICROTUNNELING EQUIPMENT

- A. MTBM Monitoring. The MTBM shall have a guidance control system using a laser or optical system which is monitored continuously, and accurately observes the MTBM's vertical and horizontal displacement from the laser beam or control line which has been accurately set to the required alignment and grade of the tunnel.
- B. MTBM Steering and Guidance. The MTBM shall have the ability to be steered to correct vertical and horizontal deviations from the required alignment.
- C. Excavation and Face Support Equipment. The CONTRACTOR shall use a Closed-Face MTBM to excavate the tunnel, support the face, and support the tunnel

perimeter in front of the jacked pipe. The equipment shall be designed and manufactured to effectively excavate the ground and provide ground control in the specific ground conditions present on this project and be compatible with the CONTRACTOR's means, methods, and materials. The equipment shall be a Slurry MTBM. The equipment shall be capable of controlling the ground at the tunnel face and tunnel perimeter in front of the jacked pipe.

Face and Ground Control: The MTBM shall maintain face control at all times including during excavation and during shutdown periods. The equipment shall control the volume of excavated material removed at the tunnel face and shall coordinate excavation with the advance rate to avoid over excavation. The equipment shall prevent the loss of ground throughout the tunnel construction sequence, including at the face and the tail. The equipment shall prevent ground loss between the MTBM and the jacked pipe.

- D. Measurement of Ground Removed: Provide equipment and instrumentation to allow accurate measurement of the quantity of excavated soil removed from the tunnel.
- E. The MTBM shall be designed to excavate through and maintain stability of the ground in the ground conditions expected for this project.
- F. The MTBM shall be a closed-face slurry machine. The MTBM shall be equipped with a system for continuous controlled removal of cuttings from the cutting chamber while maintaining slurry pressure at the face.
- G. Fluid Outside the Casing Pipe. The MTBM shall have the means to inject fluid over and around the rear of the MTBM and along the pipe length of the Casing Pipe to fill the overcut annulus, reduce ground movement onto the pipe, and lower the friction developed on the sides of the pipe during jacking. The injection system shall be such that it can automatically be controlled from the operator position.
- H. Instrumentation and Monitoring: The MTBM and jacking system shall have sufficient instrumentation to monitor and control operations including but not limited to: 1) line, grade, pitch and yaw, 2) torque, 3) jacking force, 4) lubrication/slurry delivery and pressure. 4) slurry or face pressure, and 4) jacking force.
- I. Ancillary Equipment. The CONTRACTOR shall determine the equipment used for all ancillary work including but not limited to spoil removal, water control, materials transfer and underground utilities.

## 2.2 JACKING SYSTEM

- A. Provide a total jacking system with a capacity that exceeds the maximum anticipated jacking force by at least 20 percent.
- B. The jacking hydraulic circuit shall be set to relieve pressure at the maximum safeworking capacity of the pipe as stipulated by the CONTRACTOR, or the design load for the jacking pit thrust block, whichever is less. The jacking system shall exert a uniform load to the pipe ring and at a speed commensurate with the speed of excavation advance.
- C. Provide the maximum anticipated construction loads, including maximum anticipated jacking force, and incorporate the anticipated loads into the casing design.

## 2.3 SLURRY SEPARATION PLANT

1. The slurry separation plant shall be designed to achieve the rates of spoil separation and slurry cleaning required for planned production rates. The separation plant must fit within the allowable easements shown on the Drawings. Excavated slurry pits or ponds will not be allowed. Onsite disposal shall not be permitted.

## 2.4 CASING PIPE

- A. The Casing Pipes shall be designed by the CONTRACTOR for all loading conditions experienced during construction. Steel casing pipe shall be in accordance with Section 33 05 23.31– Steel Casing Pipe.
- B. Annulus Lubrication. Lubrication in the annulus outside the Casing Pipe used during jacking to reduce friction and control the ground shall be designed by the CONTRACTOR. The lubrication shall be non-toxic and shall not release environmental contaminants into the ground or groundwater either directly or from degradation over time.

## 2.5 CARRIER PIPES

- A. The Carrier Pipe placed inside the Casing Pipe shall be as shown on the Contract Documents and as specified in Section 33 05 23.43 Carrier Pipe Installation and Backfill.

## 2.6 ENTRY AND EXIT SEALS

- A. Provide a watertight seal at the entry and exist locations designed to withstand the hydrostatic and earth pressures in addition to the slurry, lubrication and ground improvement methods, if applicable.

## 2.7 THRUST BLOCK

- A. A thrust block shall be used to transfer jacking loads to the soil behind the jacking shaft. The thrust block face shall be constructed perpendicular to the proposed pipe alignment. The thrust block shall be designed to withstand the maximum jacking forces developed by the main jacks, without excessive deflection or displacement. Forces applied to the soil shall not exceed the allowable passive earth pressure, with an applicable minimum factor of safety of 2.0 for the regular condition and a minimum factor of safety of 1.5 for the maximum possible forces after delays (set-up), as estimated previously. The CONTRACTOR shall structurally connect shaft support components to achieve required thrust reaction capacity, and/or shall use grouting or other types of ground improvement behind shaft walls to achieve sufficient thrust reaction capacity as necessary.

# PART 3 -- EXECUTION

## 3.1 GENERAL

- A. Do not begin tunneling until all instrumentation is installed and initial readings have been taken.
- B. Set the MTBM to be jacked on the planned alignment and grade, properly braced to

support the casing, and direct it in the proper line and grade required on the contract drawings. Line up the jacking assembly in the direction and grade of the casing.

- C. No gasoline powered equipment shall be permitted in jacking and receiving shafts. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable local, state, and federal regulations.
- D. Do not begin Underground Work until:
  - 1. Required submittals have been made and approved.
  - 2. Shaft excavations, stabilization, and shoring have been satisfactorily completed.
  - 3. Demonstrate soil stability at entry and exit seal prior to cutting and removal of entire opening needed for the penetration into soil.
  - 4. A pre-job method and means conference has been conducted. Arrange this conference and inform the OWNER of the time and place of the conference at least seven days in advance.
  - 5. All pre-construction surveys have been completed.
  - 6. Survey control has been established for the casing and has been verified by the ENGINEER.
    - a. Perform Underground Work in a manner that limits loss of ground and limits settlement of the ground surface, structures, and utilities above and adjacent to excavations. Take measures as necessary to protect existing structures, utilities and facilities.
    - b. Maintain clean working conditions at all times at the job site. All excavated soil, slush, grout spills, water, and any excess material shall be removed from the excavation in a timely manner.
    - c. Provide safe access for the ENGINEER at all times during active Underground Work. Access shall be for, but not be limited to, the following: to inspect and observe the work, to perform independent line and grade surveys, monitoring of instrumentation, and installation of additional instrumentation. Access shall include use of transportation facilities used by the CONTRACTOR's personnel within the shafts and casing.
    - d. Perform all Underground Work in accordance with all current applicable regulations and codes of federal, state, and local agencies. In the event of conflict, comply with the strictest or most restrictive applicable requirements.
    - e. Verify field conditions prior to commencement of work including layout and field measurements and notify the ENGINEER of discrepancies.

### 3.2 CONTINGENCY ACTION PLAN

- A. The Contingency Action Plan shall identify and develop courses of action for potential irregularities in the work that could result in each of the following:

1. Excessive settlement or ground movement beyond allowed limits, and damage to existing buildings, facilities or utilities.
2. Excessive deviation of alignment and grade
3. Inability to advance the casing
4. Obstructions
5. Contaminated ground.
6. Hydrofracture / inadvertent drilling fluid release to ground surface, catch basins, storm drains, or any other structures.

B. The Contingency Plan shall identify specific measures to:

1. Stop or modify the means, methods, equipment, and materials to immediately control the problem,
2. Identify the root cause of the irregularity and possible measures to rectify the situation, and
3. Implement measures to continue the work.

### 3.3 SUPPORT AND GUIDANCE

1. The MTBM shall be capable of not sinking in the soft soils. The allowable bearing capacity shall be evaluated by a professional engineer in comparison to the MTBM weight for the purpose of maintaining control of line and grade to the tolerances specified in Section 1.07. The CONTRACTOR shall design MTBM systems with consideration of the following as a minimum: 1) installation methods, 2) tolerances, and 3) support of the MTBM.
2. The MTBM shall have a steerable head to assist in controlling line and grade.

### 3.4 TUNNELING, JACKING AND EXCAVATION

1. The overcut, if any shall, be compatible with the soil conditions, stiffness characteristics of selected pipe, and joint system at the designed maximum jacking loads. The maximum allowable overcut is 1-inch measured on the radius for the Magna Project 1B – Trenchless Crossing tunnel.
2. Tunneling shall be conducted to minimize movement of the ground in front of and surrounding the casing and to control the loss of ground, surface settlement, and heave of the ground surface. Control the advance rate and volume of material excavated to avoid over excavation, loss of ground, and heave of the ground surface.
3. Carefully control and monitor volume of soil removed. Compare theoretical and actual volumes of soil removed. Adjust advance rate and excavation rate to avoid over excavation. Investigate potential voids created by over excavation.
4. During shutdowns and other interruptions in the work provide complete positive support for the face by positioning the head firmly against the face. Exercise the machine daily to prevent the buildup of jacking forces which may be



significant when restart is required. Exercise daily if the shutdown or interruption is greater than 72 hours.

5. Each pipe section shall be jacked forward as the excavation progresses in such a way as to provide complete and adequate support to the surrounding ground at all times.
6. Avoid damage to pipe sections and joints during jacking. In the event of damage to a pipe section or pipe joint, the CONTRACTOR shall notify the OWNER within the day of observation of the damage.
7. The CONTRACTOR shall limit the jacking force to stay at or below safe working limit of the Jacking Pipe.
8. The jacking loads shall be continuously monitored and recorded at the jacking frame.
9. Lubricant shall be applied to the external surface of the pipe to fill the overcut, support the ground and reduce skin friction. The fluid shall be suitable for the particular soil conditions.
10. Steering corrections made to the casing shall be carried out in such a manner that the joint angle of any two adjacent pipes or segments does not exceed allowable limits.
11. The CONTRACTOR shall at all times monitor and record the volumes, pressures, and location of lubricant pumping to ensure that the annulus around the pipe is completely filled with lubricant.
12. The MTBM shall be operated in Closed Mode at all times and locations. Operate the MTBM such that there is continuous, full face support of the ground at the tunnel face, and isolation of the excavation chamber.
  - a. To be in Closed Mode a Slurry Machine shall have full slurry filling the chamber and in contact with the ground in front of the cutter head, and the slurry shall be pressurized to counteract ground and groundwater loads and stabilize the ground.
  - b. Maintain slurry pressure to stabilize the ground, and to prevent ground heave and hydrofracturing.

### 3.5 GROUND STABILIZATION

- A. During periods of work stoppage, such as but not limited to nights and weekends, stabilize the working face with the head to prevent ground loss and movement of ground into the casing and excavations.

### 3.6 WATER AND GROUNDWATER CONTROL

- A. The CONTRACTOR shall take all necessary measures to create a watertight seal of the steel casing prior to annulus backfill grouting.
- B. The CONTRACTOR shall control the inflow of water into the jacking pipe and MTBM during construction.

### 3.7 CASING AND MTBM SIZE

- A. The CONTRACTOR may at the CONTRACTOR's option oversize the Casing Pipe for the Magna Project 1B – Trenchless Crossing . If the Casing Pipe is oversized the CONTRACTOR shall bear all costs for the larger pipe and completing the project with the larger pipe. If the Carrier Pipe is oversized, the CONTRACTOR shall be responsible and shall bear all costs for design and construction of affected project components including but not limited to manholes and connections. Submit changes to the ENGINEER for review and to the OWNER for approval.

### 3.8 EXCAVATED MATERIAL HANDLING AND DISPOSAL

- 1. The CONTRACTOR shall identify a spoil disposal site and shall be responsible for all transportation and disposal costs of the spoils.
- 2. Hauling and disposal of materials shall be in accordance with all federal, state, and local laws, regulations, and ordinances.
- 3. All roads used for hauling shall be kept free of debris and open for use by others. Spillage and obstructions on the road resulting from hauling shall be immediately removed.

### 3.9 GROUTING AND FINISHING

- A. Overcut, annulus and voids outside the Jacking Pipe shall be contact grouted as specified in Section 33 05 23.41 – Contact Grouting following completion of tunneling. Contact grouting shall be initiated within two working days and completed within seven days of the completion of tunneling.
- B. Following contact grouting, threaded plugs shall be installed in all ports.

### 3.10 INSTRUMENTATION

- A. The CONTRACTOR shall develop and implement an instrumentation program as shown on the Contract Drawings and as specified in Section 33 05 23.45 - Settlement Monitoring for Trenchless Utility Installations.

### 3.11 SURVEY

- A. Following completion, survey the horizontal position and elevation of the Casing Pipe invert at intervals of 20 ft or less.
- B. After installation of the Casing Pipe, provide the ENGINEER with access to the pipe for visual inspection and for verification of the line and grade.

### 3.12 GROUND MOVEMENTS

- A. Ground movements shall be limited to prevent damage to all structures, facilities and utilities in the vicinity of the work. The CONTRACTOR shall be responsible for and bear all costs associated with ground movements.
- B. In the event that the ground movement criteria are exceeded, the CONTRACTOR shall in accordance with the Contingency Action Plan immediately make adjustments in work procedures and perform necessary ground improvements to reduce ground movement to within specified limits.

- C. The CONTRACTOR shall be responsible for and bear the cost for all damages to all facilities caused by underground construction including but not limited to tunnel bores, shafts, grouting and associated phenomena including but not limited to settlement, heave, grout contamination, and hydrofracturing. The liability for damages shall include, but not be limited, to direct costs of repair or replacement and loss of use.

### 3.13 WRITTEN DAILY LOGS.

- A. Maintain Written Daily Logs recorded at intervals of ten feet or less and signed by the CONTRACTOR's Microtunnel Boring Operator/Superintendent. As a minimum, the Written Daily Logs shall include the following:

1. The underground activities on site including excavation, ground support and grouting
2. The crews for each activity with number of people on the crew by craft
3. The date, starting time, and finish time for each activity and crew
4. Description of the soils encountered, position of different soils layers, and description of ground behavior
5. Any unusual conditions, breakdowns, and delays
6. Record of starting and ending stations
7. Any movement of the Guidance System
8. Pressure, location and volume of any lubricant pumped,
9. Problems Encountered with the MTBM or Other Components or Equipment,
10. Volume of soil removed for each casing push or interval of five feet or less.
11. Tunneling logs. Results of monitoring of the jacking force at the jacking frame and the casing.
12. Installed pipe number and corresponding tunnel length
13. Lubrication volume pumped and the lubrication ports opened
14. Downtime duration and reason for delay
15. Installed pipe number and corresponding length
16. Rate of advance
17. Cutterhead speed and torque
18. Slurry flow rates and pressures
19. Bypass valve position

20. Use of any cutting or high-pressure nozzles

21. Earth and hydrostatic pressure

22. Applied face pressure

23. Steering jack positions

24. Line and grade offsets

### 3.14 CLEANUP AND RESTORATION

- A. Following each work item, remove all equipment, unused materials, and debris from the site.
- B. Clean the inside of the Casing Pipe leaving an interior free of soil, debris, and other deleterious materials.
- C. Repair all damages and deficient conditions.

END OF SECTION

## **SECTION 33 05 23.31 – STEEL CASING PIPE**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. This section specifies minimum design and performance requirements for steel casing pipe installed using microtunneling methods.
- B. Furnish all designs, tools, equipment, materials, and supplies and perform all labor required to complete the Work as indicated and specified herein.

#### **1.2 REGULATORY REQUIREMENTS**

- A. Submit compliance documentation for the covered products prior to delivery to the site.
  - 1. Provide step certification for all covered products from the time of raw material fabrication to final assembly.
  - 2. Utilize the certification form included in these specifications.

#### **1.3 REFERENCES:**

- A. ASTM Standards – the latest edition of the American Society of Testing and Materials Standards.
- B. ASTM A36 – Standard Specification for Carbon Structural Steel
- C. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- D. ASTM A139 – Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe – Grade B
- E. ASTM A515 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service – Grade 60.
- F. ASTM A572, Grade 42 - Standard Specification for High-Strength Low-Alloy Columbium- Vanadium Structural Steel
- G. AWS – “American Welding Society” – Latest Edition

#### **1.4 SUBMITTALS**

- A. Submittals shall be coordinated with all relevant submittals, assembled, and submitted as a single, comprehensive document in accordance with Section 01 33 00.
- B. Where calculations are required to be submitted, they shall be signed and sealed by a Professional Civil Engineer registered in the State of Utah. Calculations shall clearly identify all parameters used, state all assumptions made in the calculation, and identify all sources of information.
- C. All shop drawings shall be legible with dimensions accurately shown and clearly marked in English and US Customary units.

D. Pre-Construction Submittals:

1. Calculations demonstrating that the casing pipe has been designed to support the maximum anticipated construction and operational loads, with special respect to the maximum anticipated jacking loads, earth loads, and live loads, but in no case less than 0.5-inch wall thickness. Increase casing thickness, if necessary, to withstand the anticipated stresses with a minimum factor of safety of 2.5. The pipe shall resist, without buckling, crushing, or chipping the horizontal, vertical, and longitudinal loads applied to it during the installation for the maximum drive length and grouting operations. Evaluate as a minimum, axial, bending, shear, and buckling
2. Submit manufacturer's mill specification sheet listing diameter, thickness, and class of steel used in making the casing, and the mill certification.
3. Submit shop drawing of casing.
4. Submit shop drawing showing lay length and joint detail.
5. Submit manufacturer's pipe handling instructions.
6. If different casing diameter is used than that indicated on the Contract Drawings, submit written justification, including availability of closed face slurry microtunneling equipment for the alternate diameter, whichever is applicable.
7. Welder qualifications and welding certifications if welded casing pipe is submitted.

1.5 QUALITY ASSURANCE

A. The Contractor shall:

1. Record all changes and modifications to the work as required by site conditions and inspections in accordance with the Contract Documents.
2. In addition to complying with requirements of governmental agencies having jurisdiction, comply with the directions of the Owner.

**PART 2 -- PRODUCTS**

- A. Provide casing with minimum inside diameter and thickness as shown, unless the Contractor elects to adjust the excavated diameter to fit their means and methods, subject to acceptance by the Owner.
- B. The wall thickness of casing shall not be less than 0.5-inches.
- C. The Contractor may elect to increase the diameter to fit their means and methods. The Contractor shall provide written justification for review and acceptance of the Owner for the adjustment of the excavated diameter or the casing diameter. No additional cost to the contract will be allowed for an increase in the casing size to fit the Contractor's means and methods.
- D. Grout Ports
  1. Furnish pipe with grout ports as shown on the Drawings.

2. Use preinstalled threaded metal grout pipe ports with integral waterstops. Coat metal surfaces remaining exposed after casting of pipe with an approved epoxy paint system.
  - a. Field installation of ports is not allowed. Ports shall be cast during manufacture of the casing pipe.
- E. Provide casing that is specifically manufactured for jacking with a smooth outer wall and is manufactured to the following dimensional criteria:
  1. Circumference  $< 0.5\%$ , or 0.5-inch whichever is less.
  2. Exterior Roundness  $< 0.5\%$ , or 0.25-inch whichever is less.
  3. End Squareness  $\pm 1/16$ -inch
  4. Straightness deviation less than  $1/8$ -inch per 10 ft length
  5. Pipe Length  $\pm 0.25$ -inch
  6. Comply with ASTM A515, Grade 60 or approved equal.
  7. All casing segments shall be joined by continuous, full circumference, full penetration butt welds, or Permalok™ joint or approved equivalent. Joints shall be designed to prevent opening of joints.
  8. Joints must be capable of watertight performance for external hydrostatic pressures including external head pressure resulting from groundwater, construction activities and future development. The joint must be capable of efficiently transferring vertical and horizontal forces circumferentially through the pipe wall and joint.

### **PART 3 -- EXECUTION**

#### **3.1 CASING PIPE INSTALLATION**

- A. Methods: The Contractor shall install Steel Casing Pipe using microtunneling and equipment as specified in Section 33 05 23.19 – Microtunneling.
- B. Cleaning and Testing
  1. Cleaning:
    - a. Upon completion of the work of this Section, remove all rubbish, trash, and debris resulting from operations. Remove all intrusive materials, grout, soil, oil, and grease.
  2. Testing Pipe
    - a. Steel casing shall be visually inspected by the Owner after completion of the pipe jacking operation. No visible leakage will be allowed. Visible leakage will be repaired per manufacturer's recommendation.

### 3.2 INSPECTION

- A. All work done under this section shall be subject to inspection and acceptance by the Owner.

### 3.3 REPAIRS

- A. All damage detected shall be repaired in accordance with the requirements of the manufacturer and at no additional cost to the Owner.

END OF SECTION



## SECTION 33 05 23.41 – CONTACT GROUTING

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. This Section covers the work necessary for contact grouting including furnishing, mixing and placing grout; furnishing all labor, materials, equipment and incidentals; and all other related work necessary for grouting, complete.
- B. The work under this Section shall include: all work necessary to perform grouting operations including furnishing, handling, transporting, and storing of all materials and equipment for grouting; mixing and injecting grouts; capping, patching, and plugging the finished grout holes; cleanup of work areas; and all other operations incidental to grouting.
- C. Contact grouting is to fill gaps outside of the jacked casing pipe at completion of the microtunneling drive. Contact grouting includes using grout to fill void space between the ground where over excavation occurs including overcut by the microtunnel boring machine. Contact grouting is to be performed for the Magna Project 1B – Trenchless Crossing, and associated shafts.

#### 1.2 RELATED SECTIONS

- A. Section 33 05 23.19 – Microtunneling
- B. Section 33 05 23.05 – Shaft Excavation and Support
- C. Section 33 05 23.31 – Steel Casing Pipe
- D. Section 33 05 23.43 – Carrier Pipe Installation and Backfill

#### 1.3 REFERENCES, CODES AND STANDARDS

- A. The publications and standards listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the abbreviation only. Unless otherwise stated, the most recent version or edition of each publication or standard is implied.

##### 1. American Society for Testing and Materials (ASTM):

- a. A53, Standard Specification for Pipe, Steel, Black and Hot- Dipped, Zinc-Coated, Welded and Seamless.
- b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- c. C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens)C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of concrete
- d. C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
- e. C172 Standard Test Method for Sampling Freshly Mixed Concrete

- f. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
  - g. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
  - h. C940 Standard Test Method for Expansion and Bleeding of Freshly Mixed Grout for Preplaced Aggregate Concrete in the Laboratory
  - i. C1709, Standard Guide for Evaluation of Alternative Supplementary Cementitious Materials (ASCM) for Use in Concrete.
2. Utah Department of Transportation – Standard Specifications for Road and Bridge Construction

#### 1.4 DEFINITIONS

- A. Contact Grouting: An injection of neat cement grout into voids outside of initial support systems and final linings of shaft excavations and jacking pipe installed during microtunnel operations to achieve continuous and permanent contact between support systems or lining/casing pipe and the ground. This definition includes grouting the annular space outside the casing pipe string after microtunnel installations are complete.
- B. Refusal: The point at which grouting is stopped on a grout hole. It is defined as a grout injection rate of less than one-half cubic foot of grout over a 5-minute interval, at 100 percent of the required pressure.
- C. Voids: Spaces within soil that are filled with air, water, slurry or disturbed ground resulting in void ratios (volume of voids divided by volume of solids) greater than 2.0 in any given sample volume.

#### 1.5 SUBMITTALS

- A. Provide all submittals at least 30 days in advance of contact grouting operations, with the exception of daily reports, which are to be submitted per the schedule specified below.
- B. Grout Mixes:
  - 1. The CONTRACTOR shall submit to the Engineer all proposed grout mixes for contact grouting. The submittal shall be made a minimum of 30 days prior to start of grouting operations. The CONTRACTOR shall resubmit as appropriate if the mixes are modified during the course of the work.
  - 2. Submit mix designs for each contact grout mix proposed for use. Each mix design shall show the ingredients of the mix and shall include:
    - a. Type, brand, source, and amounts of cement, admixtures, and other additives.
    - b. Source and amount of water.

- c. Provide three representative UCS test results of the same grout materials and mix proportion.
    - d. Combined gradation of each mix design.
    - e. Specific gravity of all materials in the mix.
    - f. Results of each Uniaxial Compressive Strength (UCS) of required tests.
  - 3. Submit a certificate of compliance signed by the supplier identifying the type of fly ash (if used) and stating that the fly ash is in accordance with ASTM C618, Utah DOT Standard Specifications and these Specifications. Supporting test data shall be furnished for the proposed grout mixes. All testing and sampling procedures shall be in accordance with ASTM C311.
  - 4. Submit material specifications and instructions for use of any proposed concrete admixtures.
- C. Work Plan: The CONTRACTOR shall submit prior to the start of any excavation a work plan for contact grouting. The work plan for placing contact grout shall cover each type of contact grouting required and shall include:
- 1. Contact grouting methods, procedures and sequences for each tunnel segment as well as locations determined within the shafts that require contact grout.
  - 2. Method of transporting grouting equipment, grout, and materials into and within the tunnel and shafts.
  - 3. Quantitative prediction of grout volumes required at each location, with consideration of volume of annular space due to difference between the excavated diameter and outside diameter of initial support system or jacked pipe, ground loss volumes, soil stand-up time and diametrical closure.
  - 4. Means for measuring grout takes (volume) per foot or segment of initial support system or pipe.
  - 5. Means for measuring grout pressures and planned grout pressure limits for refusal criteria.
  - 6. Timing of grout injection.
  - 7. Maximum grout pressure for shaft and for tunnel, signed and sealed by the CONTRACTOR's Utah licensed professional engineer
- D. Grouting Equipment:
- 1. Submit prior to the start of grouting operations calibration records for all meters and gauges to be used in grouting operations.
  - 2. Submit the following for the contact grouting equipment proposed:
    - a. Manufacturer's specifications and operation instructions for grout conveyance equipment.
    - b. Pump specifications.

- c. Grout hose, valve and port sizes and specifications.
  - d. Grout pressure gauges and pressure gauge calibration data. Flowmeter to be used for measuring volumes including calibration data.
- E. Grouting Records and Testing: All sampling shall be performed in accordance with ASTM C172. Submit records of grouting operations as specified hereinafter.
  - 1. Submit prior to performing grouting of microtunnel segment:
    - a. Mill test reports for Portland cement.
    - b. Certificates of compliance for each load of Portland cement and fly ash (if used).
    - c. Certificates of compliance for all admixtures.
    - d. Proposed contact grout mix designs with mix data for all components, mix properties including admixtures, slump (per ASTM C143), wet unit weight, cured unit weight (per ASTM C138), bleed (per ASTM C940), height change (per ASTM C1090, and compressive strength tests (per ASTM C39 or C109) from an AASHTO and ASTM certified testing laboratory.
  - 2. Submit the following daily reports and records for contact grouting within a day of completion:
    - a. Daily logs of grouting operations at all contact grouting locations (station and position) of grout ports, including pressures, volumes, and grout mix pumped, times of injecting, locations where grout samples for test cylinders are taken, and grout slump results per ASTM C143.
    - b. An analysis of overcut annulus volume at the time of grouting with consideration of soil stand-up time, diametrical closure and effects of injected bentonite slurry volumes. Provide a comparison of anticipated annulus volume with grout volume placed by contact grouting for each pipe.
    - c. Compressive strength test reports from a certified testing laboratory in accordance with ASTM C39 or C109 test methods.

## **PART 2 -- PRODUCTS**

### **2.1 CONSTITUENTS OF PORTLAND CEMENT GROUT**

- A. Portland cement, water and flyash shall conform to the requirements of the Utah DOT Standard Specifications.
- B. Bentonite or other clay-like materials shall not be used as an admixture.

### **2.2 FLUIDIFIER**

- A. Fluidifier shall be a compound with characteristics that will hold the solid constituents of the grout in colloidal suspension, be compatible with the cement and water used in the grout mix and contain a shrinkage compensator. Fluidifier shall not contaminate

the groundwater.

- B. Fluidifier shall be furnished in moisture resistant paper sacks shipped in sealed containers and shall be handled and stored to avoid absorption of moisture, damage, or waste. Material which has become caked due to moisture absorption will be rejected.

### 2.3 CONTACT GROUT

- A. Contact grout shall consist of a mixture of water and Portland cement or other suitable materials, with mineral fillers or admixtures as necessary to achieve a non-shrink (less than 0.1% height change per ASTM C1090), non-bleed (0% wick induced bleed at 3 hours per ASTM C940) flowable grout. The grout shall have a minimum 24-hour compressive strength of 100 psi and a minimum 28-day compressive strength of 250 psi.

### 2.4 EQUIPMENT, CONTACT GROUTING

- A. Mixers shall be colloidal type capable of providing a homogenized mix and shall be capable of an impeller speed of not less than 1500 RPM. The grout mixer shall pump the grout into a mechanically agitated holding tank. Mixer and mechanical agitator tanks shall be of sufficient capacity to ensure an uninterrupted supply of grout to the grout pump. Means of accurately measuring the separate grout ingredients at the mixer shall be provided. Means shall be provided for increasing or decreasing the water-cement ratio, as required by the ground conditions encountered.
  - 1. Pumping equipment shall deliver grout from the holding tank to the point of injection at a steady pressure without pulsation. Grout pumps shall be capable of delivering grout to the point of injection at a pressure equal to 3 psi for every foot of overburden. Pumping equipment shall be capable of handling water-cement ratios of the CONTRACTOR's proposed mix design.
  - 2. Means shall be provided for accurately determining the amount of grout injected with a flowmeter. The flowmeter shall be accurate within 10 percent at a flow rate of 2.5 gallons per minute.
  - 3. The grout plant shall be equipped with reliable pressure gauges at point of injection and at the pump. The pressure gauges shall have a range such that the maximum pressure specified shall be approximately two thirds of the capacity of the gauge. The gauges shall be protected from grout contamination by an oil or air buffer and shall be easily cleaned in the field.
  - 4. Flexible hose for pressure grouting shall have an inside diameter not less than 1 inch and shall be capable of withstanding the maximum water and grout pressures to be used. Grout pipes shall have an inside diameter of 1.5 inch or larger. A diaphragm valve shall be provided on each grout hose and a straightway valve at each grout pipe to regulate flow. Packers for grouting shall be pneumatic, hydraulic, or mechanical expandable rubber packers.
  - 5. At the point of injection or bulkhead, suitable valves and pressure gauge shall be provided so that the pressure may be monitored, and the grout flow regulated by increasing or decreasing the flow. Suitable stop valves shall be provided at the collar of the hole for use in maintaining pressure as required until the grout has set.

6. All metal pipe, standard plugs and fittings required for grouting operations shall be minimum Schedule 40 pipe conforming to ASTM Designation A53.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

- A. The OWNER shall be notified at least 24 hours in advance of the start of grouting operations.
- B. If out of visible contact, continuous communication shall be maintained between the CONTRACTOR's personnel at the grout plant and the injection point by radio or other means acceptable to the OWNER.
- C. Grout in the mixer and holding tanks shall be continuously agitated. Portland cement grout which is not injected into the hole within 2 hours after mixing shall be removed from the mixer, holding tank and supply line and shall be discarded.
- D. Grout shall be maintained at temperature above 50° F until injected. The temperatures of mixing water shall range from 50° F to 100° F when added to the grout mixer. Grout materials shall be stored at temperatures above freezing. Grouted ground shall be no colder than 41° F when grout is injected.
- E. Grout holes shall be protected from becoming clogged or obstructed prior to grouting by means of a cap or other suitable device on the collar of the hole. Any hole that becomes blocked or otherwise unsuitable for its intended purpose shall be cleaned out in a satisfactory manner or replaced at the expense of the CONTRACTOR.
- F. All grout hole locations shall be flagged and protected. In addition, they shall be clearly labeled for easy identification and shall be clearly visible.
- G. Contact grouting shall be performed in such a manner as to reduce groundwater inflow, to fill voids, to minimize ground movement into the excavation, and to provide firm and uniform contact between the support system and the ground.
- H. Equipment and lines shall be kept clean by constant circulation of grout and periodic flushing with water. Leakage from connections shall not be permitted. Plugs on ends of nearby grout holes or pipes shall be removed to permit escape of air and water and the filling of spaces with grout.
- I. Once started, grouting of a hole shall not be interrupted. Grouting of a hole shall not be considered complete until that hole refuses to take grout as defined under Paragraph 1.04, DEFINITIONS. After grouting of a holding or any stage of a hole has reached refusal, the pressure on the hole shall be maintained by means of a stopcock or other suitable device until the grout has set. The grouting of any hole shall not be considered complete until all voids have been filled to the maximum extent practicable. After the grouting of any hole is finished, the pressure shall be maintained by means of the stop valve until the grout has set to the extent that it will be retained in the hole.
- J. Check operating gauges daily to determine that they are in working order. Do not grout without appropriate gauges in place and in working order.
- K. Where grouting in soil, the grouting pressure at the injection point shall not exceed 0.5 psi per foot of depth of soil overburden, unless otherwise proposed by the

CONTRACTOR, with the Engineer's concurrence. In all cases, the grouting pressures shall be limited as necessary to avoid damage to the pipeline and avoid grout release at the ground surface.

### 3.2 CONTACT GROUTING

#### A. Contact Grouting for Shaft Excavations:

1. Perform contact grouting outside of casing immediately after completion of the microtunnel drive.
2. Locate grout holes as necessary to accomplish the work and to thoroughly fill the voids outside of the initial support system. Drill grout holes for contact grouting through the initial supports and into the annular space between the initial support and surrounding ground.
3. Perform contact grouting to reduce groundwater inflow, to fill voids, to minimize ground movement into the excavation, and to provide firm and uniform contact between the support system and the ground. The CONTRACTOR's ground support design engineer shall determine a refusal criteria and the maximum grout pressure that is consistent with the design of the ground support system. The ENGINEER may periodically request that check holes be drilled to determine if unacceptable voids exist outside of the ground support system. Additional contact grouting shall be completed at no additional cost to the OWNER where checking indicates the presence of unacceptable voids.

#### B. Contact Grouting of Casing Pipe Installed by Microtunneling:

1. For grouting of casing pipe, commence contact grouting promptly (within 48 hours) following completion of the drive. Once started for a tunnel drive, perform continuous contact grouting until contact grouting for the entire drive has been completed.
2. Inject grout in continuous progression of the grout holes along the length of the tunnel. At any time during the grouting operations, sufficient contact grout holes ahead of the hole to be grouted shall be opened, plugs removed, holes cleaned, and valves attached for controlled discharge (venting) of lubrication slurry, disturbed soil and groundwater within the overcut annulus. Ports shall be closed if there is uncontrolled release of slurry, soil, or groundwater. Keep grout port valves in a fully open position within a maximum safe grout communication distance, as determined by the CONTRACTOR and reviewed by the ENGINEER in the contact grouting submittal. This distance may vary along the tunnel with variations in adjacent soil and groundwater conditions. Close or regulate discharge at ports opened for venting, as necessary to prevent lost ground from squeezing, a blow-in, or excessive groundwater seepage. Continue venting from each opened port until grout of normal consistency (not mixed with slurry, soil, or water) is discharged from the vent holes. Ports shall be closed if uncontrolled release of lubrication or water occurs or if any ground loss through port is observed. After an acceptable grout discharge is observed at a port, close the valve until a hook-up is made at the port for injection of grout.
3. Attempt to hook-up and pump grout at every port. In general, contact grouting at a port will be considered completed when refusal is met per the definition in 1.04 (also see section 3.1.I). After grouting is finished, the valve shall be closed until

grout has set. After a valve is closed following injection, the grout header and hoses shall be moved to the next port in progression.

4. Volume of contact grout injected shall be measured, recorded, and compared with the anticipated volume per foot of pipe grouted with compensation for grout wasted in lines and vented through ports. Submit this data as part of the grouting record submittals.
5. At the completion of grouting, remove valves after grout has set and replace valves with screw type grout plugs.

### 3.3 GROUT AND DRAINAGE HOLES

- A. Grout ports for contact grouting of jacking pipe shall be pre-installed pipe nipples. Holes for injecting grout through jacking pipe or to allow air release or drainage during grouting shall be formed by casting in the pipe. New grout holes shall not be drilled through pipe walls.
- B. Grout pipes shall be fixed in the holes in the casing pipe to prevent grout return around the perimeter of the pipe. Grout pipes and fittings shall be thoroughly cleaned before connecting to each grout hole. Grout pipes shall be set so that grout can flow freely to voids behind the pipe.
- C. Suitable stop valves shall be provided at the collar of the grout hole for use in maintaining pressure as required until the grout has set.

### 3.4 FIELD QUALITY CONTROL

- A. Data or notes taken by the ENGINEER during periodic inspections of grouting will not relieve the CONTRACTOR's responsibility in documenting grouting operations.
- B. Test three cylinders for every 250 cubic feet or fraction thereof of grout placed. Minimum cylinder diameter shall be 3 inches. Tests performed on grout cubes or prisms shall not be accepted for verifying strength.
- C. During grouting operations, verify:
  1. Hole location, depth, and spacing satisfy criteria specified herein.
  2. Ensure that grouting is performed from the bottom upwards, and continuously in all aspects.
  3. Communication between grout holes.
  4. Maximum recommended grout pressures are not exceeded.
  5. Grout mixes satisfy the criteria specified herein.
  6. Grout lines are not plugged or obstructed.
  7. Grouting operations are performed in the correct sequence, specified herein.
  8. Closure criteria and/or refusal criteria are satisfied prior to terminating grouting of each hole.



D. Master Gauges and Meters:

1. Perform testing of all field gauges and meters no less often than weekly using master gauges and meters.
2. Perform field tests in the presence of the ENGINEER.
3. Verify accuracy of master gauges and meters through the use of a test laboratory no less frequently than every two months.

3.5 RECORDS

- A. The CONTRACTOR shall record the stationing and the volume of contact grout pumped and grout pressure behind the tunnel lining/casing pipe or shaft support lining during each day of grouting at each grout hole location. The records shall be submitted to the ENGINEER after each day of grouting by noon on the following day.

3.6 CLEANUP

- A. The CONTRACTOR shall prevent the setting of grout which may escape upon finished pipe or structure surfaces, and shall remove such grout slurry, water and all other materials, and restore the surface to its original condition.

END OF SECTION

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## **SECTION 33 05 23.43 – CARRIER PIPE INSTALLATION AND BACKFILL**

### **PART 1 – GENERAL**

#### **1.1 SUMMARY**

- A. This Section presents requirements for installation of the Carrier Pipe in the steel casing and backfilling the annulus.

#### **1.2 REQUIREMENTS**

- A. The annulus outside Carrier Pipe shall be completely backfilled throughout the entire tunnel length.
- B. Backfill shall be cellular concrete.
- C. Backfilling shall be conducted in accordance with all the requirements for safety, permits and underground work presented Section 33 05 23.19– Microtunneling.
- D. The CONTRACTOR shall provide testing of materials and verification of material properties as stated in Section 33 95 43

#### **1.3 REGULATORY REQUIREMENTS**

- A. Submit compliance documentation for the covered products prior to delivery to the site.
- B. Provide step certification for all covered products from the time of raw material fabrication to final assembly.
- C. Utilize the certification form included in these specifications.

#### **1.4 QUALIFICATIONS**

- A. The Installation Specialty CONTRACTOR or subcontractor shall meet all of the following experience requirements:
  - 1. At least five years of experience in the installation of pipe in tunnels.
  - 2. Have successfully completed at least three projects installing prefabricated pipe in tunnels. At least two of those projects shall have used similar methods in which a pipe string was pushed into a tunnel.
- B. The Backfilling Specialty Contractor or subcontractor shall meet all the following experience requirements:
  - 1. At least five years of experience in the development and use of cellular concrete for tunnels and underground excavations.
  - 2. Have successfully completed at least three similar backfill projects with cellular concrete using equipment and methods similar to this project. At least two of those projects shall have used backfill delivery lines to introduce and verify backfill of cellular concrete in a tunnel.

- C. The Installation Superintendent shall meet all of the following experience requirements:
  - 1. At least five years of experience in tunneling and placement of prefabricated pipes in tunnels.
  - 2. Have successfully completed at least three jobs within the last five years installing prefabricated pipe in tunnels and been in responsible charge of at least one of those projects. At least two of those projects shall have used similar methods in which a pipe string was pushed or pulled into a tunnel.
  - 3. The Installation Superintendent shall be thoroughly knowledgeable about the transportation, placement, securement of prefabricated pipe in tunnels, and shall be knowledgeable about cellular concrete and backfilling.
- D. The Backfilling Superintendent shall meet all of the following experience requirements:
  - 1. The Backfill Superintendent shall be thoroughly knowledgeable about the properties behavior and placement methods of cellular concrete including in underground applications.
  - 2. At least five years of experience in tunneling and backfilling with cellular concrete for tunnels and underground excavations.
  - 3. Have successfully completed at least three similar projects within the last five years and been in responsible charge of at least one of those projects. At least two
  - 4. of those jobs shall have used backfill delivery lines to introduce and verify backfill of cellular concrete in a tunnel.
  - 5. The Backfill Superintendent shall be approved by the manufacturer and supplier of foaming agent to use the foaming agent with the methods and equipment proposed.

#### 1.5 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00.
- B. Pre-Construction Submittals:
  - 1. Written documentation summarizing the qualifications and experience of the CONTRACTOR's Installation and Backfilling specialty contractor or subcontractor including details of the projects listed in fulfillment of the required experience.
  - 2. Detailed Pipe Installation and Backfill Work Plan describing the methods, equipment and materials of the work. The submittal shall include the following as a minimum:
    - a. Descriptions and shop drawings describing and illustrating methods and equipment proposed for installation of the carrier pipe in the tunnel. The submittal shall address as a minimum pipe transportation, assembly of the carrier pipe with the pipe supports, pipe section joining, and jacking.

Descriptions, shop drawings, and calculations for securing the pipe during annulus backfilling. Calculations shall be submitted which evaluate: the buoyant force(s) generated during backfilling of each stage; the loads on the pipe supports; stresses on the carrier pipes; bending stresses on the carrier pipe between the pipe supports, maximum number of lifts required to meet a factor of safety of 2.0 against pipe floatation, and the maximum allowable backfill injection pressure. The calculations shall be prepared, stamped by and sealed by a Professional Engineer registered in the State of Utah with experience in comparable tunneling and pipeline work.

- b. Provide method and equipment for measuring the jacking force on the pipe during the pullback operation for real-time measurements and recording of the maximum stress imposed on the pipe during installation.
- c. Provide temperature calculations for the heat of hydration of the cellular concrete. Provide sufficient factor of safety to not melt or alter the physical properties of the PVC pipe.
- d. Certification from the pipe supplier that proposed securing details to prevent floatation, and backfilling procedures are in accordance with their recommendations and will not damage pipe.
- e. Design and details of the pipe supports including manufacturer and model number if applicable.
- f. Backfill mix including: 1) proportions of constituent materials, 2) wet properties of density and viscosity, 3) properties of the cured backfill including density and strength.
- g. Description of equipment and methods proposed to mix cellular concrete, including mixing equipment, quantity controls and instrumentation. Description of trial batches, trial batch testing and proof of acceptable delivery and placement of cellular concrete in the tunnel.
- h. Arrangement of the backfill injection points and backfill delivery lines in the tunnel including the length, position, and termination point of lines.
- i. Sequence and pressure(s) for backfilling including stages and observations of verification of backfill position such as with backflow and sensing through the backfill delivery lines, and verification that the backfill is complete.
- j. Injection methods for the backfill including pumping equipment, hoses, boosters, pumping distances, flow rates, and pressures. Include methods and description of instrumentation to monitor and control placement of the backfill, and procedures to be used to verify backfill volumes.

### 3. Construction Submittals

- a. Pipe Installation and Backfill Schedule. Submit a schedule of pipe installation and backfill activities at least three weeks before beginning the work and update weekly. Notify the Owner at least one working day in advance of schedule changes.

- b. Written Installation and Backfill Logs. The written daily logs shall have as a minimum the information specified below in this section. Logs shall be submitted at the end of each shift.
  - c. Results of all material tests specified herein. Test results shall be submitted within one week after completion of each test.
  - d. Written Daily Logs. The written daily logs shall have as a minimum the information specified in Part 3 below in this Section.
  - e. Results of all material tests specified herein including field tests and laboratory tests. Test results shall be submitted within one week after completion of each test.
  - f. Survey results of the carrier pipe prior to installation of the casing pipe.
4. Post-Construction Submittals.
- a. Summary sheet of the quantity of backfill placed each shift, the total backfill placed, and the theoretical volume of the annulus.

## **PART 2 -- EQUIPMENT AND PRODUCTS**

### **2.1 MATERIALS**

#### **A. Annulus Backfill**

- 1. Annulus Backfill shall be cellular concrete.
- 2. Cellular concrete shall be composed of cement, water and foam. No aggregate or fillers are allowed. Additives may be used only with review of the ENGINEER.
- 3. The foaming agent for cellular concrete shall be in accordance with ASTM C 869 and shall be tested in accordance with ASTM C 796.
- 4. Cellular concrete shall have a minimum wet density of 40 pcf.
- 5. Cellular concrete shall have a minimum 7-day compressive strength of 250 psi and minimum 28-day compressive strength of 250 psi and shall be tested in accordance with ASTM C 495.

### **2.2 PRODUCTS**

- A. Backfill Delivery Lines: Small diameter sacrificial pipes used to introduce backfill into the tunnel and to monitor the progress of the backfill operation. The CONTRACTOR shall determine the size and material for the backfill delivery lines. The backfill delivery lines shall not soften, deform, or melt with the temperatures experienced in the backfill operation.
- B. Carrier Pipe Support (Casing Spacers)
  - 1. Casing Spacers shall be constructed of circular stainless-steel bands, which bolt together forming a shell around the carrier pipe. The spacers shall be designed with risers and runners to support the carrier pipe within the casing and maintain

a clearance of no greater than one inch between the casing ID and the spacer OD. The design shall maintain pipeline integrity in the event the pipeline floats during installation of backfill grouting.

2. The band shall be manufactured of 12 inches wide 14-gauge T-304 stainless steel. The risers shall be constructed of 10-gauge T-304 stainless steel having a minimum length of 10 inches and a height to be determined based on the annular space  
between the carrier OD and the casing ID. The number of runners and risers is to be determined by the manufacturer's recommendation.
3. Abrasion resistant runners, having a minimum length of 10 inches and a minimum width of 2 inches, shall be attached to each band and/or riser to minimize friction between the casing pipe and the carrier pipe as it is installed. Runner material shall be a polymer with a minimum compressive strength of 33,000 psi, flexural strength of 40,000 psi and tensile strength of 27,000 psi. The ends of all runners shall be beveled to facilitate installation over rough weld beads or welded ends of misaligned or deformed casing pipe.
4. Interior surfaces of the circular stainless-steel band shall be lined with PVC, having a minimum thickness of .090 inches with a hardness of Durometer "A" 85
5. Position spacers 1 to 2 feet on either side of the joint and one placed every 6 – 8 feet apart thereafter.
6. Casing spacers must be situated such that a minimum of 2 inches is present between the inner diameter of the casing pipe and the outer diameter of the carrier pipe. See carrier pipe and casing spacer drawings for details.
7. Manufacturers:
  - a. PSI Products, Inc. (Vancouver, BC)
  - b. Advance Product & System, Inc. (Lafayette, LA)
  - c. Approved Equal

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

- A. Do not begin Work until:
  1. Required submittals have been made and approved.
  2. All monitoring and instrumentation has been installed and initial measurements have been obtained.
  3. A pre-job method and means conference has been conducted. Arrange this conference and inform the Owner of the time and place of the conference at least seven days in advance.
  4. The casing pipe has been contact grouted.

5. The line and grade of the tunnel have been surveyed and have been verified to allow for installation of the carrier pipes to the tolerances and clearances specified and shown.
6. The tunnel has been cleaned with removal of debris, dirt and deleterious materials resulting in clean bare inside face of the casing pipe.
  - a. Verify conditions prior to commencement of work including layout and field measurements and notify the Owner of discrepancies.

### 3.2 PIPE INSTALLATION AND SECURING

- A. The carrier pipe shall be installed in the tunnel by jacking a pre-assembled string of completed carrier pipe into the tunnel. Joints for the carrier pipes shall be assembled incrementally in the launching shaft as the casing pipes are jacked into the tunnel.
- B. The carrier pipes shall be secured in the tunnel with pipe supports.
- C. Pipe supports shall be spaced as necessary to prevent movement during all installation phases including but not limited to jacking, in-place without backfill, backfilling, and completely surrounded with wet backfill. Ensure that the carrier pipe and each pipe segment are firmly secured to prevent flotation, settlement, lateral and axial movement, and pipe deflection
- D. Pipe joints shall be mated and secured in accordance with the pipe manufacturer's requirements and the Contract Documents.
- E. Use ballast in the carrier pipe in combination with limited backfill lifts as needed to stabilize the carrier pipes.

### 3.3 BACKFILL PLACEMENT

- A. Remove all standing water from interior of casing prior to commencing backfill placement.
- B. Backfill shall be introduced into the annulus at the shafts and with backfill delivery lines.
- C. Completely backfill the annulus between the carrier pipe and the casing pipe with annulus backfill. Completely fill the spaces below and around the carrier pipes.
- D. The injection points for annulus backfill shall be at intervals of 100 feet or less along the length of the tunnel. Closer spacing of discharge points shall be used as necessary to assure continuity of the backfill.
- E. The method of backfilling shall ensure that the annulus is completely filled between injection points and from the tunnel invert to the tunnel crown. Verification of satisfactory backfilling shall be determined as the difference between the calculated annulus volume and the actual volume of backfill placed being within 1 percent.
- F. Place backfill in a continuously advancing front beginning at one end of the tunnel and advancing to the other end. The methods and sequence of placement shall advance a front of backfill from one end of the tunnel to the other assuring complete coverage and that there are no remaining voids or trapped air pockets.



- G. Use the backfill delivery lines to track the location of the front of the backfill by sensing with slight air pressure and/or return of backfill through the lines. Sequentially use each of the backfill delivery lines to place backfill at each injection point. Inject the backfill only below the surface of the backfill using methods similar to tremie placement.

#### 3.4 TOLERANCES

- A. The carrier pipe shall be installed in the casing pipe within +/- 1-inch vertically and horizontally of the design line and grade shown on the drawings.

#### 3.5 SURVEY

- A. Survey the invert of the casing pipe at intervals not exceeding 20 feet prior to installation of the carrier pipes.
- B. The survey shall be for both line and grade to an accuracy of 0.01 feet or better.

#### 3.6 BACKFILL TESTING

- A. Test methods shall be in accordance with ASTM C 495. Cast the specimens into blocks made from a weak material such as polystyrene foam with cylindrical holes. Separate and remove the specimens for testing by cutting and trimming the block material surrounding the cylinders.
- B. Cellular Concrete Mix Design: Two sets of compression test specimens shall be made. One set of specimens shall be tested at an age of 7 days and the other set shall be tested at an age of 28 days. The mix shall be tested for unit weight, viscosity, and air content at the time of cylinder casting.
- C. Index Testing of Cellular Concrete: A set of index tests shall be made from the first batch of cellular concrete mixed each day, after a change in mix design, and from each batch of cellular concrete from which compression test specimens are made. Additionally, index tests shall be conducted two hours to verify the concrete's properties. Index tests shall include as a minimum: the wet unit weight (wet density), viscosity, and air content at the time of placement.
- D. Compression Testing of Cellular Concrete: A minimum of one set specimens shall be made each day when up to 25 cubic yards of cellular concrete is placed. At least one additional set of specimens shall be made from each additional 50 cubic yards, or major fraction thereof, placed in any one day, but no more than three sets of specimens will be required for each day. Two specimens of each set shall be tested at an age of 7 days and two specimens shall be tested at an age of 28 days. One specimen shall be held in storage. For tests of Annulus Backfill and at the CONTRACTOR's option as an alternative to the 7-day tests, tests may be conducted at any time not exceeding 14 days.

#### 3.7 QUALITY ASSURANCE AND QUALITY CONTROL

- A. Monitor and record as a minimum all data necessary to complete the required Submittals.
- B. Pressure gauges of appropriate diameters and ranges for monitoring the Annulus Backfill injection pressures shall be located as close as possible to the point of injection

in the line transporting the backfill grout.

- C. The volume of annulus backfill injected shall be measured, recorded, and compared with the anticipated volume per foot of annulus backfill. A flowmeter shall be used during backfilling to verify volumes.
- D. Before placement of annulus backfill in the tunnel, demonstrate, using trial mixes of the same design as those proposed for use and the same equipment proposed for placement,  
the ability to produce cellular concrete of the required density and strength. Demonstrate the ability to pump the cellular concrete mix the distances proposed without loss of cellular concrete quality. This requirement may be satisfied by providing records from previous projects in which the same mix, water and cement sources, materials and equipment were successfully used.
- E. Samples of annulus backfill shall be obtained from the backfill delivery lines at the tunnel portal or alternatively at a simulated point of discharge through the same or greater pumping distance.
- F. In addition to the tests required to be performed by the CONTRACTOR, the CONTRACTOR shall take samples for the Owner and/or allow access for the Owner to obtain samples of the backfill, as determined by the Owner.

### 3.8 CONSTRUCTION RECORDS

- A. The CONTRACTOR shall maintain written Daily Logs for pipe installation and backfilling. The Daily Logs shall be signed by the Backfilling Specialty Contractor as appropriate, or the Superintendent or Foreman and shall contain the following:
  - 1. Crews and subcontractors onsite with their personnel and equipment, and the work performed. The reports shall be broken down into work time and down/standby time for each crew and subcontractor.
  - 2. Record of Carrier Pipe installed and position of the leading edge of the Carrier Pipe.
  - 3. Record of backfill quantity with the total for the day and quantity injected into each point, and the delivery pressures in each.
  - 4. Records of the verification of Backfill advance from the air pressure and backfill backflow through backfill delivery lines and other methods.
  - 5. Results of material property tests performed.
  - 6. Problems or unusual conditions encountered, and actions taken to address these situations.

### 3.9 CLEANUP AND RESTORATION

- A. Following each work item, remove all equipment, unused materials, and debris from the site.

END OF SECTION

**SECTION 33 05 23.45 – SETTLEMENT MONITORING  
FOR TRENCHLESS UTILITY INSTALLATIONS**

**PART 1 -- GENERAL**

**1.1 GENERAL REQUIREMENTS**

**A. SCOPE:**

1. This section includes the minimum requirements for furnishing, installing, and monitoring settlement for measuring ground movements around and above trenchless construction operations. The work includes, but is not limited to, installing and monitoring reflectorless monitoring points, surface monitoring points, subsurface monitoring points, inclinometers, and piezometers; furnishing monitoring equipment; and recording observations and measurements from the monitoring instruments on a periodic basis before, during, and after trenchless construction.
2. The CONTRACTOR is responsible for surveying the elevations of the monitoring points, and other instrumentation locations in accordance with the requirements of this Section. Starting elevations shall be determined before operations begin to establish a baseline, and during and after operations to monitor any movements related to the trenchless construction. All monitoring points shall be surveyed after trenchless construction has been completed to evaluate long-term settlements, as specified herein.
3. Minimum monitoring point location requirements are shown on the Contract Documents and specified herein. Additionally, the CONTRACTOR shall install other monitoring points as necessary to control operations, monitor ground conditions and ground response to achieve specified project requirements, and to prevent damage to existing structures, utilities, and facilities.
4. CONTRACTOR shall review and become thoroughly familiar with the soils and groundwater conditions as presented in the Geotechnical Report prepared for the Project by others and attached as Appendix A.

**1.2 REFERENCES**

**A. DEFINITIONS:**

1. Monument Covers: A locking steel enclosure case installed to provide protection for instrumentation from vandalism, traffic, and/or debris.
2. Soil Deformation Monitoring Point (SDMP): A system for monitoring vertical deformation (settlement or heave) below the ground surface using optical survey techniques.
3. Inclinometer (INC): An instrument in which an inclinometer probe is lowered into a specially grooved inclinometer casing to monitor horizontal ground displacements relative to fixity at the bottom of the casing that might occur during excavation of shafts or other subsurface structures.

4. Optical Survey Target (OST): Target established to monitor by optical survey methods the occurrence and amount of vertical and horizontal displacements.
5. Open Standpipe Piezometer (OSP): Open standpipe piezometers (or piezometers) shall consist of a slotted PVC well screen and a PVC riser pipe installed in a borehole at a prescribed depth. The slotted well screen is installed in a sand filter at the base of the borehole. The top of the sensing zone is sealed with bentonite and the annulus around the riser pipe is filled with grout.
6. Automatic Total Station (ATS): Total station programmed to automatically monitor and record vertical displacements of reflectorless points on specified time intervals.
7. Reflectorless Point (RLP): Location established to monitor vertical displacements by automatic total station (ATS) that does not involve installation of a reflector or target on the ground.
8. Monitoring Point Array (MPA): Monitoring points arranged perpendicular to the tunnel alignment to capture lateral extents of settlement.

### 1.3 SUBMITTALS

- A. The following information shall be submitted for review in accordance with Section 01 33 00:
  1. A copy of this specification section, with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.
  2. Qualifications: Submit surveying personnel qualifications in accordance with this Section.
  3. Submit the following, at least one month before scheduled installation of monitoring points:
    - a. Monitoring Point Schedule: Submit the proposed schedule for installing the surface and subsurface monitoring points.
    - b. Description of methods and materials for installing and protecting surface and subsurface monitoring points.
    - c. If deviations from the locations shown on the Contract Documents are proposed, submit drawings with locations of proposed monitoring points shown in plan and profile.
    - d. Product Data: Cut sheets from manufacturers' catalogs indicating make and model number for each type of data acquisition and management system, instrumentation component, and monitoring device shall be submitted at least 30 days prior to installing instruments.
    - e. Plan for taking corrective measures when Threshold Value, Contractor Response Value, and Maximum Allowable Value are reached.
    - f. Drill Logs: Boring logs describing soils encountered while drilling to install

instruments in boreholes. Field logs shall not be an acceptable submittal. Soils shall be classified in accordance with ASTM D2487 and D2488.

- g. Pre-construction and post-construction surveys.
- h. Locations of all reference prisms for ATS.

#### 1.4 Reports and Records:

- A. The CONTRACTOR shall submit all reports of monitoring data to the OWNER daily.
- B. Within 72 hours following installation of the monitoring points, submit:
  - 1. Drawings showing the actual as-built installed location
  - 2. Monitoring point identification number
  - 3. Monitoring point type
  - 4. Installation date and time
  - 5. For subsurface monitoring points: tip elevation and monitoring point length
  - 6. Details of installed monitoring points, accessories, and protective measures including all dimensions and materials used.
- C. Submit surveyed measurements of all monitoring points at least seven days prior to commencing trenchless operations to establish baseline readings.
- D. Submit surveyed measurements of monitoring points during and after construction in accordance with Paragraph 3.02 of this Section.
- E. A daily report including a summary of all monitoring data collected the previous day. Provide the data in electronic form suitable for plotting, and in hard copy, in a format acceptable to the OWNER and ENGINEER.

#### 1.5 DESIGN CRITERIA

- A. Ground movements shall be limited to values that will not cause damage to existing structure, utilities, and facilities. Appropriate ground control measures shall be taken to prevent settlements from exceeding the applicable values listed in Table 1 below and values listed in applicable permits.

**Table 1 – Maximum Allowable Ground Movements**

<b>Site Feature</b>	<b>Maximum Allowable Movement (inches)</b>
HWY 201 Pavement (Vertical)	0.5
Underground Utilities (Vertical and Horizontal)	0.5

Unimproved Ground (Vertical)	0.5
Inclinometers and Optical Survey Targets at Shafts	0.5

- B. When the monitoring points indicate movement equal to 50 percent of the maximum allowable value has occurred, the Threshold Value is said to have been reached. At this time, the CONTRACTOR shall meet with the OWNER and ENGINEER to discuss their construction means and methods to determine what changes, if any, shall be made to better control ground movement.
- C. When the monitoring points indicate movement equal to 90 percent of the maximum allowable value has occurred, the Contractor Response Value is said to have been reached. At this time, the CONTRACTOR shall actively control ground movement to prevent reaching the Shutdown Value.
- D. When the monitoring points indicate movement equal to 100 percent of the maximum allowable value has occurred, the Shutdown Value is said to have been reached. At this time, the CONTRACTOR shall stop all work immediately, except for that work required to continue to stabilize the tunnel face and annulus, and must meet with the OWNER and ENGINEER to develop a plan of action before work can be resumed.
- E. When the threshold value is reached, the frequency of readings for any affected instruments shall be double the frequency stated in in Section 3.05, whichever is applicable, or as otherwise directed by the ENGINEER. The increased frequency of reading shall be maintained until readings made during five consecutive working days are below the Threshold Value for the instrument(s) in question or reading values have stabilized as determined by the ENGINEER.

#### 1.6 QUALITY ASSURANCE

- A. Surveyor Qualifications: All surveying shall be performed by a land surveyor licensed in the State of Utah with at least three years of experience surveying for the detection of surface deformations.
- B. Should actual field conditions prevent installation of one or more monitoring point(s) at the location shown on the Contract Documents, obtain written acceptance from the ENGINEER for new instrument location and elevation.
- C. Surveying for monitoring settlement shall be referenced to the same control points and benchmarks established for setting out the work. Control points shall be tied to benchmarks and other monuments outside of the zone of influence of the excavation or trenchless construction.
- D. CONTRACTOR shall provide access and assistance to the OWNER and ENGINEER for obtaining supplemental monitoring data, as requested.
- E. Notify OWNER and ENGINEER immediately if any threshold, response, or shutdown values are reached.

## PART 2 -- PRODUCTS

## 2.1 SURFACE MONITORING POINTS (SMP)

- A. Surface settlement markers in paved areas shall be hardened steel markers with an exposed convex head having a minimum diameter of 1/2 inch, a minimum length of 2 inches, and similar to surveyor's "PK" nails.
- B. Surface settlement markers in unpaved areas shall be 2-inch by 2-inch by 12-inch long hardwood hubs driven to grade.

## 2.2 Soil Deformation Monitoring Points (SDMP)

- A. Provide soil deformation monitoring points as shown on the Contract Drawings.

## 2.3 INCLINOMETER SYSTEM (INC)

- A. Provide an inclinometer readout system that is capable of data storage and retrieval, storing inclinometer readings, and to present the data for immediate representation by the printer in either tabular or graphic form, or both. The system shall allow editing, correction and adjustment of data, and shall provide error checking routines.
- B. Casing shall be aluminum or plastic pipe with internal longitudinal grooves, and with telescoping couplings, caps, and fittings, as indicated or required. Casing shall have a minimum inside diameter of 2.75 inches.
- C. Provide inclinometer sensor with 50 feet of cable.

## 2.4 OPEN STANDPIPE PIEZOMETERS (OSP)

- A. Piezometers shall consist of 2-inch nominal diameter Schedule 40 PVC riser pipe with a vented cap in which an air vent hole 0.2 inches in diameter has been drilled and a slotted Schedule 40 PVC well screen. The cap shall be easy to remove. The well screen shall conform to the requirements shown on the drawings.
- B. Filter sand shall conform to ASTM C778, Standard Specification for Standard Sand, type 20-30 sand.
- C. Granular bentonite shall be Enviropug Medium, as manufactured by Wyo-Ben, Inc., Billings, Montana, or Holeplug, as manufactured by Barold Division, Petroleum Services, Inc., Houston, Texas, or equal.
- D. Water level indicator shall be an electrical indicator cable of appropriate length with graduations at 12-inch or smaller intervals.

## 2.5 OPTICAL SURVEY TARGETS (OST)

- A. Surveyor's prisms or reflectors compatible with the survey equipment used and capable of providing measurements within the specified tolerances. Provide optical survey targets as shown on the Contract Drawings.

## 2.6 ACCESS COVERS

- A. Furnish access cover and install at the ground surface to protect installed inclinometer casings, soil deformation monitoring points, and piezometers. Use steel of sufficient

strength to withstand AASHTO (HS-20) truck loadings where traffic rated covers are required. Provide a traffic rated, minimum 8 inches ID, watertight access cover. Grout covers in place in areas where instrumentation is subject to damage by construction operation. Install suitable barriers or guard posts as necessary to protect the monuments.

## 2.7 AUTOMATIC TOTAL STATION (ATS)

- A. Use Soldera Centaur automatic total station or equivalent. The CONTRACTOR shall choose suitable positions of the Automatic Total Stations to provide continuous readings of optical survey targets on structures and reflectorless monitoring points. Automatic total stations shall be robust and weather resistant, and be capable of operating to the specified accuracy in all weather conditions. ATS shall be suitably mounted on a secure foundation or purpose-built bracket. The mounting shall be birdproof and vandal and theft proof. The positions of the reference prisms are to be selected by the CONTRACTOR outside of the construction zone, and zone of influence of the underground works. Where reference points are within the zone of influence the data processing software shall recalculate the position of these points based on survey by other ATS to allow correct calculation of the position of all total stations using those reference points. The CONTRACTOR shall propose the number and position of reference points outside the zone of influence subject to the agreement of the ENGINEER. Results from monitoring of reflectorless target positions by the automated total monitoring station shall be presented as change in elevations with an overall accuracy of 0.1 inches. Reflectorless target positions are shown in the Contract Drawings.

## PART 3 -- EXECUTION

### 3.1 INSTALLATION

- A. Monitoring point installations and baseline readings shall be completed at least seven days in advance of commencing trenchless construction.
- B. Install all monitoring points within 0.5 foot of the horizontal and vertical location shown on the Contract Documents or as directed by the ENGINEER.
- C. Surface Monitoring Points: Establish a system of surface monitoring points. Surface monitoring point locations are shown on the Contract Documents. Up to ten additional surface monitoring points may be required and shall be installed as directed by the ENGINEER.
- D. All Instrumentation:
  - 1. Notify the Owner Representative at least 7 days in advance of installation.
  - 2. The monitoring points shall be installed as close as practicable to the locations shown on the Contract Documents. The ENGINEER may modify monitoring point locations depending on field conditions, conflicting utilities, and monitoring objectives.
  - 3. Locate and confirm all utilities and relocate monitoring points as necessary to protect all utilities. Follow State laws and accepted industry procedures for one-call notification and visual confirmation of locations of all crossing or adjacent



utilities.

4. Protection: Install protective housing with cap for piezometers, inclinometers, and utility monitoring points. Protective housing shall be installed within a flush-mounted precast concrete box or vault if in traffic lanes or paved areas, so as not to obstruct vehicle or foot traffic, and shall be in accordance with standards and permit requirements. Install access covers as specified in Section 2.06 where required.

E. Open Standpipe Piezometer

1. Bentonite drilling mud shall not be used when drilling boreholes for piezometer installation.
2. For any piezometer to be installed in the soil overburden, a standard split spoon sample shall be taken at the top and bottom of the piezometer sensing zone.
3. The well screen, riser pipe, filter pack, filter pack seal, and annular space seal shall be installed as shown on the Drawings. Pipe joints shall be made secure and watertight. The drill casing shall be withdrawn slowly as the backfill materials are placed at the same rate as backfill placement, so that collapse of the borehole does not occur. Casing shall not be rotated during withdrawal.
4. Filter pack material shall be placed slowly so that bridging does not occur in the boring and to prevent the well screen and riser pipe from being lifted as the casing is withdrawn. A measuring rod, cylindrical sounding hammer or similar device shall be used to measure the height of the filter pack to ensure that the filter pack is installed over the proper depth interval. The measuring rod shall be carefully raised and lowered while the filter pack is installed, to prevent bridging and to tamp the filter pack in place.
5. After the filter pack is placed, the filter pack seal, consisting of granular bentonite, shall be placed as shown on the Drawings. Granular bentonite shall be placed slowly so that bridging does not occur in the boring and to prevent the well screen and riser pipe from being lifted as the casing is withdrawn. Depth to the top of each increment of granular bentonite shall be checked using a cylindrical sounding hammer. The granular bentonite shall not be tamped.
6. An annular space seal, consisting of Portland cement grout, shall be placed above the filter pack seal to fill the annular space between the riser pipe and borehole. The annular space seal shall be placed by tremie grouting. The grout shall be placed in such a manner as to not disturb the integrity of the filter pack and seal.
7. Each installation shall be developed a minimum of 24 hours after completion. Development shall be continued until the water becomes clear and, in the opinion of the ENGINEER, the material soil filter has been developed.
8. After completion of piezometer development, a post-installation acceptance test shall be performed within seven calendar days after development by conducting a falling head permeability test to verify seal integrity to the satisfaction of the ENGINEER.

- F. Inclinometers: Install inclinometer casings in accordance with the manufacturer's recommendations and the approved submittals. Grout annulus between the inclinometer casing and the drill hole in accordance with the manufacturer's recommendations. Grout installations from the bottom of the hole to the ground surface. Use a grout tube inside the casing, connected to grout port connection in bottom cap only when external tremie pipes will not be possible. Grout casing into hole immediately after installation.
  - G. Automatic Total Station (ATS)
    - 1. The total station shall reference stable points (prisms) outside the zone of influence and the system shall be configured to self-correct for any movement of the total station.
    - 2. Monitor reflectorless points as shown on the drawings with the ATS.
  - H. Optical Survey Targets: Install optical survey targets at shafts as shown on the drawings.
  - I. Monitoring Point Protection, Maintenance, and Repair: Protect the monitoring points from damage. Damaged installations shall be replaced or repaired prior to continuing trenchless construction, unless permitted otherwise in writing by the ENGINEER.
- 3.2 Preconstruction and Post-Construction Surveys of Adjacent Structures
- A. At the preconstruction conference, the CONTRACTOR shall submit plans for the preconstruction survey to the OWNER and ENGINEER.
  - B. The OWNER will assign a representative to participate in the survey. The CONTRACTOR shall be required to submit the results of the survey in a report. The survey shall include photographing and video taping the exterior of each structure including pavement, retaining walls, or any other structures and recording (including sketches) any evidence of distress, such as cracks, distortions of the structure, and any evidence of total and differential settlement. Cracks and other evidence of existing distress shall be marked, catalogued, and photographed. For each structure, a file shall be prepared that contains the photographic records, and a form report that records the preconstruction observations. This information shall be presented in a report and provided to the OWNER. Where evidence of distress or damage is present, the information CONTRACTOR shall have to be disclosed information about the observed damage or distress to the owner of the structure. The OWNER may concurrently perform independent surveys at selected locations to verify the CONTRACTOR's survey. The CONTRACTOR and OWNER shall exchange results of the surveys and reconcile any differences in their findings before construction begins. The survey shall include all structures within 150-ft in plan of the tunnel and shafts.
  - C. Additional surveys may be performed of existing structures along the alignment if there is evidence of damage to any of the adjacent structures, or any allegations of damage by any of the property owners along the project alignment. At least a minimum one additional survey, referred to as the post-construction survey, shall be performed at the end of all construction activities at each trenchless crossing location.

### 3.3 MONITORING

- A. Surveying of all monitoring points will consist of determining the elevation of each monitoring point with respect to a benchmark selected by the OWNER, to a precision of 0.01 foot.
- B. CONTRACTOR shall install and perform a baseline survey of all monitoring points described in this Section and shown on the Contract Drawings at least 7 days prior to start of shaft excavation or trenchless construction. A minimum of three readings shall be taken and averaged to arrive at the baseline.
- C. Regular survey measurements shall be obtained after beginning excavation, or trenchless construction.
  - 1. All monitoring instrumentation and points within 100 feet of shafts, within 50 feet ahead of the tunnel face, and within 50 feet of completed excavated tunnel, shall be surveyed at least once per day during trenchless and shaft operations except for Reflectorless monitoring points which shall be monitored continuously. Points outside of this zone shall be monitored at least once per week.
  - 2. Once shafts are excavated and final support installed, inclinometer and piezometer readings may be reduced to once per week.
  - 3. Once shafts are completely backfilled and trenchless construction including contact grouting is complete, all monitoring devices and points shall be surveyed once at seven days, once at 14 days, and once at 30 days after completion of the trenchless excavation.
  - 4. Upon completion of construction, monitoring shall continue for any monitoring points that show movement from the prior survey, until three consecutive surveys each taken at least 24 hours apart show no additional movement.
  - 5. Upon request, provide such assistance, labor and equipment necessary for the OWNER or ENGINEER to monitor instruments, if desired, at no additional cost to the OWNER.

### 3.4 ABANDONMENT/REMOVAL

- A. All instrumentation shall remain the property of the CONTRACTOR following completion of the work and shall be removed or abandoned according to applicable codes and standards, unless otherwise noted.
- B. Surface Monitoring Points: Remove all surface monitoring points during the cleanup and restoration work, or as required by the OWNER.
- C. Soil Deformation Monitoring Points, Inclinometers, Piezometers:
  - 1. Properly abandon all monitoring point boreholes (Piezometers, SDMPs, and Inclinometers) by grouting the drilled holes in accordance with local laws.
  - 2. Remove flush mounted surface boxes.

3. Restore surface to original condition.

END OF SECTION

## SECTION 33 95 43 – LARGE POLYVINYL CHLORIDE NON-PRESSURE PIPING

### PART 1 – GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide all 30-inch underground PVC non-pressure pipe (PS46, ASTM F679) and appurtenant, complete and in place, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM D 1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

#### 1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The CONTRACTOR shall submit Shop Drawings of all pipe, joints, bends, special fittings, and piping appurtenances in accordance with Section 01 33 00 –CONTRACTOR Submittals.
- B. Certificates: The CONTRACTOR shall provide manufacturer's certificates for materials indicating conformance to the Contract Documents.

#### 1.4 QUALITY ASSURANCE

- A. Testing: Materials testing shall be based upon applicable ASTM Test Methods and AWWA Standards referenced herein. Costs of such inspection and tests shall be borne by the CONTRACTOR.
- B. Mandrel Test: In addition to the requirements as specified in Section 01 74 20 - Gravity Pipeline Testing, all PVC gravity sewer pipe shall be tested for deflection and obstructions. The mandrel test shall be performed after backfilling and compacting but prior to final paving and prior to leakage testing. A rigid mandrel, with a circular cross section having a diameter at least 95 percent of the base inside diameter as defined in ASTM F 679, shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. If the mandrel sticks in the pipe at any point the pipe shall be repaired and retested.
- C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the CONTRACTOR.

- D. The pipe shall be subjected to the specified flattening resistance, impact resistance, and stiffness tests.

## 1.5 CLEANUP

- A. In addition to the requirements set forth in the contract documents, the CONTRACTOR, upon completion of backfilling and grading over trenches, shall remove excess materials and equipment from the Site.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. PVC pipe, in compliance with this Specification, shall be continuously and permanently marked with the manufacturer's name and code, pipe size, PVC minimum cell classification, pipe stiffness designation, and the designation ASTM F 679.
- B. The manufacturer's code shall include the year, month, day, shift, plant and extruder of manufacture. This coding shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

### 2.2 PIPE

- A. PVC pipe shall be PS46 joined by compression joints unless otherwise indicated, and shall conform to the following requirements:
  - 1. Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM F 679. Material for PVC pipe shall conform to the requirements of ASTM D 1784 for Class 12364-C or 12454-C as defined therein. Maximum filler content shall be 10 percent.
  - 2. Rubber gaskets for compression type joints for PVC pipe and fittings shall conform to the requirements of ASTM F 477.

### 2.3 FITTINGS

- A. Fittings for PVC pipe shall conform to the requirements of ASTM F 679. The ring groove and gasket ring shall be compatible with PVC pipe ends.
- B. The minimum wall thickness of the fittings shall be not less than the minimum wall thickness of the equivalent size of pipe.

### 2.4 BEDDING MATERIAL

- A. Bedding shall conform to the requirements of 31 30 00 – Earthwork.

## PART 3 -- EXECUTION

### 3.1 GENERAL

- A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the OWNER's representative, and shall be subject to his approval before acceptance. Material found during the progress to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the Site.
- B. Installation shall conform to the requirements of ASTM D 2321 and to the requirements of 31 30 00 – Earthwork.
- C. The internal diameter of the pipe barrel shall not be reduced by more than 3 percent of its base diameter when measured after backfilling and compacting but prior to final paving. If this amount of allowable pipe deflection is exceeded, the CONTRACTOR shall uncover the pipe and shall improve the quality of the pipe zone backfill material and/or compaction to the extent that the allowable pipe deflection is not exceeded. Excessive deflection shall be checked for by pulling a mandrel through the pipe, or by other methods acceptable to the RPR.

### 3.2 TRENCHING AND BACKFILL

- A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 – Earthwork, and as required herein.
- B. The minimum depth of cover over the top of the pipe shall be 36-inches unless otherwise indicated.

### 3.3 LAYING PIPE

- A. The pipe shall be installed in accordance with the requirements of ASTM D 2321 and this Section and the pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- B. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the CONTRACTOR for safe and efficient execution of the WORK. Pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
- C. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.
- D. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged, or unsound pipe shall be repaired or replaced. Foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying.

Openings in the pipeline shall be closed with watertight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

- E. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the WORK shall be furnished by the CONTRACTOR at its own expense.
- F. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the CONTRACTOR in cooperation with OWNERS of such utility structures. Unless otherwise indicated, this WORK shall be performed at the CONTRACTOR's expense.

### 3.4 HANDLING

- A. Handling of the PVC pipe shall be done with care to ensure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.
- B. Pipe shall be inspected both prior to and after installation in the ditch and defective lengths shall be rejected and immediately removed from the working area.

### 3.5 FIELD JOINTING

- A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.
- B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time, a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.
- C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.
- D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe that has floated shall be removed from the trench, cleaned, and re-laid in an acceptable manner. No pipe shall be laid when, in the opinion of the OWNER's representative, the trench conditions or weather are unsuitable for such WORK.

### 3.6 INSTALLATION OF BENDS, TEES, AND REDUCERS

- A. Fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no



circumstances shall the cable, rope or other device be attached through the fitting's interior for handling. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

3.7 ANCHOR BLOCKS

- A. Not applicable.

3.8 TRENCH DAMS

- A. Not applicable.

3.9 TESTING

- A. Field testing of gravity sewer pipe shall conform to the requirements of Section 01 74 20 – Gravity Pipeline Testing.

END OF SECTION

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## **APPENDIX A**

### **Geotechnical Report**



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July 15, 2022

Magna Water District  
c/o Trevor Andra  
2711 South 8600 West  
Magna, Utah

**Subject:** Geotechnical Investigation  
MWD Sewer Influent Line  
Project 1B  
Magna, Utah  
IGES Job No. 00599-015

Mr. Andra:

This report presents the results of our geotechnical investigation performed for the proposed Magna Water District (MWD) Westside Connector Sewer Line, Project 1B in Magna, Utah. The purpose of the investigation was to observe and document subsurface conditions along portion 1B of the proposed pipe alignment and provide design and construction recommendations as they relate to the proposed pipe installation. This report has been prepared to summarize the field investigation program, laboratory testing program and recommendations as they relate to the proposed improvements. Preliminary work on Project 1B was performed in fall 2021 and summarized in the IGES report titled "Preliminary Geotechnical Investigation MWD Sewer Influent Line Projects 1B and 2, Magna, Utah," dated November 24, 2021. This additional study has been completed at your request to provide supplementary information in general accordance with our proposal dated February 28, 2022. This study and the information and recommendations presented herein supersede the referenced preliminary report.

## **PROPOSED CONSTRUCTION**

Based on conceptual design drawings prepared by Stantec titled, "Magna Westside Collection System Improvements Magna, Utah," dated December 10, 2021, it is proposed to construct a sewer influent line in Magna, Utah. Project 1B of the alignment will connect to a new sewer manhole (Project 1A) near 2100 South then proceed south along to 8000 West crossing beneath SR-201 where it will later connect with Project 2 (see Figure A-1). The total pipe length associated with Segment 1B is on the order of 2,800 linear feet. The pipe is proposed to be 30 inches in nominal diameter and constructed of polyvinyl chloride (PVC). The invert elevation of the pipe ranges between 4,220 feet at the north extents of Project 1B and 4,222 feet at the south end where it will connect to future Project 2 (0.06% slope). This corresponds to an installation depth ranging between approximately 10 and 20 feet. It is our understanding that segment 1B of the pipe will largely be installed using conventional open cut and cover methods. We understand that the SR 201 highway crossing will require a trenchless jack and bore installation with accompanying jacking (north of highway) and receiving (south of highway) pits.



## **FIELD INVESTIGATION**

Characterization of the subsurface conditions along the alignment was undertaken with six soil borings and one standpipe piezometer installation. Explorations were performed at relatively uniform intervals along 8000 West with closer intervals near the trenchless crossing of SR-201. One piezometer was installed near the proposed receiving shaft to the south of SR-201. Investigation locations were selected by IGES representatives in consultation with Stantec and MWD personnel and were field located using existing features. Prior to the field program a Blue Stakes of Utah request was submitted to delineate public utilities. Encroachment permits were obtained for explorations completed within the SR 201 right of way (UDOT) and 8000 West (Salt Lake County). Traffic control plans and equipment were subcontracted to Utah Barricade. Explorations were advanced in areas accessible to the equipment and clear of marked utilities. Following performance of the field program, as-performed investigation locations were surveyed by CRS Engineers as directed by Stantec. A summary of the explorations performed to date is presented in Table 1. The approximate locations of the explorations are shown in Figure A-2.

## **SOIL BORINGS**

Seven test borings were performed in two mobilizations between November 4 and 10, 2021 and March 29 to 31, 2022. Three of the explorations (1B-21-2, 1B-21-4, 1B-21-5) were completed as part of the referenced preliminary assessment and the remaining three borings and standpipe piezometer (1B-22-1, 1B-22-3, 1B-22-4A, 1B-22-5PZ) installation were completed during the more recent phase. The borings are numbered north to south along the alignment. The borings were performed to depths ranging between 21.5 and 31.5 feet beneath the existing grade. The approximate locations of the explorations are shown in Figure A-2. The borings were advanced by South Slope Drilling utilizing a track-mounted CME 55 drill rig equipped with 4 ¼-inch-inside diameter hollow stem augers. Samples generally were obtained at 2.5-foot intervals between 10 and 20 feet (the pipe zone) and 5-foot intervals elsewhere. Split barrel type samples were collected with a split spoon or California sampler with interior brass rings in general accordance with ASTM D1586 and ASTM D3550 as applicable. Split barrel samplers were advanced utilizing an auto trip 140-pound hammer free falling 30 inches. The energy transfer ratio of the hammer was measured during the November field program to be 72.1 percent. Blow counts for the sampling events were recorded by an IGES representative and were corrected for hammer energy using the measured hammer energy transfer ratio. Large diameter samplers (e.g. California, Type-U) were corrected to a standard split spoon utilizing the method detailed in Fang (1991). Soil samples were packaged in sealed containers and transported in general accordance with ASTM D4220 to the IGES geotechnical laboratory in South Salt Lake for subsequent review and testing. A representative of IGES observed the boring being performed, visually classified the samples in general accordance with ASTM D2488 and prepared the graphical boring logs shown in Figures A-3 through A-9. A key to the soil symbols and terminology used in the graphical logs is shown in as Figure A-10. Upon completion, borings were backfilled with the removed material with minimal compactive effort. Where present, concrete and asphalt were removed with coring and surfaces were reinstated using Utilibond™ pavement bonding compound. A summary of the borings is presented in Table 1.

## **MONITORING WELL INSTALLATION**

One monitoring well designated 1B-22-5PZ was installed by the driller following sampling activities in



general accordance with ASTM D5092. The well was 2-inch in nominal diameter with a 10-slot screen. The collection zone was formed by placing 10/20 sand from slightly below the base of the well to 2 feet above the screened interval. Bentonite chips were utilized to create a seal above the collection zone and cuttings were extended to the surface. The driller verified depths throughout the installation process utilizing a weighted tape measure. A concrete encased ductile iron exterior and galvanized steel interior flush mount protective measure was constructed. Monthly monitoring well readings are being provided to Stantec as they are taken through the remainder of calendar year 2022.

**Table 1: Summary of Subsurface Explorations**

Field Exploration	Surface Elevation <sup>1</sup> (feet)	Total Depth of Exploration (feet)	Encountered Groundwater Depth below surface (feet)	Estimated Groundwater Elevation (feet)
1B-22-1	4231.95	26.5	6.5	4225.5
1B-21-2	4232.52	21.5	13.3	4219.2
1B-22-3	4233.60	26.5	7.8	4225.8
1B-21-4	4236.41	31.5	8.0	4228.4
1B-22-4A	4240.37	31.5	11.5	4228.9
1B-21-5	4235.89	31.5	12.5	4223.4
1B-22-5PZ	4235.22	21.5	7.0 <sup>2</sup>	4228.2

Notes:

- 1) As drilled elevation survey provided by Stantec
- 2) Monthly readings to be collected through the remainder of 2022 and reported separately.

Compiled by IGES in 2022

## **LABORATORY PROGRAM**

Geotechnical laboratory tests were conducted by IGES on relatively undisturbed and bulk soil samples obtained during the field investigation. The laboratory testing program was designed to evaluate the engineering characteristics of on-site earth materials. Laboratory tests conducted during this investigation included the following:

- **Index Testing**
  - o In situ Moisture Content and *Unit Weight* (ASTM D7263 and D2216)



- o Atterberg Limits (ASTM D4318)
  - o Particle-Size Analysis (ASTM D6913)
  - o Percent Fines (ASTM D1140)
- **Strength Testing**
  - o Unconsolidated-Untrained Triaxial Compression (ASTM D2850)
- **Corrosion Potential**
  - o Sulfate (ASTM C1580)
  - o Chloride (ASTM D4327)
  - o pH (American Association of State Highway and Transportation Officials [AASHTO] T289)
  - o Electrical Resistivity (AASHTO T288)

Selected results have been presented on the attached boring logs in Appendix A. The full results of the laboratory testing along with a summary table are provided in Appendix B.

## **GENERALIZED SITE CONDITOINS**

### **EXISTING CONDITIONS**

Conditions at the site were observed during the field programs. 8000 West is currently a two-lane paved road with minimal to no shoulder bordered by industrial, residential and undeveloped land to the east and undeveloped land and a small canal running north-south to the west. Where the alignment is currently proposed to cross beneath SR 201, there is a gravel frontage road running east-west and parking area to the north and an asphalt paved park and ride lot to the south. SR-210 consists of nine lanes of traffic and concrete pavement in the vicinity of the trenchless crossing. The area to the south of the alignment appears to be used for agriculture. Based on the referenced drawings prepared by Stantec, there are multiple existing buried and overhead utilities within the vicinity of the proposed pipe alignment. Along 8000 West, there is buried gas and sewer and overhead utilities to the west of the road and buried water and telecommunications and overhead power to the east of the road. The telecommunications lines crosses to the west side of the road approximately 100 feet south of 2100 South. side of the road. Vegetation and occasional mature trees are present. Near the intersection with SR-210, the alignment will likely cross gas and water lines.

### **SOIL**

Surficial conditions within 8000 West consisted of 4 ½ to 10 inches of asphalt and 2 to 3 feet of poorly graded gravel with varying amounts of silt and sand road base overlying the native material. Within SR-201, surficial condition consisted of 14 inches of concrete pavement overlying approximately 4 feet of poorly gravel with silt and sand road base overlying approximately 5 feet of possible undocumented fill consisting of very loose to loose, moist clayey gravel overlying the native soil. Within the park and ride area to the south of SR-201, surficial conditions consisted of 4 inches of asphalt overlying 2 to 3 feet of poorly graded gravel with silt and sand road base over native soil.



In general, the native subsurface conditions observed in the explorations completed along this alignment consisted of soft to stiff, moist to wet, lean clay with varying amounts of sand. On occasion, the clays exhibited organic odor and coloration characteristic of marsh deposits. Layers of loose to medium dense, wet, poorly graded to silty sand or stiff sandy silt ranging in thickness from one to five feet were observed throughout the soil profile.

## **GROUNDWATER**

Groundwater was encountered in each of the explorations performed during this investigation. Groundwater was observed between 6.5 and 13.25 feet below the existing grade corresponding to elevations ranging from 4219 to 4229 feet. Mapping by both Jensen et. al. (1985) and Seiler and Waddell (1983) indicates that groundwater is present at 0 to 5 feet below grade. Mapping by the Utah SGID (Utah AGRC) indicates water is present at a depth of 10 feet. These documents validate the field observations. Groundwater conditions vary seasonally and annually with changes in precipitation, runoff, development, and other atmospheric conditions.

A piezometer was installed in 1B-22-5PZ following sampling activities. Monthly water level readings will be collected from this piezometer and reported to Stantec to aid in further assessment of seasonal groundwater fluctuation in the area.

## **ENVIRONMENTAL CONDITIONS**

Possible indications of impacted soil including odors or soil staining were not observed in the explorations performed as part of this investigation. A field or lab environmental characterization program was beyond the scope of this analysis. The absence of indications of environmental conditions does not serve as an evaluation or quantification of environmental conditions at the site.

## **DISCUSSION AND RECOMMENDATIONS**

The recommendations presented in this report are based on our understanding of the provided project plans, the subsurface conditions observed during field exploration, the results of in-situ and laboratory soil testing and our engineering analyses. At the time of this report, conceptual plan and profile sheets showing horizontal and vertical alignment were made available (Stantec, 2021). It is possible that variations in the soil and groundwater conditions exist between and beyond the points explored. The nature and extent of the variations may not be evident until construction occurs, and additional explorations/excavations are completed. If subsurface conditions other than those described herein are encountered in conjunction with construction, and/or if design and layout changes are initiated, our firm should be informed so that the recommendations herein can be reviewed and revised as changes or conditions may require.

## **EARTHWORK RECOMMENDATIONS**

### *Site Preparation*

Following rough grading of pipe areas, yielding or otherwise unsuitable material such as; disturbed soil





loose granular soil, soft fine-grained soil, soils containing pinholes, frozen soils, expansive soil, construction debris or waste, soils containing organics or debris laden fill should be removed in their entirety and replaced with structural fill in accordance with the recommendations of this report. Scarification, moisture conditioning and recompaction of the material at the base of the excavation may also be possible if deemed acceptable to the project geotechnical engineer. Site grading should be designed to provide positive drainage away from the proposed construction area. Positive site drainage should be maintained throughout the construction activities. Subgrade preparation and inspection requirements from governing authorities should take precedence where more stringent. Based on our experience, an excavator with a flat bucket limits the disturbance to the subgrade and thus material that must be recompacted or removed.

#### *Sensitive Subgrade*

During exploration activities, the subsurface conditions encountered were variable and generally wet. Based on laboratory index testing, subgrade conditions are expected to deteriorate rapidly with prolonged exposure to moisture and/or construction disturbances. Time between final grading and construction should be minimized to reduce the risk for detrimental impacts to the subgrade. If the stability of the subgrade is compromised, it is considered unsuitable and should be removed and replaced with structural fill or stabilized as described herein.

#### *Subgrade Stabilization*

It is likely that subgrade conditions will be poor and that extensive overexcavation and replacement will be impractical within trenches. In these conditions, subgrade stabilization can be accomplished by over excavating a minimum of 12 inches, placing a nonwoven geotextile (minimum weight 8 oz) over the soft subgrade and up the sidewalls of the trench enough to eventually encase the depth of stabilization material (i.e. the thickness of the stabilization material plus 2/3 of the trench width for each sidewall). Seams should be overlapped a minimum of 18 inches along the length of the trench, or as recommended by the manufacturer. The geotextile should then be covered with a minimum of 12 inches of crushed, angular ¾--to 4-inch diameter drain rock to the base of the pipe bedding. The geotextile can then be laid atop the stabilization rock and overlapped (transverse to sidewalls, fully encasing the rock) prior to placing pipe bedding. The bedding, pipe zone and trench zone backfill may then be placed and compacted according to the designers specifications.

#### *Fill Materials*

Fill placed for the support of pavement should consist of structural fill. Structural fill may consist of approved onsite soils or an approved imported granular soil. Fill materials should be accepted by the Geotechnical Engineer for the specific use of the fill. Structural fill should conform with the following requirements:

- Granular, well-graded material with a maximum particle size of ¾-inch and a fines content between 5 and 15 percent when testing in accordance with ASTM D6913;
- Hard, durable particles of stone or gravel; or crushed to the specific sized and gradations; free from organic matter, clay chunks, asphalt, construction debris and other deleterious material;



- Material having liquid limit less than 20 and a plasticity index less than 10 when tested in accordance with ASTM D4318;
- Non-corrosive to metals, concrete or other building materials
- Free of unsuitable material such as; soils containing pinholes, frozen soils, expansive soil, construction debris or waste, or oils containing organics.

Fill for material utilized within the pavement section should conform to all applicable materials and construction standards and specifications.

#### *Fill Placement*

The engineered fill material shall be placed in maximum 8-inch loose lifts. Thinner lifts may be required to achieve required compaction depending on the equipment and methods chosen by the contractor. All fill should be placed and compacted on a horizontal plane unless otherwise approved by the Geotechnical Engineer. Each lift shall be spread evenly and be thoroughly mixed during the spreading to promote uniformity of material in each lift. Material should be mechanically compacted to the required maximum dry density and optimum moisture content as indicated in Table 2. Compaction by water injection should not be permitted.

**Table 2: Summary of Compaction Requirements**

<b>Backfill Area<sup>1</sup></b>	<b>Percent of Maximum Dry Density<sup>2</sup></b>	<b>Moisture Content at Time of Compaction</b>
Landscaped areas	90.0	Optimum <sup>2</sup> to + 2.0 percent of optimum
Untreated Base Course	95.0	
Pavement Areas	95.0	

**Notes:**

- 1) Required compaction shall be determined considering proposed construction above fill (e.g. foundation walls backfilled beneath a proposed pavement area must be compacted to pavement area specification)
- 2) As determined by ASTM D1557

Source: Compiled by IGES in 2022

Fill placed on existing fill or slopes steeper than four horizontal to one vertical (4H:1V) should be keyed and benched into firm native soil, properly compacted fill, or rock. Benches should be a minimum of 2 feet high, maximum of 4 feet high and should be wide enough to accommodate standard earthwork equipment. Keying and benching can be conducted simultaneously with placement and compaction of engineered fill. As a minimum, granular structural fill should extend at least 24 inches beyond the edge of



pavement in each direction.

These are general recommendations and the contractor should also be aware of Salt Lake County and MWD's requirements for pavement and subgrade thickness, gradation, compaction and testing for rehabilitation/replacement of pavement sections disturbed during construction. If there is a conflict between our recommendations and the standards of a municipality, the most stringent requirements should govern.

#### *Utility Trench Backfill*

Utility bedding and backfill type and thickness should be specified to appropriately support the utility by the designer. Bedding should be in complete contact with the utility as required. It is recommended that bedding material has a Sand Equivalent (SE) of 30 or greater. In each case the utility bedding, utility zone backfill (immediately above the bedding) and remaining trench backfill should meet the design criteria of the manufacturer and designer. Specifications from governing authorities having their own precedence for backfill and compaction should be followed where they are more stringent.

#### *Reuse of Onsite Material as Fill*

It is expected that the project will generate an excess of soils from excavation activities. The majority of near-surface onsite soils appear to have a high fines content, water content and plasticity. We anticipate that they would provide poor pavement support, even when compacted. For these reasons it is our opinion that the soils are generally unsuitable to be used as fill. If the contractor desires to re-use these soils for specific applications on the project, they should justify the suitability of the onsite material for use as fill, outlining appropriate means and methods for moisture-conditioning and compaction of native soils and receiving approval from the geotechnical engineer prior to placement. In general, moisture conditioning, placement and compaction of fine grained material is not practical and can be nearly impossible in winter months.

#### EXCAVATION STABILITY

It is our understanding that conventional cut and cover methods will be utilized for the majority of sewer line installation in Project 1B. For purposes of trench excavation and utility installation, we recommend that the soils encountered be considered Occupational Safety and Health Administration (OSHA) Standards for Excavations Part 1926 Subpart P, Type C soils. This recommendation is based on the shallow water and soft nature of the fine grained soils encountered. For excavations deeper than 5 feet, the walls of the excavation should be constructed with side slopes no steeper than one and one-half horizontal to one vertical (1.5H:1V, 34 degrees). Further flattening of slopes may be necessary if shoring/shielding measures are not implemented.

The contractor is responsible for site safety, including all temporary slopes and trenches excavated at the site and design of any required temporary shoring. The contractor is responsible for providing the competent person required by OSHA standards to evaluate soil conditions and regularly perform excavation inspections. Sloping or benching for excavations greater than 20 feet deep shall be designed by a Professional Engineer registered in the State of Utah.



### SHORING AND SHIELDING FOR PIPE INSTALLATION

Given the planned installation depths (10 to 18 feet below grade) and the proximity to existing roads and utilities, open cut methods are likely not practical as they would necessitate further disturbance to existing infrastructure, disruption to traffic, and additional earthwork and importing of fill material. We anticipate that shoring/shielding measures will be implemented to minimize the width of trenches at the surface and minimize disturbance to existing improvement as well as providing protection to persons, equipment, and installed piping in the trench or excavations. Sheet piling or slide rail systems are likely the most appropriate methods of shoring and trench boxes may be considered for shielding based on the linear nature, tight horizontal clearances, and mobile nature of the work. Shoring methods will likely limit undermining of the pavement section as compared to shielding methods, which typically do not provide complete contact with the sidewall.

### DEWATERING FOR PIPE INSTALLATION

Due to the mapped and observed shallow static groundwater, it is expected that temporary dewatering measures will be required for excavations at this site. A design and construction planning groundwater depth of 5 feet is recommended. Based on the fine-grained nature of the soil and linear nature of the work, a closely spaced vacuum well point system spacing is likely appropriate for dewatering. Due to the fine grained nature of the soil , a deep well system may not be adequate to control the water level. Submersible pumps may be utilized for local dewatering of nuisance water not captured by the dewatering system. Dewatering may be needed on the internal portion of the jacking and receiving pits. Design, operation, and maintenance of the dewatering system is the responsibility of the contractor. Consideration should be given to the storage, treatment, removal, or discharge of the fluid from the dewatering system. All applicable jurisdictional requirements should be strictly adhered to.

trenchless crossing discussion and recommendationsA trenchless, 166-foot long jack and bore installation is currently proposed crossing SR-201. A jacking pit is proposed to the north of SR-201 and receiving pit is proposed to the south. A 42-inch inner diameter steel casing is proposed between the two pits. Shoring and a dewatering system will likely be required due to the depth and extent of the excavation.

#### *Strength of Geotechnical Units*

Two geotechnical units are present at depths near the proposed trenchless crossing. In general, soils are composed of very soft to soft, wet lean clay or very loose to medium, wet silty sand dense silty sand. Representative geotechnical parameters based on the field and lab program are presented in Table 3.



**Table 3: Strength of Earth Materials in Trenchless Crossing**

Material	Total Unit Weight (pcf)	Buoyant Unit Weight (pcf)	Effective Stress, Drained		Total Stress, Undrained	
			Cohesion, c (psf)	Friction Angle, $\Phi'$ (degrees)	Cohesion, c (psf)	Friction Angle, $\Phi'$ (degrees)
Native very soft to soft Lean Clay	120.0	57.6	--	--	600	0
Native very loose to medium dense Silty Sand/ stiff to very stiff Sandy Silt	115.0	52.6	0	29	--	--

Notes:

Source: Compiled by IGES in 2022

#### *Trenchless Crossing Shoring and Dewatering*

Due to the relatively weak, predominantly fine-grained soil and shallow water table, a shoring system consisting of sheet piles, possibly with bracing, is likely most appropriate. Submersible pumps may be utilized for local dewatering of nuisance water (i.e. rain, construction spoils) not captured by the dewatering system. Dewatering may be needed on the internal portion of the shafts. Due to the fine-grained soil, a closely spaced vacuum well point system is likely the most appropriate dewatering system, though further observations during construction and the contractors' experience in the area may inform otherwise. Due to the fine grained nature of the soil, a deep well system may not be adequate to control the water level. A full scale field pump testing program should be considered to aid in design of the system. Stabilized subgrade or a concrete mat may be required to address excavation base stability caused by the differential in head between the exterior and interior of the shaft.

#### *Lateral Earth Pressure for Trenchless Crossing Shoring*

Lateral pressure coefficients are presented for native material. Appropriate earth pressure parameters should be selected based on the thickness of the backfill against wall and the type of movement expected of the wall. If the walls are to be restrained from lateral movement or braced, it is recommended that at-rest earth pressures be used for design. If the walls are anticipated to deflect during loading (i.e., unbraced at the top), it is recommended that active earth pressure be used in design. If active earth pressures are used in design, slight deflections of the wall should be expected. Appropriate equivalent fluid densities should be used with regard to the location of the water table. Hydrostatic pressure must be added where applicable.

The use of passive soil resistance in design is cautioned against. Significant movement of the structure is required for passive resistance to be mobilized. Removal of material with the passive zone, incomplete contact with soil, frost action, or variable moisture conditions may negate the passive resistance.



Ultimate lateral earth pressures from native soil and structural fill acting against vertical walls with level backfill may be computed from the equivalent fluid densities presented in Table 4.

**Table 4: Lateral Pressure Coefficients for Jacking and Receiving Pits**

Material	Total Unit Weight (pcf)		Earth Pressure Coefficient		
	Above Water Table	Below Water Table <sup>8</sup>	Active	At-Rest	Passive
			Static <sup>1,2</sup>	Static <sup>1,2</sup>	Static <sup>1,2</sup>
Native Lean Clay	120.0	57.6	0.49	0.66	2.04
Native Silty Sand/Sandy Silt	115.0	52.6	0.35	0.52	2.88

Notes:

- A) Applicable surcharge should be added with a uniform pressure distribution and a height of action equal to the buried height of wall divided by 2
- B) Hydrostatic pressure should be added where applicable

Loading Profile

- 1) Triangular Distribution

Height of Action

- 2) Height of Wall divided by 3

Source: Compiled by IGES in 2022

#### PIPE DEFLECTION – E' VALUES

Vertical deflection of installed pipeline is largely a function of the embedment material selected and the degree to which it is compacted above/around the pipe. Following the recommendation and methods specified by Howard (2015) values of E' (Modulus of Soil Reaction) are provided below for use in calculation of pipe deflection by others. These values should be used only with the Reclamation Equation presented in Howard (2015) for estimation of vertical deflection; noting that horizontal deflection is generally 25 to 50 percent of the vertical deflection.

Backfill properties will vary along the alignment depending on the use of native/imported material as backfill and native soil conditions in the exposed trench side walls. General backfill above the pipe zone can largely be ignored in estimating pipe deflection. We recommend that native soils are excluded from placement within the pipe zone. The width of trench, distance between installed pipe and native soils must also be considered in estimating pipe deflection. If trench walls will be more than two pipe diameters from the installed piping at the spring-line (total trench width greater than 5 pipe diameters), E'<sub>b</sub> values for compacted embedment soils shown in Table 5 may be used in estimating pipe deflection.



If the trench sidewalls are closer than two pipe-diameters, a composite  $E'$  value must be calculated using  $E'_n/E'_b$  and the ratio of trench width to pipe diameter as outlined in Howard (2015). If near surface native soil will not be as stiff as imported and compacted backfill material, we recommend that  $E'_n$  values shown in Table 5 be used to represent existing material in determining a composite  $E'$  value.

**Table 5: Recommended  $E'$  Values for Imported and Native Soils**

Soil Type		Recommended $E'$ (lb/in <sup>2</sup> )
Compacted Granular Import <sup>1</sup>	≤ 12 percent fines	2,000 <sup>2</sup>
	> 12 percent i	1,000 <sup>2</sup>
Native Lean Clay		500 <sup>3</sup>
Native Silty Sand		1,000 <sup>3</sup>

Notes:

- 1) Compaction greater than 90 percent of the maximum dry unit weight determined by ASTM D-698 or AASHTO T-99 (Standard Proctor compaction).
- 2) Represents  $E'_b$
- 3) Represents  $E'_n$

Source: Compiled by IGES in 2022 based on Howard (2015)

## EXISTING UTILITIES

Utilities are present in the vicinity of the proposed alignment. The contractor should coordinate with each individual utility to delineate and protect in place utilities during construction.

## MOISTURE PROTECTION AND DRAINAGE

During construction, over-wetting the soils prior to, during or after construction may result in softening and pumping, causing equipment mobility problems and difficulty in achieving compaction. Every effort should be taken to ensure positive drainage away from construction areas. The recommended minimum slope is two percent in pavement areas. Moisture should not be allowed to infiltrate the soils in the vicinity of, or upslope from, the construction area. Moisture should not be allowed to accumulate in the construction area.

## SOIL CHEMISTRY

Samples were tested for soil resistivity, soluble chloride and pH to evaluate the corrosion potential for ferrous metal in contact with onsite soil, and tested for soluble sulfates to evaluate the potential for



sulfate attack of cementitious concrete. A summary of typical indicators for a soil's corrosion potential to concrete and metals is presented in Table 6. completed results of the corrosion testing for soils along with the associated corrosion potentials are presented in Table 7 and in Appendix B.

**Table 6: Corrosion Potential Indicators for Concrete and Steel**

Corrosion Potential	Soluble Sulfate (ppm)	Soluble Chlorides (ppm)	Electrical Resistivity ( $\Omega$ -cm)
Low	0 – 150	0 – 200	> 30,000
Mild	--	--	30,000 – 10,000
Moderate	150 – 1,000	200 – 700	10,000 – 2,000
Severe	1,000 – 2,000	700 – 1,500	2,000 – 500
Very Severe	> 2,000	> 1,500	< 500

Notes:

- 1) pH values less than 5 or greater than 9 are outside range typically expected in soils.

Source: Compiled by IGES in 2022

**Table 7: Corrosion Potential Indicator Testing Summary**

Sample		Corrosion Potential Indicator		
Exploration	Depth (ft)	Sulfate Potential	Chloride Potential	Electrical Resistivity
1B-22-1 <sup>(1)</sup>	12.5	Low	Moderate	Severe
1B-21-B2	10.0	Moderate	Low	Severe
1B-22-3	13.0	Low	Low	Severe
1B-22-4A	15.0	Low	Moderate	Severe

Notes:

- 1) pH slightly higher than typical range

Source: Compiled by IGES in 2022

Based on limited testing, site soils exhibit a low to moderate potential for sulfate attack to concrete and a low to moderate potential for chloride attack to steel while resistivity testing results indicated that the





soils throughout the alignment are severely corrosive to steel at the planned pipe depth. One pH result was tested to be slightly higher than is typically expected and may indicate a problem soil.

Corrosion protection based on the above results should be considered for selection of pipe materials and any buried elements of the proposed project including the use of specialized coatings and sacrificial steel thicknesses depending on the nature and criticality of the specific element. Designers of structures with steel reinforcement should consider the corrosive nature of site soils in design. Where it is not practicable to minimize the use of buried steel, we recommend that a qualified corrosion engineer be consulted for any metals that are to be embedded at the site.

### **CONSTRUCTION OBSERVATIONS AND APPROVAL**

Our geotechnical design recommendations are based on a limited site investigation and laboratory testing. Depending on subsurface conditions encountered during construction, field adjustments to subgrade preparation recommendations contained in this report may be required. We recommend that adequately trained personnel observe geotechnical construction aspects of the project for compliance with design concepts, specifications, and recommendations, and to assist in development of design changes should subsurface conditions differ from those anticipated. Specifically, subgrade preparation for all foundation and pavement areas should be observed by IGES to determine if additional over excavation is required prior to placement of structural fills and concrete.



## **CLOSURE AND LIMITATIONS**

The concept of risk is a significant consideration of geotechnical analyses. The analytical means and methods used in performing geotechnical analyses and development of resulting recommendations do not constitute an exact science. Analytical tools used by geotechnical engineers are based on limited data, empirical correlations, engineering judgment, and experience. As such, the solutions and resulting conclusions and recommendations presented in this report cannot be considered risk-free and constitute IGES's best professional opinions and recommendations based on the available data and other design information available at the time they were developed. IGES has developed the preceding analyses, recommendations and opinions, at a minimum, in accordance with generally accepted professional geotechnical engineering practices and care being exercised in the project area at the time our services were performed. No warranties, guarantees or other representations are made.

The information contained in this report is based on limited field data and understanding of the project. If any conditions are encountered at this site that are different from those described in this report, IGES must be immediately notified so that we may make any necessary revisions to recommendations and opinions contained in this report. In addition, if the scope of the proposed construction or grading changes from those described in this report, our firm must also be notified.

This report was prepared for our client's exclusive use on the project identified in the foregoing. Use of the data, recommendations, opinions or design information contained herein for any other project or development of the site not as specifically described in this report is at the user's sole risk and without the approval of IGES, Inc. It is the client's responsibility to see that all parties to the project including the designer, contractor, subcontractors, etc. are made aware of this report in its entirety.

We recommend that IGES be retained to review the final design plans, grading plans and specifications to determine if our engineering recommendations have been properly incorporated in the project development documents. We also recommend that IGES be retained to evaluate, construction performance and other geotechnical aspects of the projects as construction initiates, continues and progresses through its completion

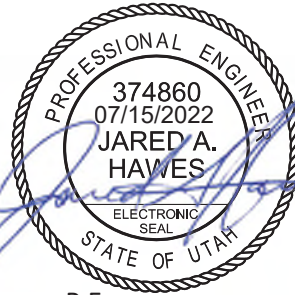


We appreciate the opportunity to be of service on this project. Should you have any questions regarding the report or wish to discuss additional services, please do not hesitate to contact us at your convenience.

Respectfully submitted,

IGES, Inc.

Brian Lowe, P.E.  
Staff Engineer



Jared Hawes, P.E.  
Senior Engineer, Project Manager

Attachments:

Appendix A

Figure A-1	Vicinity Map
Figure A-2	Exploration Map
Figures A-3 to A-9	Test Boring Logs
Figures A-10	Key to Soil Symbols and Terminology

Appendix B

Lab Summary Table
Lab Results



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Geotechnical Investigation  
MWD Sewer Influent Line  
Project 1B  
Magna, Utah

# Appendix A



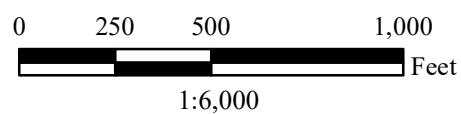
Geotechnical Investigation  
MWD Sewer Influent Line  
Project 1B  
Magna, Utah

# Maps





BASE IMAGE:  
Utah AGRC Aerial Imagery 2018



Project Number - 00599-015

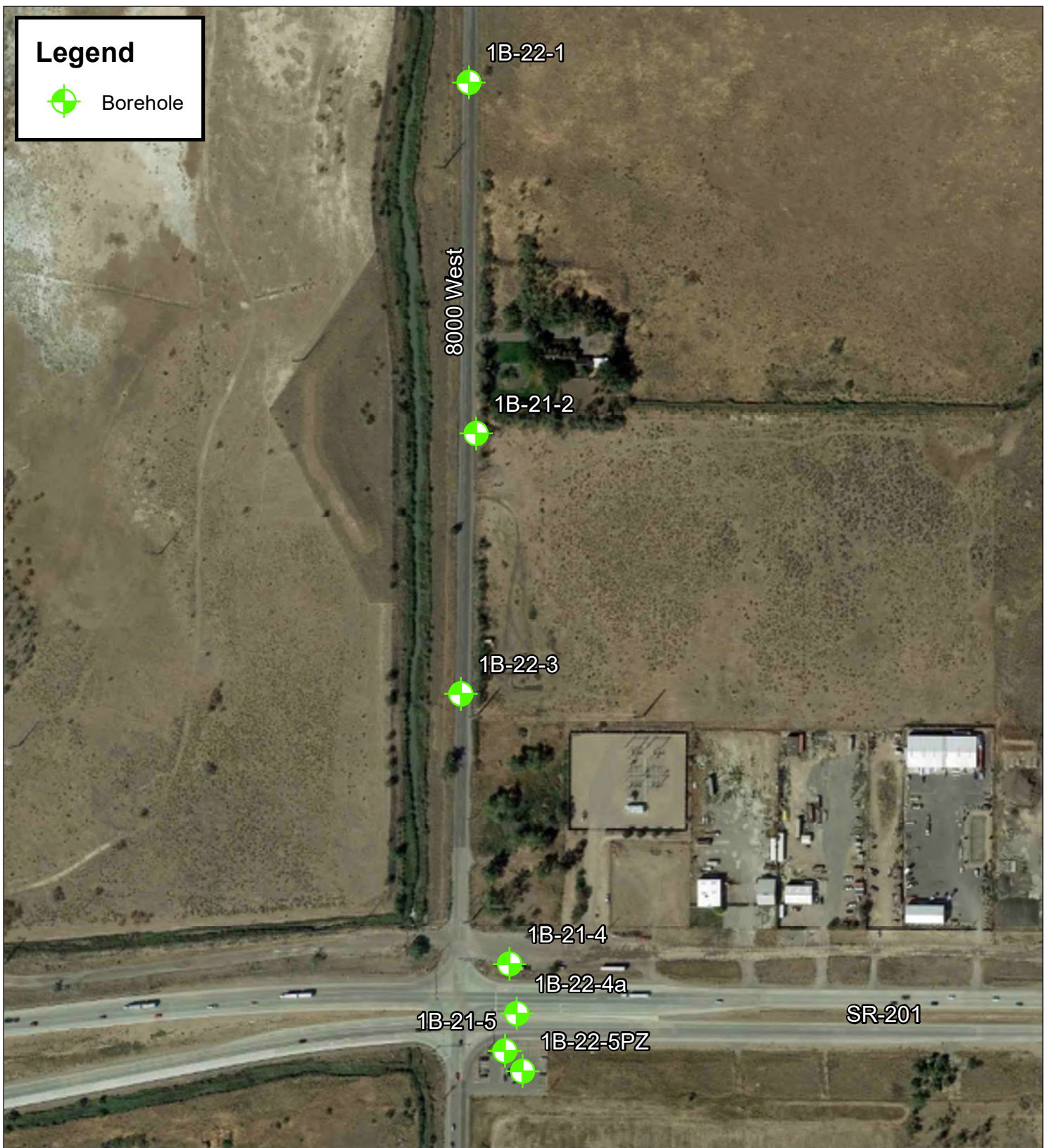
Geotechnical Investigation  
MWD Sewer Influent Line  
Project 1B  
Magna, Utah

**SITE VICINITY MAP**

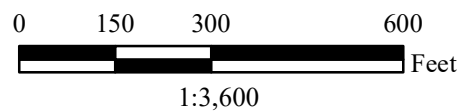
**FIGURE**

**A-1**





BASE IMAGE:  
Utah AGRC Aerial Imagery 2018



Project Number - 00599-015

Geotechnical Investigation  
MWD Sewer Influent Line  
Project 1B  
Magna, Utah

**EXPLORATION MAP**

**FIGURE**

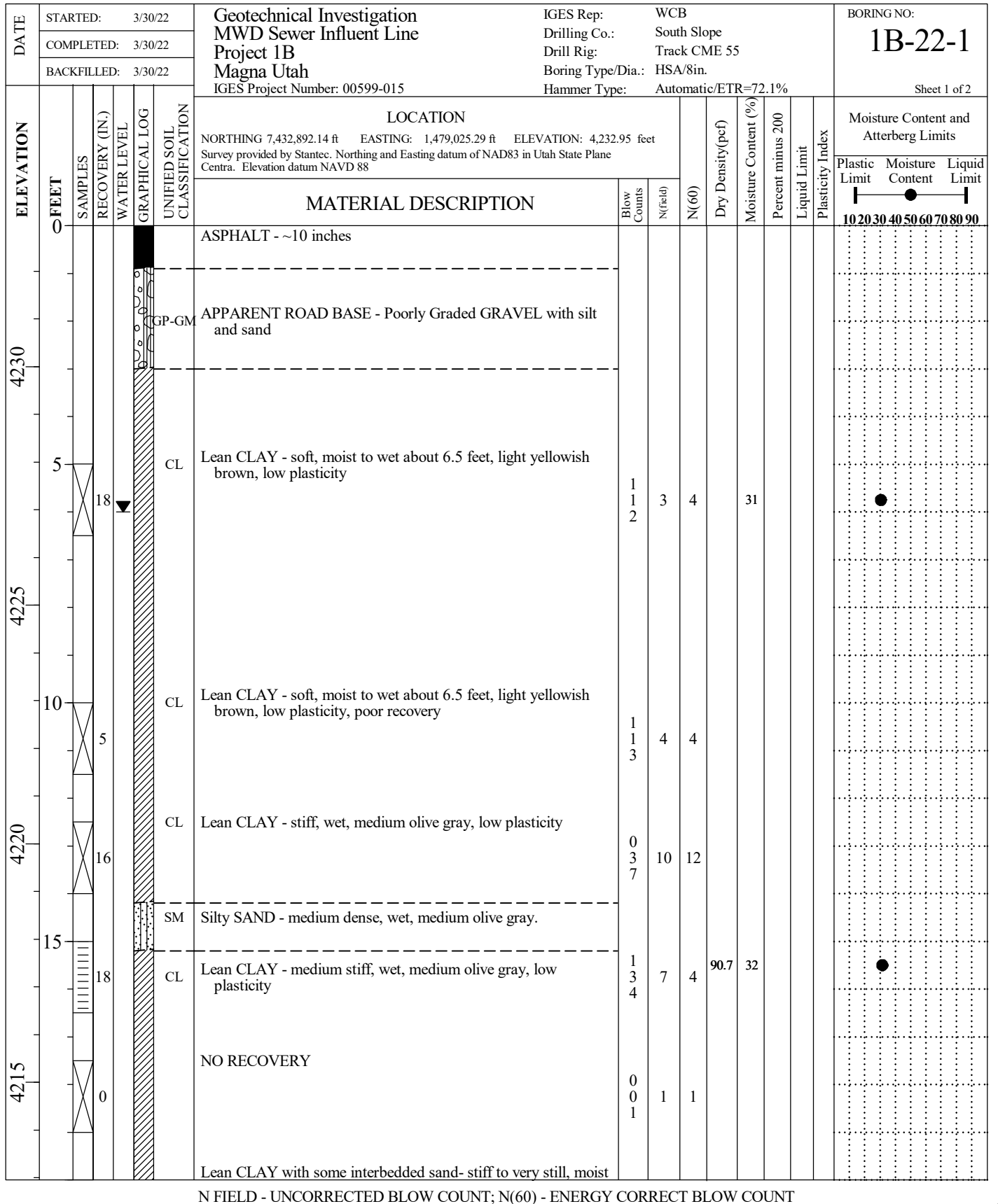
**A-2**





Geotechnical Investigation  
MWD Sewer Influent Line  
Project 1B  
Magna, Utah

# Exploration Logs



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler  
☒ 3.25" O.D./2.42" I.D. 'U' Sampler  
☒ 3" O.D. Thin-Walled Shelby Sampler  
☐ 3" O.D./2.375" I.D. California Sampler  
☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler  
☐ Sample from Auger Cuttings

# BORING LOG

#### NOTES:

WATER LEVEL

▼ - MEASURED    ▽ - ESTIMATED

## FIGURE

**A-3a**

DATE	STARTED: 3/30/22	<b>Geotechnical Investigation</b> <b>MWD Sewer Influent Line</b> <b>Project 1B</b> <b>Magna Utah</b> IGES Project Number: 00599-015	IGES Rep: WCB Drilling Co.: South Slope Drill Rig: Track CME 55 Boring Type/Dia.: HSA/8in. Hammer Type: Automatic/ETR=72.1%	BORING NO: <b>1B-22-1</b> Sheet 2 of 2												
	COMPLETED: 3/30/22															
	BACKFILLED: 3/30/22															
ELEVATION	FEET	SAMPLES	RECOVERY (IN.)	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION	Blow Counts	N(Field)	N(60)	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits
							NORTHING 7,432,892.14 ft EASTING: 1,479,025.29 ft ELEVATION: 4,232.95 feet Survey provided by Stantec. Northing and Easting datum of NAD83 in Utah State Plane Centra. Elevation datum NAVD 88									Plastic Limit    Moisture Content    Liquid Limit 
							MATERIAL DESCRIPTION									
	20		18			CL	to wet, medium gray, low plasticity	4 8 12	20	16	102.1	24				
	25		18				Lean CLAY with some fine sand- stiff, wet, medium olive gray, low plasticity	0 2 6	8	10		31				
	4205						- Groundwater estimated at 6.0 feet upon completion - Backfilled with cuttings - Core reinstated with Utilibond (TM)  Bottom of Boring @ 26.5 Feet									
	4200															
	35															
	4195															

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler  
☒ 3.25" O.D./2.42" I.D. 'U' Sampler  
☒ 3" O.D. Thin-Walled Shelby Sampler  
☐ 3" O.D./2.375" I.D. California Sampler  
☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler  
☐ Sample from Auger Cuttings

## BORING LOG

NOTES:

WATER LEVEL

☒ - MEASURED    ☐ - ESTIMATED

FIGURE

A-3b

DATE		STARTED: 11/4/21		COMPLETED: 11/4/21		BACKFILLED: 11/4/21		Geotechnical Investigation MWD Sewer Influent Line Project 1B Magna Utah IGES Project Number: 00599-015				IGES Rep: WCB Drilling Co.: South Slope Drill Rig: Track CME 55 Boring Type/Dia.: HSA/8in. Hammer Type: Automatic/ETR=72.1%				BORING NO: <b>1B-21-2</b> Sheet 1 of 2				
ELEVATION	E	F	S	R	W	G	U	LOCATION				N(60)	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits		
								NORTHING 7,432,214.18 ft EASTING: 1,479,024.58 ft ELEVATION: 4,232.52 feet Survey provided by Stantec. Northing and Easting datum of NAD83 in Utah State Plane Centra. Elevation datum NAVD 88										Plastic Limit	Moisture Content	Liquid Limit
MATERIAL DESCRIPTION								Blow Counts	N(Field)											
								ASPHALT - ~8 inches												
4230								CL Lean CLAY - stiff, moist, moderate yellowish brown - trace sand, trace roots, trace iron oxide	2 3 4	7	8		27							
4225								CL Lean CLAY - stiff, moist, moderate grayish brown - trace sand, trace iron oxide	1 3 4	7	8		30							
4220								No Recovery	3 5 8	13	11									
4215								CL Lean CLAY with sand - medium stiff, wet, dark gray	3 2 2	4	5		28	85						
								CL Lean CLAY with sand - soft, wet, dark gray	2 2 2	4	4									

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler
- ☒ 3.25" O.D./2.42" I.D. 'U' Sampler
- ☒ 3" O.D. Thin-Walled Shelby Sampler
- ☐ 3" O.D./2.375" I.D. California Sampler
- ☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler
- ☐ Sample from Auger Cuttings

## BORING LOG

NOTES:

WATER LEVEL

▼ - MEASURED ▽ - ESTIMATED

FIGURE

A-4a

[illegible]

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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SAMPLE TYPE
-------------

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler
- ☒ 3.25" O.D./2.42" I.D. 'U' Sampler
- ☒ 3" O.D. Thin-Walled Shelby Sampler
- ☐ 3" O.D./2.375" I.D. California Sampler
- ☐ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler
- ☒ Sample from Auger Cuttings

# BORING LOG

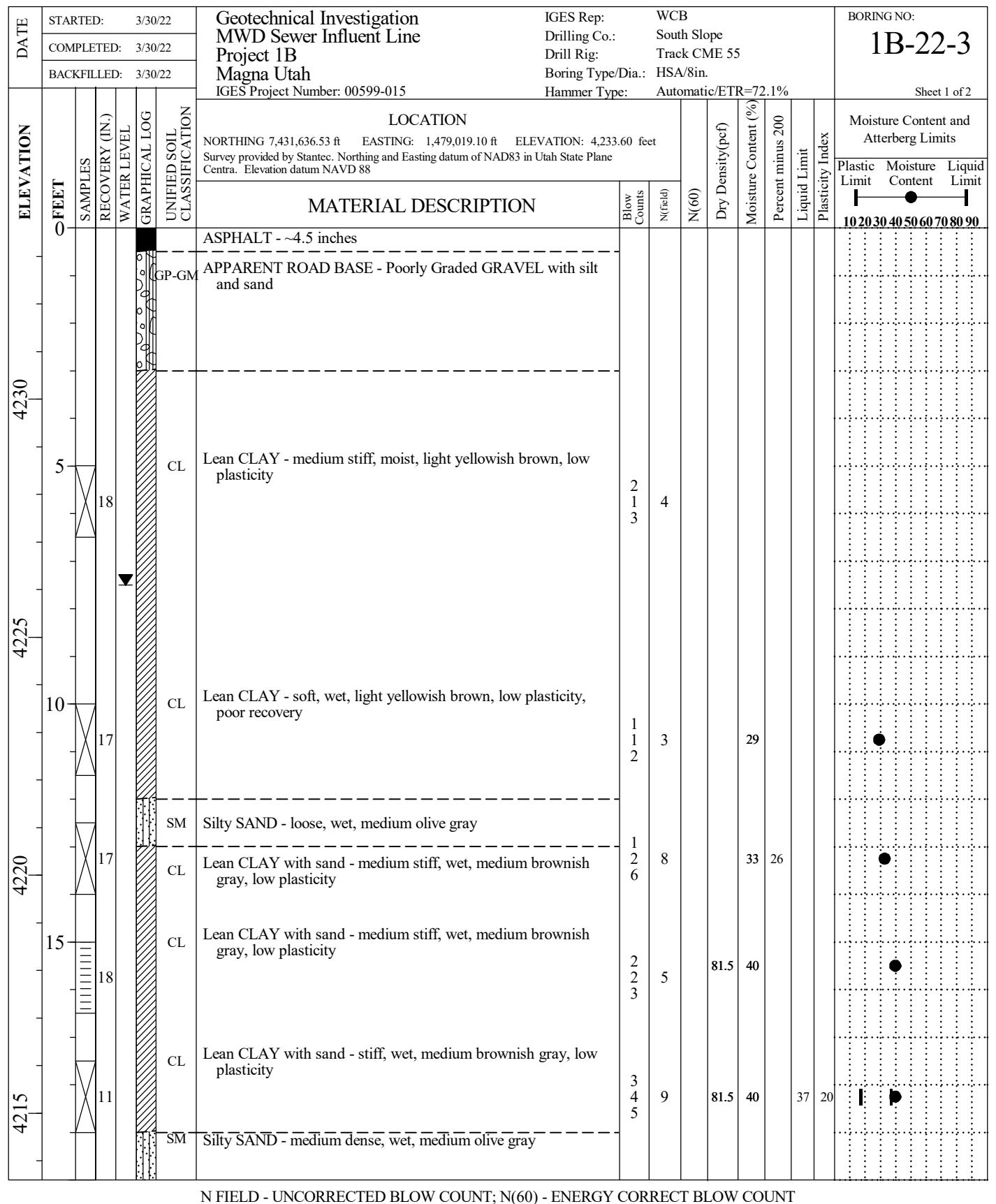
#### NOTES:

WATER LEVEL

▼ - MEASURED      ▽ - ESTIMATED

## FIGURE

**A-4b**



N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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**SAMPLE TYPE**

☒ 2" O.D./1.38" I.D. Split Spoon Sampler  
☒ 3.25" O.D./2.42" I.D. 'U' Sampler  
☒ 3" O.D. Thin-Walled Shelby Sampler  
☒ 3" O.D./2.375" I.D. California Sampler  
☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler  
☒ Sample from Auger Cuttings

**BORING LOG**

NOTES:

**WATER LEVEL**
☒ - MEASURED    ☒ - ESTIMATED
**FIGURE****A-8**

DATE	STARTED: 3/30/22	<b>Geotechnical Investigation</b> <b>MWD Sewer Influent Line</b> <b>Project 1B</b> <b>Magna Utah</b> IGES Project Number: 00599-015	IGES Rep: WCB Drilling Co.: South Slope Drill Rig: Track CME 55 Boring Type/Dia.: HSA/8in. Hammer Type: Automatic/ETR=72.1%	BORING NO: <b>1B-22-3</b> Sheet 2 of 2												
	COMPLETED: 3/30/22															
	BACKFILLED: 3/30/22															
ELEVATION	FEET	SAMPLES	RECOVERY (IN.)	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION NORTHING 7,431,636.53 ft EASTING: 1,479,019.10 ft ELEVATION: 4,233.60 feet Survey provided by Stantec. Northing and Easting datum of NAD83 in Utah State Plane Centra. Elevation datum NAVD 88	Blow Counts	N(Field)	N(60)	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits Plastic Limit    Moisture Content    Liquid Limit 
							MATERIAL DESCRIPTION									10 20 30 40 50 60 70 80 90
4210	20	18				CL	Lean CLAY with some interbedded sand- stiff to very still, wet, medium gray, low plasticity	3 7 10	17							
4205	25	18				CL	Lean CLAY - very stiff, wet, dark olive gray, low plasticity	3 5 8	13							
4195	30						- Groundwater estimated at 7.5 feet upon completion - Backfilled with cuttings - Core reinstated with Utilibond (TM)  Bottom of Boring @ 26.5 Feet									

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler  
☒ 3.25" O.D./2.42" I.D. 'U' Sampler  
☒ 3" O.D. Thin-Walled Shelby Sampler  
☐ 3" O.D./2.375" I.D. California Sampler  
☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler  
☐ Sample from Auger Cuttings

## BORING LOG

NOTES:

WATER LEVEL

▼ - MEASURED    ▽ - ESTIMATED

FIGURE

A-9



DATE		STARTED: 11/9/21		COMPLETED: 11/9/21		BACKFILLED: 11/9/21		Geotechnical Investigation MWD Sewer Influent Line Project 1B Magna Utah IGES Project Number: 00599-015				IGES Rep: WCB Drilling Co.: South Slope Drill Rig: Track CME 55 Boring Type/Dia.: HSA/8in. Hammer Type: Automatic/ETR=72.1%				BORING NO: <b>1B-21-4</b> Sheet 1 of 2						
ELEVATION		O FEET		SAMPLES		RECOVERY (IN.)		WATER LEVEL		GRAPHICAL LOG		UNIFIED SOIL CLASSIFICATION		LOCATION NORTHING 7,431,025.43 ft EASTING: 1,479,094.57 ft ELEVATION: 4,236.41 feet Survey provided by Stantec. Northing and Easting datum of NAD83 in Utah State Plane Centra. Elevation datum NAVD 88				Moisture Content and Atterberg Limits				
MATERIAL DESCRIPTION												Blow Counts	N(Field)	N(60)	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index	Plastic Limit	Moisture Content	Liquid Limit
												10	20	30	40	50	60	70	80	90		
AGGREGATE Parking Lot																						
CL Lean CLAY with sand - very stiff, slightly moist, light yellowish brown - trace roots												3 5 8	13	16								
CL Lean CLAY with sand - very soft, wet, light yellowish brown - sand stringers												WH 1 1	2	2								
CL Lean to Fat CLAY - soft, wet, olive gray - trace sand, weak sulfur (organic) odor												2 2 2	4	4	67.8	55						
CL Lean to Fat CLAY - very soft, wet, olive gray - trace sand, weak sulfur (organic) odor												WH/1.0 2	2	2	74.0	47						
SM Silty SAND - medium dense, wet, medium brown - trace silt												4 5 5	10	12			27	29				
CL Sandy Lean CLAY - medium stiff, moist - trace sand, weak sulfur (organic) odor																	24	63				
Poorly Graded SAND with silt - very loose, wet, dark gray to																						

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler
- ☒ 3.25" O.D./2.42" I.D. 'U' Sampler
- ☒ 3" O.D. Thin-Walled Shelby Sampler
- ☒ 3" O.D./2.375" I.D. California Sampler
- ☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler
- ☒ Sample from Auger Cuttings

## BORING LOG

NOTES:

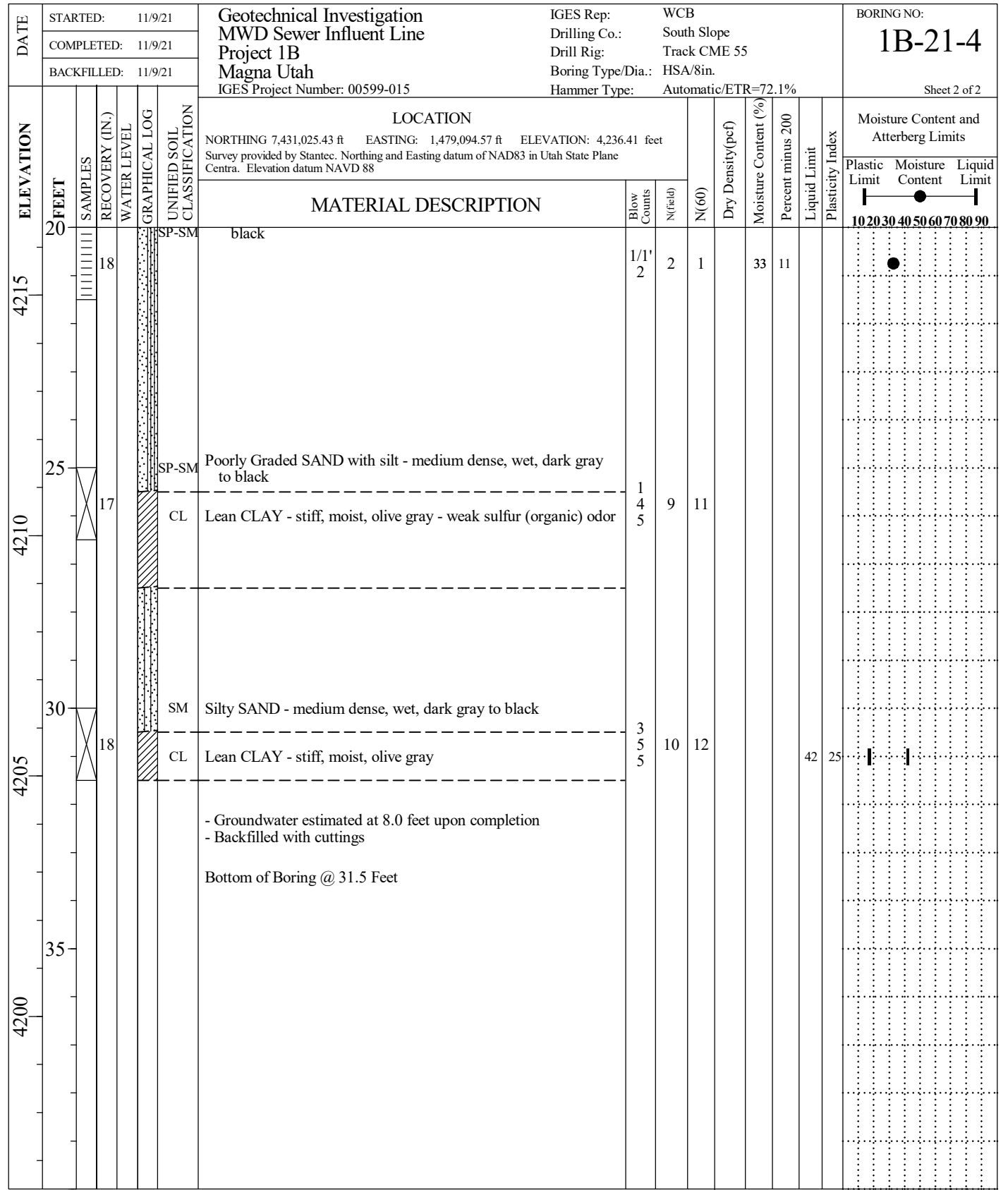
WATER LEVEL

▼ - MEASURED ▽ - ESTIMATED

FIGURE

A-5a





N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler
- ☒ 3.25" O.D./2.42" I.D. 'U' Sampler
- ☒ 3" O.D. Thin-Walled Shelby Sampler
- ☒ 3" O.D./2.375" I.D. California Sampler
- ☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler
- ☒ Sample from Auger Cuttings

## BORING LOG

NOTES:

WATER LEVEL

▼ - MEASURED ▽ - ESTIMATED

FIGURE

A-5b



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler  
☒ 3.25" O.D./2.42" I.D. 'U' Sampler  
☒ 3" O.D. Thin-Walled Shelby Sampler  
☐ 3" O.D./2.375" I.D. California Sampler  
☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler  
☐ Sample from Auger Cuttings

# BORING LOG

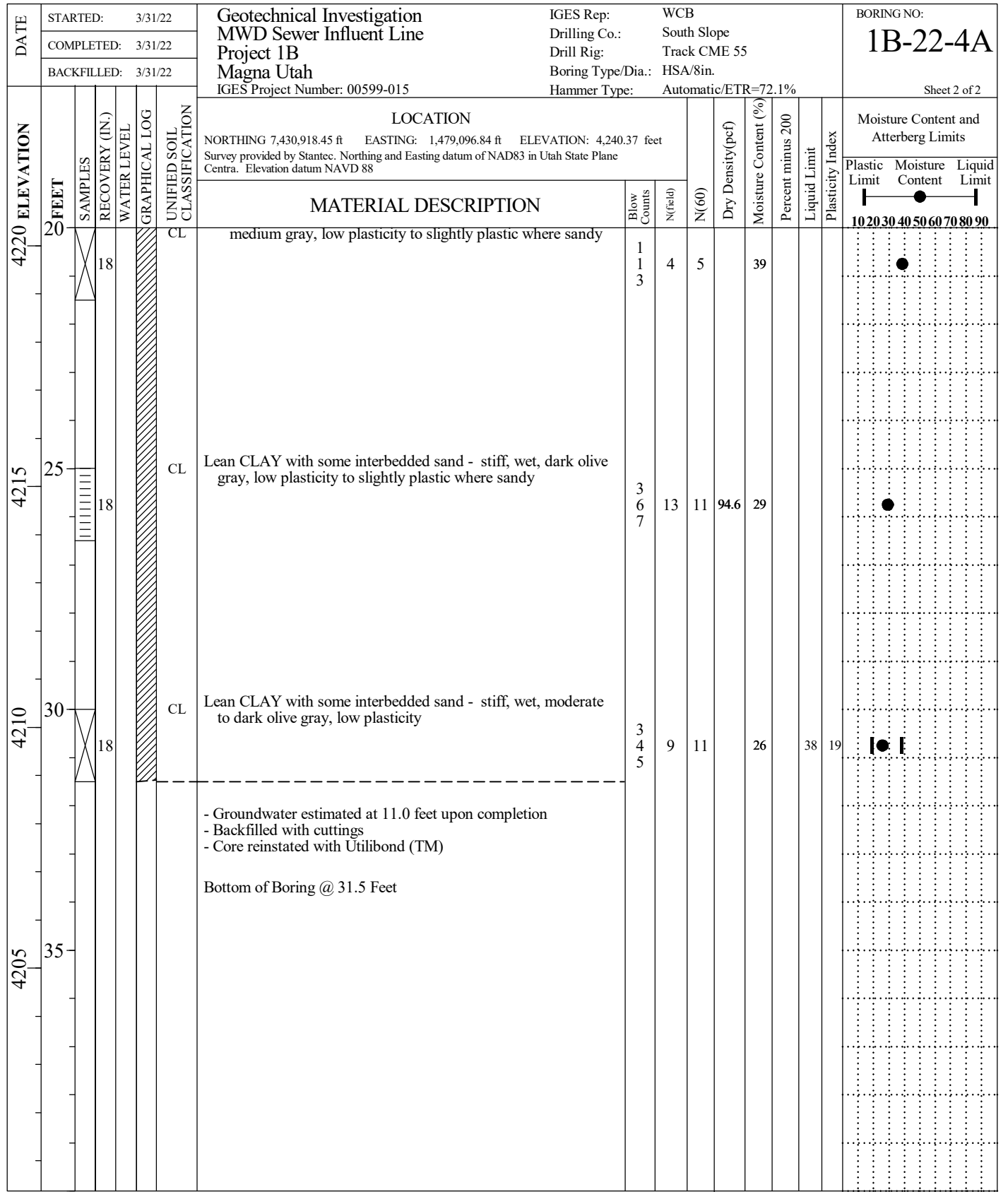
#### NOTES:

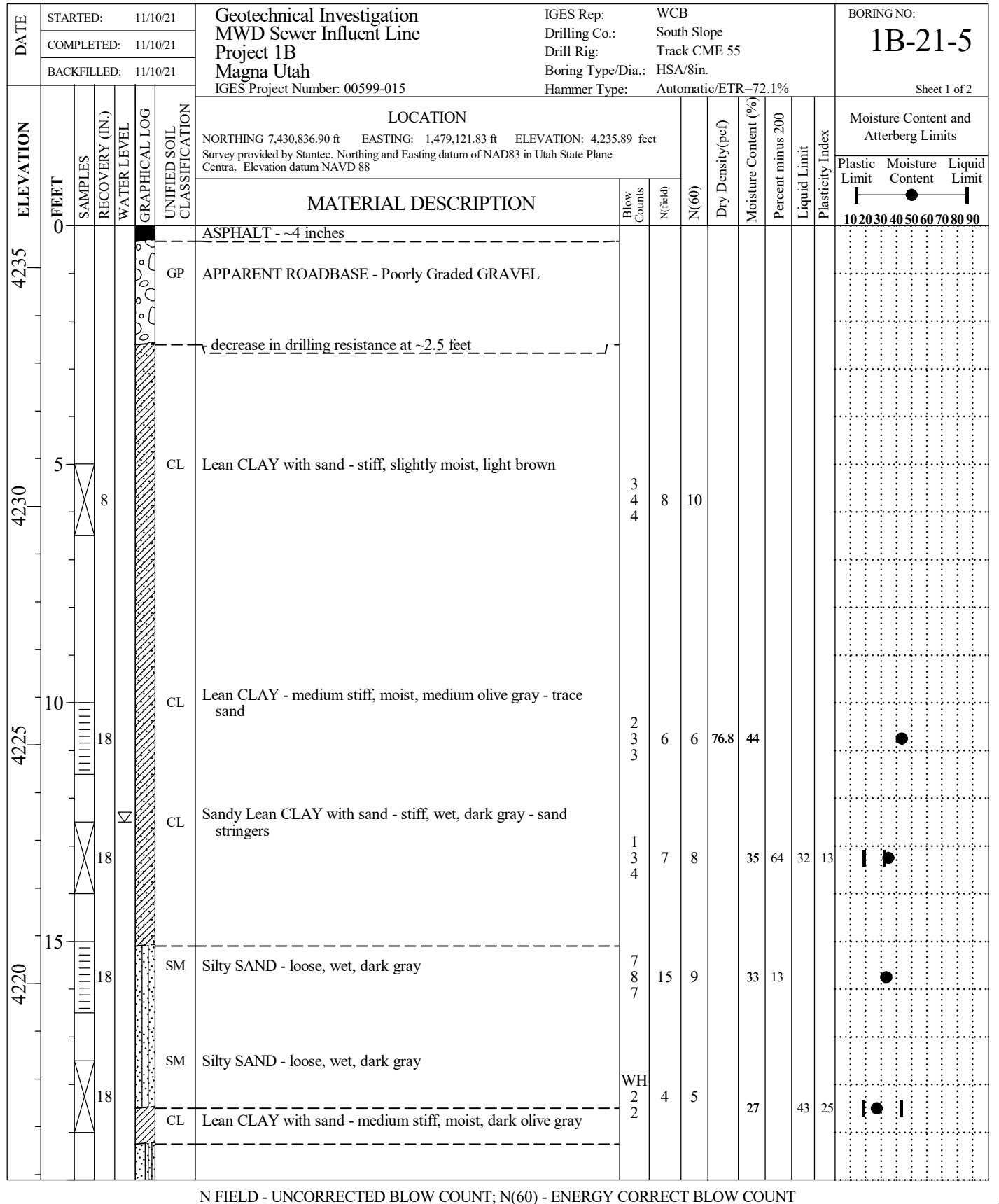
WATER LEVEL

▼ - MEASURED    ▽ - ESTIMATED

## FIGURE

**A-6a**





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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler
- ☒ 3.25" O.D./2.42" I.D. 'U' Sampler
- ☒ 3" O.D. Thin-Walled Shelby Sampler
- ☐ 3" O.D./2.375" I.D. California Sampler
- ☐ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler
- ☐ Sample from Auger Cuttings

# BORING LOG

NOTES:

WATER LEVEL

▼ - MEASURED    ▽ - ESTIMATED

## FIGURE

**A-7a**

DATE		STARTED: 11/10/21		COMPLETED: 11/10/21		BACKFILLED: 11/10/21		Geotechnical Investigation MWD Sewer Influent Line Project 1B Magna Utah IGES Project Number: 00599-015				IGES Rep: WCB Drilling Co.: South Slope Drill Rig: Track CME 55 Boring Type/Dia.: HSA/8in. Hammer Type: Automatic/ETR=72.1%				BORING NO: <b>1B-21-5</b> Sheet 2 of 2			
ELEVATION	FEET	SAMPLES	RECOVERY (IN.)	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION				N(60)	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits		
							NORTHING 7,430,836.90 ft EASTING: 1,479,121.83 ft ELEVATION: 4,235.89 feet Survey provided by Stantec. Northing and Easting datum of NAD83 in Utah State Plane Centra. Elevation datum NAVD 88										Plastic Limit	Moisture Content	Liquid Limit
MATERIAL DESCRIPTION							Blow Counts	N(Field)											
4215	20		18			SP-SM	Poorly Graded SAND with silt - loose, wet, dark gray	1	5	6									
4215						CL	Lean CLAY - medium stiff, wet, light olive gray	2											
4210	25		18			CL	Lean CLAY - very stiff, wet, olive green to olive gray	3											
4210								5	24	19	107.0	21							
4210								10											
4210								14											
4205	30		12			CL	Lean CLAY - stiff, wet, light grayish brown - sand stringers	2	7	8									
4205								2											
4205								2											
4205								5											
4200	35						- Groundwater estimated at 12.5 feet upon completion - Backfilled with cuttings  Bottom of Boring @ 31.5 Feet												

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler  
☒ 3.25" O.D./2.42" I.D. 'U' Sampler  
☒ 3" O.D. Thin-Walled Shelby Sampler  
☐ 3" O.D./2.375" I.D. California Sampler  
☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler  
☐ Sample from Auger Cuttings

## BORING LOG

NOTES:

WATER LEVEL

☒ - MEASURED    ☐ - ESTIMATED

FIGURE

A-7b

DATE		STARTED: 3/29/22		COMPLETED: 3/29/22		BACKFILLED: 3/29/22		Geotechnical Investigation MWD Sewer Influent Line Project 1B Magna Utah IGES Project Number: 00599-015		IGES Rep: WCB Drilling Co.: South Slope Drill Rig: Track CME 55 Boring Type/Dia.: HSA/8in. Hammer Type: Automatic/ETR=72.1%		BORING NO: <b>1B-22-5PZ</b> Sheet 1 of 2	
ELEVATION		FOOT		SAMPLES		RECOVERY (IN.)		WATER LEVEL		GRAPHICAL LOG		UNIFIED SOIL CLASSIFICATION	
4235		0											
4230		5		18									
4225		10		18									
4220		15		12									
<p><b>LOCATION</b>  NORTHING 7,430,811.44 ft    EASTING: 1,479,147.67 ft    ELEVATION: 4,235.22 feet  Survey provided by Stantec. Northing and Easting datum of NAD83 in Utah State Plane Centra. Elevation datum NAVD 88</p>													
<p><b>MATERIAL DESCRIPTION</b></p>													
<p>ASPHALT - ~4 inches</p>													
<p>GP-GM APPARENT ROAD BASE - Poorly Graded GRAVEL with silt and sand</p>													
<p>CL Lean CLAY - medium stiff, slightly moist, light grayish brown, low plasticity</p>													
<p>CL Lean CLAY with trace fine sand - soft, moist to wet, light to medium gray, low plasticity</p>													
<p>ML Sandy SILT - very stiff, wet, medium gray</p>													
<p>ML Silty SAND - stiff, wet, dark olive gray</p>													
<p><b>Moisture Content and Atterberg Limits</b></p>													
<p>Plastic Limit    Moisture Content    Liquid Limit</p>													
<p>10 20 30 40 50 60 70 80 90</p>													

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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**SAMPLE TYPE**

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler
- ☒ 3.25" O.D./2.42" I.D. 'U' Sampler
- ☒ 3" O.D. Thin-Walled Shelby Sampler
- ☒ 3" O.D./2.375" I.D. California Sampler
- ☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler
- ☒ Sample from Auger Cuttings

**BORING LOG**

NOTES:

WATER LEVEL

▼ - MEASURED    ▽ - ESTIMATED

**FIGURE****A-8a**



DATE		STARTED: 3/29/22		COMPLETED: 3/29/22		BACKFILLED: 3/29/22		Geotechnical Investigation MWD Sewer Influent Line Project 1B Magna Utah IGES Project Number: 00599-015				IGES Rep: WCB Drilling Co.: South Slope Drill Rig: Track CME 55 Boring Type/Dia.: HSA/8in. Hammer Type: Automatic/ETR=72.1%				BORING NO: <b>1B-22-5PZ</b> Sheet 2 of 2							
ELEVATION	FEET	SAMPLES	RECOVERY (IN.)	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION				Blow Counts	N(Field)	N(60)	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits				
							NORTHING 7,430,811.44 ft EASTING: 1,479,147.67 ft ELEVATION: 4,235.22 feet Survey provided by Stantec. Northing and Easting datum of NAD83 in Utah State Plane Centra. Elevation datum NAVD 88												Plastic Limit	Moisture Content	Liquid Limit		
4215	20		18			CL	Lean CLAY with trace sand- stiff, wet, medium olive gray, low plasticity				3 4 7	11	9	91.3	31								
							- 2" Piezometer installed with 10 feet of well screen (10 - 20 feet) - 10/20 filter pack to 8 feet (8 - 20 feet) - bentonite chips to 4.5 feet (4.5 - 8 feet) - groundwater at 7.0 feet upon completion  Bottom of Boring @ 21.5 Feet																
4210	25																						
4205	30																						
4200	35																						

N FIELD - UNCORRECTED BLOW COUNT; N(60) - ENERGY CORRECT BLOW COUNT



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## SAMPLE TYPE

- ☒ 2" O.D./1.38" I.D. Split Spoon Sampler  
☒ 3.25" O.D./2.42" I.D. 'U' Sampler  
☒ 3" O.D. Thin-Walled Shelby Sampler  
☐ 3" O.D./2.375" I.D. California Sampler  
☒ 2.5" O.D./1.875" I.D. Mod. Cal. Sampler  
☐ Sample from Auger Cuttings

## BORING LOG

NOTES:

WATER LEVEL

☒ - MEASURED    ☐ - ESTIMATED

FIGURE

A-8b

# UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS  (More than half of material is larger than the #200 sieve)	GRAVELS  (More than half coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GP POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GM SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS  (More than half coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SP POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SM SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS  (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS  (Liquid limit less than 50)	ML INORGANIC SILTS & CLAYEY SILTS WITH SLIGHT PLASTICITY	
		CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, LEAN CLAYS	
		OL ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY	
	SILTS AND CLAYS  (Liquid limit greater than 50)	MH INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT	
		CH INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
		OH ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY	
HIGHLY ORGANIC SOILS		PT PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS	

## MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
SLIGHTLY MOIST	CONTAINING A MINIMAL AMOUNT OF MOISTURE, NOT DRY OR MOIST
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

## STRATIFICATION

DESCRIPTION	THICKNESS	DESCRIPTION	FREQUENCY
SEAM	1/16-1/2"	OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
LAYER	1/2-12"	FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

## APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATE 12" WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

## CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE	POCKET PENETROMETER	FIELD TEST
		UNDRAINED SHEAR STRENGTH (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

## GENERAL NOTES

- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
- No warranty is provided as to the continuity of soil conditions between individual sample locations.
- Logs represent general soil conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

## OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

## CEMENTATION

DESCRIPTION	DESCRIPTION
WEAK	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATE	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONG	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

## STRUCTURE

DESCRIPTION	DESCRIPTION
STRATIFIED	ALTERNATING LAYERS OF VARYING MATERIAL OR COLOR WITH LAYERS AT LEAST 6MM THICK
LAMINATED	ALTERNATING LAYERS OF VARYING MATERIAL OR COLOR WITH THE LAYERS LESS THAN 6 MM THICK
FISSURED	BREAKS ALONG DEFINITE PLANES OF FRACTURE WITH LITTLE RESISTANCE TO FRACTURING
SLICKENSIDED	FRACTURE PLANES APPEAR POLISHED OR GLOSSY, SOMETIMES STRIATED
BLOCKY	COHESIVE SOIL THAT CAN BE BROKEN DOWN INTO SMALL ANGULAR LUMPS WHICH RESIST FURTHER BREAKDOWN
LENSED	INCLUSION OF SMALL POCKETS OF DIFFERENT SOILS, SUCH AS SMALL LENSES OF SAND SCATTERED THROUGH A MASS OF CLAY
HOMOGENOUS	SAME COLOR AND APPEARANCE THROUGHOUT

## MODIFIERS

DESCRIPTION	TRACE	FEW	LITTLE	SOME	MOSTLY
PERCENT	< 5	5 - 10	15 - 25	30 - 45	50 - 100







Geotechnical Investigation  
MWD Sewer Influent Line  
Project 1B  
Magna, Utah

## Appendix B

SUMMARY OF LABORATORY TEST RESULTS TABLE

Geotechnical Investigation

Project Number: 00599-015

Sample Location	Surface Elevation*	Depth	Sample Length	Depth to Sample Midpoint	Sample Midpoint Elevation	Dry Unit Weight	Natural Moisture Content	Total Unit Weight	Gravel	Sand	Fines	Atterberg Limits		Unconsolidated Undrained (UU) Triaxial Compression		Corrosion			
									> No. 4 & < 3"	> No. 200 & < No. 4	< No. 200	Liquid Limit	Plasticity Index	Confining Stress	Shear Stress at Failure	Soluble Sulfate	Soluble Chloride	Resistivity Minimum	pH
									(%)	(%)	(%)	(%)	(%)	(psf)	(psf)	(ppm)	(ppm)	(ohm-cm)	(#)
ID	(ft)	(ft)	(ft)	(ft)	(ft)	(pcf)	(%)	(pcf)	(%)	(%)	(%)	(%)	(%)	(psf)	(psf)	(ppm)	(ppm)	(ohm-cm)	(#)
1B-22-1	4231.95	5.0	1.5	5.75	4226.2	-	30.6	-	-	-	-	-	-	-	-	-	-	-	-
1B-22-1	4231.95	12.5	1.5	13.25	4218.7	-	-	-	-	-	-	-	-	-	-	102	239	598	9.3
1B-22-1	4231.95	15.5	0.5	15.75	4216.2	90.7	31.5	119.3	-	-	-	-	-	1779	1123	-	-	-	-
1B-22-1	4231.95	20.5	0.5	20.75	4211.2	102.1	23.6	126.2	-	-	-	-	-	-	-	-	-	-	-
1B-22-1	4231.95	25.0	1.5	25.75	4206.2	-	31.4	-	-	-	-	-	-	-	-	-	-	-	-
1B-21-2	4232.52	5.0	1.5	5.75	4226.77	-	27.2	-	-	-	-	-	-	-	-	-	-	-	-
1B-21-2	4232.52	10.0	1.5	10.75	4221.77	-	29.6	-	-	-	-	-	-	-	-	371	156	1066	8.8
1B-21-2	4232.52	15.0	1.5	15.75	4216.77	-	28.5	-	0.5	15	84.6	-	-	-	-	-	-	-	-
1B-22-3	4233.60	10.0	1.5	10.75	4222.85	-	29.1	-	-	-	-	-	-	-	-	-	-	-	-
1B-22-3	4233.60	12.5	1.5	13.25	4220.35	-	32.7	-	N/P	N/P	25.7	-	-	-	-	-	-	-	-
1B-22-3	4233.60	13.0	0.5	13.25	4220.35	-	-	-	-	-	-	-	-	-	-	91	98	1589	8.8
1B-22-3	4233.60	15.5	0.5	15.75	4217.85	81.5	39.7	113.9	-	-	-	-	-	1801	976	-	-	-	-
1B-22-3	4233.60	17.5	1.5	18.25	4215.35	-	-	-	-	-	-	37	20	-	-	-	-	-	-
1B-21-4	4236.41	13.0	0.5	13.25	4223.159	67.8	55	105.1	-	-	-	-	-	-	-	-	-	-	-
1B-21-4	4236.41	15.5	0.5	15.75	4220.659	74	46.6	108.5	-	-	-	-	-	-	-	-	-	-	-
1B-21-4	4236.41	17.5	1.5	18.25	4218.159	-	26.9	-	0	71.1	28.9	-	-	-	-	-	-	-	-
1B-21-4	4236.41	18.5	0.5	18.75	4217.659	-	23.9	-	N/P	N/P	63.2	-	-	-	-	-	-	-	-
1B-21-4	4236.41	20.0	1.5	20.75	4215.659	-	32.7	-	0.2	88.6	11.2	-	-	-	-	-	-	-	-
1B-21-4	4236.41	30.5	0.5	30.75	4205.659	-	-	-	-	-	-	42	25	-	-	-	-	-	-
1B-22-4A	4240.37	11.5	0.5	11.75	4228.62	-	-	-	-	-	-	43	21	-	-	-	-	-	-
1B-22-4A	4240.37	15.0	1.5	15.75	4224.62	-	39.5	-	-	-	-	-	-	-	-	92	425	490	8.8
1B-22-4A	4240.37	18.0	0.5	18.25	4222.12	74.8	46.5	109.6	-	-	-	-	-	2032	622	-	-	-	-
1B-22-4A	4240.37	20.0	1.5	20.75	4219.62	-	38.6	-	-	-	-	-	-	-	-	-	-	-	-
1B-22-4A	4240.37	25.5	0.5	25.75	4214.62	94.6	29.2	122.2	-	-	-	-	-	-	-	-	-	-	-
1B-22-4A	4240.37	30.0	1.5	30.75	4209.62	-	25.8	-	-	-	-	38	19	-	-	-	-	-	-
1B-21-5	4235.89	10.5	0.5	10.75	4225.14	76.8	43.5	110.2	-	-	-	-	-	-	-	-	-	-	-
1B-21-5	4235.89	12.5	1.5	13.25	4222.64	-	34.8	-	N/P	N/P	64.2	32	13	-	-	-	-	-	-
1B-21-5	4235.89	15.0	1.5	15.75	4220.14	-	33.4	-	0	87.5	12.5	-	-	-	-	-	-	-	-
1B-21-5	4235.89	18.5	0.5	18.75	4217.14	-	27.2	-	-	-	-	43	25	-	-	-	-	-	-
1B-21-5	4235.89	20.5	0.5	20.75	4215.14	-	26.3	-	N/P	N/P	86.7	-	-	-	-	-	-	-	-
1B-21-5	4235.89	25.5	0.5	25.75	4210.14	107	20.9	129.4	-	-	-	-	-	-	-	-	-	-	-
1B-22-PZ5	4235.22	10.5	0.5	10.75	4224.47	69.4	52.5	105.8	-	-	-	-	-	-	-	-	-	-	-
1B-22-PZ5	4235.22	15.0	1.5	15.75	4219.47	-	26.06	-	-	-	-	-	-	-	-	-	-	-	-
1B-22-PZ5	4235.22	20.5	0.5	20.75	4214.47	91.3	31.1	119.7	-	-	-	-	-	-	-	-	-	-	-

\*As drilled surface elevation surveyed by Stantec

N/P - Test Not Performed



**Water Content and Unit Weight of Soil**

(In General Accordance with ASTM D7263 Method B and D2216)



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**Project: Magna Water****No: 00599-015****Location: Magna, Utah****Date: 4/14/2022****By: BRR**

Sample Info.	Boring No.	1B-22-1	1B-22-1	1B-22-1	1B-22-1	1B-22-3	1B-22-3	1B-22-3	1B-22-4A
	Sample								
	Depth	5.0'	15.5'	20.5'	25.0'	10.0'	12.5'	15.5'	15.0'
	Split	No	No	No	No	No	No	No	No
	Split sieve								
Total sample (g)									
Moist coarse fraction (g)									
Moist split fraction (g)									
Unit Weight Data	Sample height, H (in)		5.960	2.998				6.005	
	Sample diameter, D (in)		2.408	2.413				2.404	
	Mass rings + wet soil (g)		849.81	587.37				2159.87	
	Mass rings/tare (g)		0.00	133.15				1345.43	
	Moist unit wt., $\gamma_m$ (pcf)		119.3	126.2				113.8	
	Wet soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Water Content Data	Wet soil + tare (g)	1062.15	971.80	580.31	999.11	1210.03	434.73	950.18	408.75
	Dry soil + tare (g)	885.84	769.48	493.74	800.17	1010.28	358.33	720.18	328.82
	Tare (g)	310.49	126.90	127.15	167.11	324.19	124.38	141.47	126.71
	Water content (%)	30.6	31.5	23.6	31.4	29.1	32.7	39.7	39.5
Water Content, w (%)		30.6	31.5	23.6	31.4	29.1	32.7	39.7	39.5
Dry Unit Wt., $\gamma_d$ (pcf)			90.7	102.1				81.5	

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

# Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)



© IGES 2006, 2022

Project: **Magna Water**

No: **00599-015**

Location: **Magna, Utah**

Date: **4/14/2022**

By: **BRR**

Sample Info.	Boring No.	1B-22-4A	1B-22-4A	1B-22-4A	1B-22-4A	1B-22-PZ5	1B-22-PZ5		
	Sample								
	Depth	18.0'	20.0'	25.5'	30.0'	10.5'	20.5'		
	Split	No	No	No	No	No	No		
	Split sieve								
Total sample (g)									
Moist coarse fraction (g)									
Moist split fraction (g)									
Unit Weight Data	Sample height, H (in)	5.981		4.033		6.001	5.021		
	Sample diameter, D (in)	2.393		2.407		2.409	2.409		
	Mass rings + wet soil (g)	774.13		767.45		1033.22	940.24		
	Mass rings/tare (g)	0.00		178.71		273.86	221.03		
	Moist unit wt., $\gamma_m$ (pcf)	109.6		122.2		105.8	119.7		
	Wet soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Water Content Data	Wet soil + tare (g)	892.70	1229.62	708.70	350.19	1144.21	843.93		
	Dry soil + tare (g)	649.50	1011.65	575.94	304.55	884.35	673.98		
	Tare (g)	127.02	446.66	121.41	127.92	389.29	126.85		
	Water content (%)	46.5	38.6	29.2	25.8	52.5	31.1		
Water Content, w (%)		46.5	38.6	29.2	25.8	52.5	31.1		
Dry Unit Wt., $\gamma_d$ (pcf)		74.8		94.6		69.4	91.3		

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Water Content and Unit Weight of Soil**

(In General Accordance with ASTM D7263 Method B and D2216)



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**Project: Magna Sewer Line****No: 00599-014****Location: Magna, Utah****Date: 11/17/2021****By: BFS**

Sample Info.	Boring No	1B-21-2	1B-21-2	1B-21-2	1B-21-4	1B-21-4	1B-21-4	1B-21-4	1B-21-5
	Sample								
	Depth	5.0'	10.0'	15.0'	13.0'	15.5'	18.5'	20.0'	10.5'
	Split	No	No	No	No	No	No	No	No
	Split sieve								
Total sample (g)									
Moist coarse fraction (g)									
Moist split fraction (g)									
Unit Weight Data	Sample height, H (in)				4.007	1.998			2.000
	Sample diameter, D (in)				2.408	2.421			2.426
	Mass rings + wet soil (g)				682.11	349.20			352.07
	Mass rings/tare (g)				178.91	87.21			84.74
	Moist unit wt., $\gamma_m$ (pcf)				105.1	108.5			110.2
	Wet soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Water Content Data	Wet soil + tare (g)	225.82	253.34	1041.44	625.80	384.81	359.15	416.15	390.87
	Dry soil + tare (g)	204.60	224.90	913.55	447.60	302.08	313.03	343.42	310.13
	Tare (g)	126.64	128.76	464.07	123.62	124.36	119.95	120.71	124.39
	Water content (%)	27.2	29.6	28.5	55.0	46.6	23.9	32.7	43.5
Water Content, w (%)		27.2	29.6	28.5	55.0	46.6	23.9	32.7	43.5
Dry Unit Wt., $\gamma_d$ (pcf)					67.8	74.0			76.8

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Water Content and Unit Weight of Soil**

(In General Accordance with ASTM D7263 Method B and D2216)



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**Project: Magna Sewer Line****No: 00599-014**Location: **Magna, Utah**Date: **11/17/2021**By: **FB**

Sample Info.	Boring No.	1B-21-5	1B-21-5	1B-21-5	1B-21-5	1B-21-5			
	Sample								
	Depth	12.5'	15.0'	18.5'	20.5'	25.5'			
	Split	No	No	No	No	No			
	Split sieve								
Total sample (g)									
Moist coarse fraction (g)									
Moist split fraction (g)									
Unit Weight Data	Sample height, H (in)					2.010			
	Sample diameter, D (in)					2.415			
	Mass rings + wet soil (g)					402.43			
	Mass rings/tare (g)					89.61			
	Moist unit wt., $\gamma_m$ (pcf)					129.4			
	Wet soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Water Content Data	Wet soil + tare (g)	405.67	389.93	46.14	375.13	440.50			
	Dry soil + tare (g)	340.08	324.02	38.95	322.91	386.40			
	Tare (g)	151.69	126.60	12.50	124.60	128.07			
	Water content (%)	34.8	33.4	27.2	26.3	20.9			
<b>Water Content, w (%)</b>		<b>34.8</b>	<b>33.4</b>	<b>27.2</b>	<b>26.3</b>	<b>20.9</b>			
<b>Dry Unit Wt., <math>\gamma_d</math> (pcf)</b>						<b>107.0</b>			

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Liquid Limit, Plastic Limit, and Plasticity Index of Soils**  
(ASTM D4318)

**Project:** Magna Water

**No:** 00599-015

**Location:** Magna, Utah

**Date:** 4/13/2022

**By:** BRR

**Grooving tool type:** Plastic

**Liquid limit device:** Mechanical

**Rolling method:** Hand

**Boring No.:** 1B-22-3

**Sample:**

**Depth:** 17.5'

**Description:** Grey lean clay

**Preparation method:** Wet

**Liquid limit test method:** Multipoint

**Screened over No.40:** Yes

**Larger particles removed:** Wet sieved

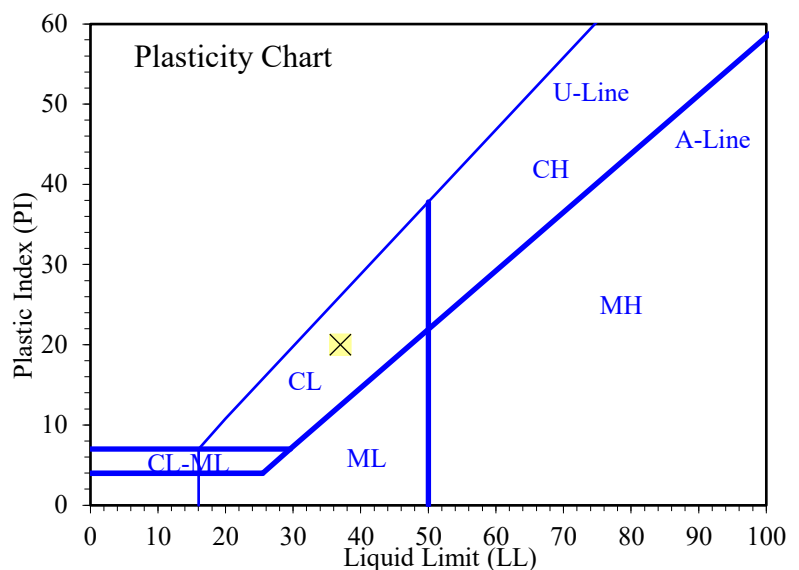
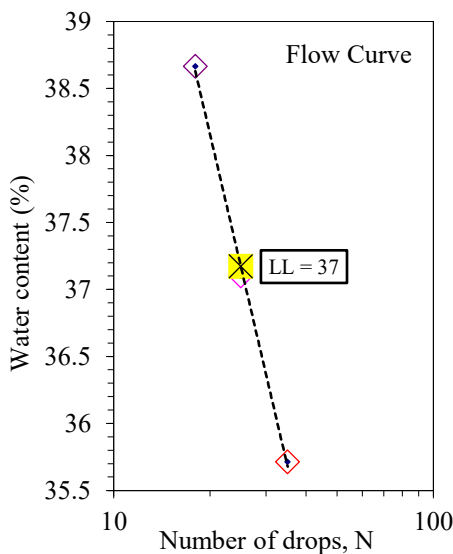
**Plastic Limit**

Determination No	1	2				
Wet Soil + Tare (g)	14.21	13.68				
Dry Soil + Tare (g)	13.14	12.72				
Water Loss (g)	1.07	0.96				
Tare (g)	7.08	7.12				
Dry Soil (g)	6.06	5.60				
Water Content, w (%)	17.66	17.14				

**Liquid Limit**

Determination No	1	2	3			
Number of Drops, N	35	25	18			
Wet Soil + Tare (g)	14.90	14.34	14.63			
Dry Soil + Tare (g)	12.95	12.37	12.60			
Water Loss (g)	1.95	1.97	2.03			
Tare (g)	7.49	7.06	7.35			
Dry Soil (g)	5.46	5.31	5.25			
Water Content, w (%)	35.71	37.10	38.67			
One-Point LL (%)		37				

<b>Liquid Limit, LL (%)</b>	<b>37</b>
<b>Plastic Limit, PL (%)</b>	<b>17</b>
<b>Plasticity Index, PI (%)</b>	<b>20</b>



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Liquid Limit, Plastic Limit, and Plasticity Index of Soils**  
(ASTM D4318)

**Project:** Magna Sewer Line

**No:** 00599-014

**Location:** Magna, Utah

**Date:** 11/18/2021

**By:** BRR

**Grooving tool type:** Plastic

**Liquid limit device:** Mechanical

**Rolling method:** Hand

**Boring No.:** 1B-21-4

**Sample:**

**Depth:** 30.5'

**Description:** Brown lean clay

**Preparation method:** Wet

**Liquid limit test method:** Multipoint

**Screened over No.40:** Yes

**Larger particles removed:** Wet sieved

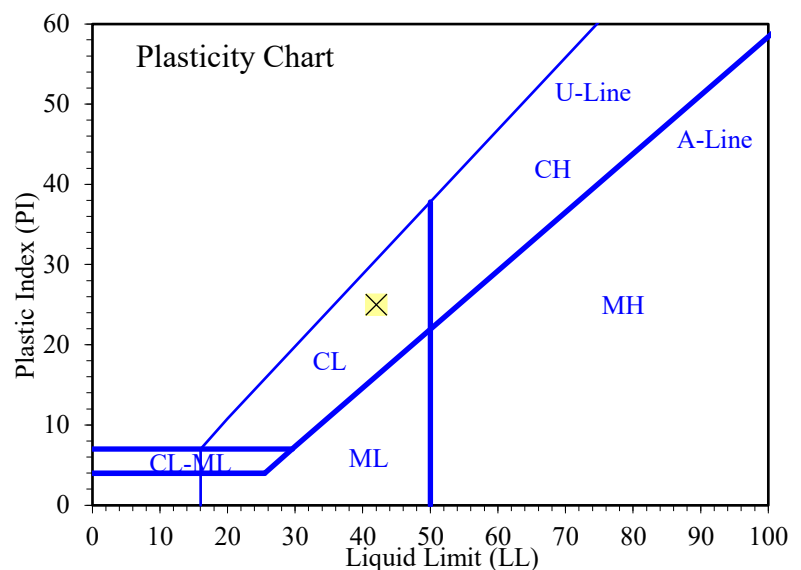
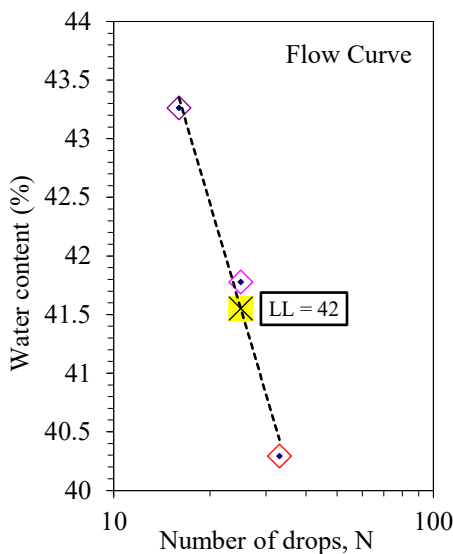
**Plastic Limit**

Determination No	1	2				
Wet Soil + Tare (g)	14.64	14.52				
Dry Soil + Tare (g)	13.55	13.46				
Water Loss (g)	1.09	1.06				
Tare (g)	7.12	7.17				
Dry Soil (g)	6.43	6.29				
Water Content, w (%)	16.95	16.85				

**Liquid Limit**

Determination No	1	2	3			
Number of Drops, N	33	25	16			
Wet Soil + Tare (g)	15.48	15.03	15.43			
Dry Soil + Tare (g)	13.28	12.82	12.99			
Water Loss (g)	2.20	2.21	2.44			
Tare (g)	7.82	7.53	7.35			
Dry Soil (g)	5.46	5.29	5.64			
Water Content, w (%)	40.29	41.78	43.26			
One-Point LL (%)		42				

<b>Liquid Limit, LL (%)</b>	<b>42</b>
<b>Plastic Limit, PL (%)</b>	<b>17</b>
<b>Plasticity Index, PI (%)</b>	<b>25</b>



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_



**Liquid Limit, Plastic Limit, and Plasticity Index of Soils**  
(ASTM D4318)

**Project:** Magna Water  
**No:** 00599-015  
**Location:** Magna, Utah  
**Date:** 4/13/2022  
**By:** BRR  
**Grooving tool type:** Plastic  
**Liquid limit device:** Mechanical  
**Rolling method:** Hand

**Boring No.:** 1B-22-4A  
**Sample:**  
**Depth:** 11.5'  
**Description:** Brown lean clay  
**Preparation method:** Wet  
**Liquid limit test method:** Multipoint  
**Screened over No.40:** Yes  
**Larger particles removed:** Wet sieved

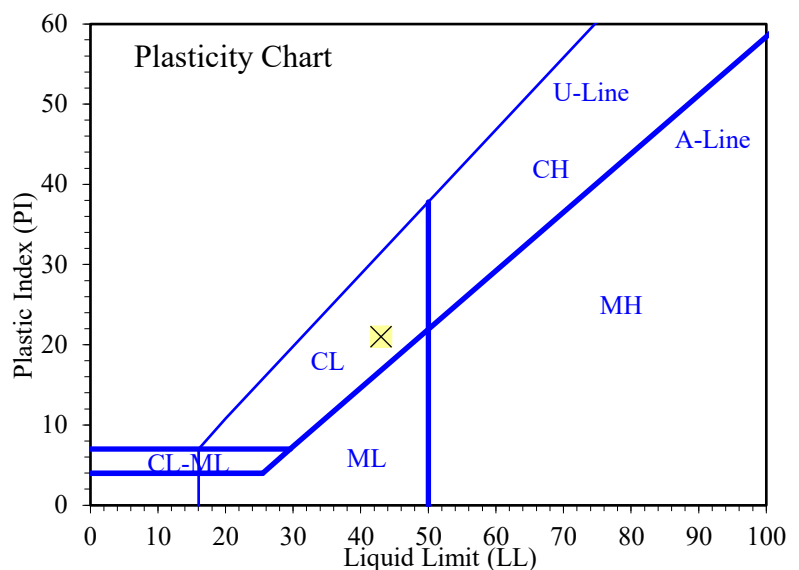
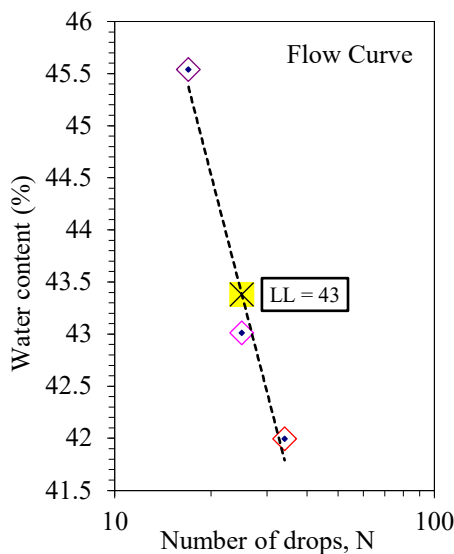
**Plastic Limit**

Determination No	1	2				
Wet Soil + Tare (g)	13.79	14.27				
Dry Soil + Tare (g)	12.58	13.07				
Water Loss (g)	1.21	1.20				
Tare (g)	7.04	7.51				
Dry Soil (g)	5.54	5.56				
Water Content, w (%)	21.84	21.58				

**Liquid Limit**

Determination No	1	2	3			
Number of Drops, N	34	25	17			
Wet Soil + Tare (g)	14.91	12.62	13.32			
Dry Soil + Tare (g)	12.68	11.02	11.38			
Water Loss (g)	2.23	1.60	1.94			
Tare (g)	7.37	7.30	7.12			
Dry Soil (g)	5.31	3.72	4.26			
Water Content, w (%)	42.00	43.01	45.54			
One-Point LL (%)		43				

<b>Liquid Limit, LL (%)</b>	<b>43</b>
<b>Plastic Limit, PL (%)</b>	<b>22</b>
<b>Plasticity Index, PI (%)</b>	<b>21</b>



Entered by: \_\_\_\_\_  
Reviewed: \_\_\_\_\_

**Liquid Limit, Plastic Limit, and Plasticity Index of Soils**  
(ASTM D4318)

**Project:** Magna Water

**No:** 00599-015

**Location:** Magna, Utah

**Date:** 4/13/2022

**By:** BRR

**Grooving tool type:** Plastic

**Liquid limit device:** Mechanical

**Rolling method:** Hand

**Boring No.:** 1B-22-4A

**Sample:**

**Depth:** 30.0'

**Description:** Grey lean clay

**Preparation method:** Wet

**Liquid limit test method:** Multipoint

**Screened over No.40:** Yes

**Larger particles removed:** Wet sieved

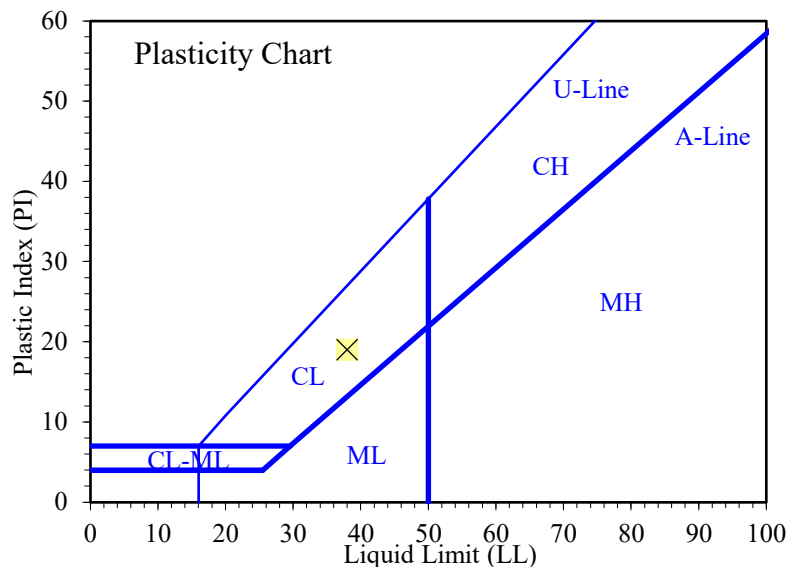
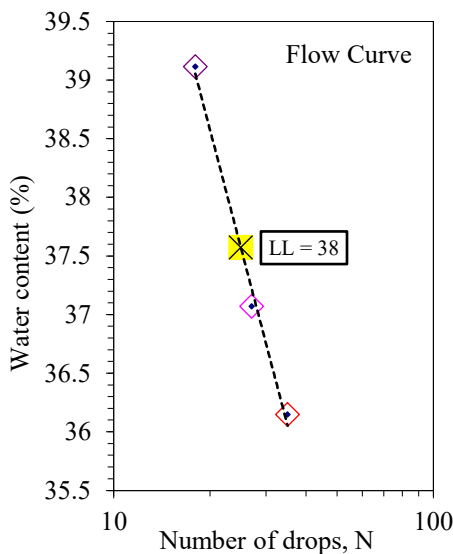
**Plastic Limit**

Determination No	1	2				
Wet Soil + Tare (g)	14.23	14.05				
Dry Soil + Tare (g)	13.16	12.95				
Water Loss (g)	1.07	1.10				
Tare (g)	7.47	7.07				
Dry Soil (g)	5.69	5.88				
Water Content, w (%)	18.80	18.71				

**Liquid Limit**

Determination No	1	2	3			
Number of Drops, N	35	27	18			
Wet Soil + Tare (g)	14.46	14.63	15.27			
Dry Soil + Tare (g)	12.49	12.58	13.06			
Water Loss (g)	1.97	2.05	2.21			
Tare (g)	7.04	7.05	7.41			
Dry Soil (g)	5.45	5.53	5.65			
Water Content, w (%)	36.15	37.07	39.12			
One-Point LL (%)		37				

<b>Liquid Limit, LL (%)</b>	<b>38</b>
<b>Plastic Limit, PL (%)</b>	<b>19</b>
<b>Plasticity Index, PI (%)</b>	<b>19</b>



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Liquid Limit, Plastic Limit, and Plasticity Index of Soils**  
(ASTM D4318)

**Project:** Magna Sewer Line

**No:** 00599-014

**Location:** Magna, Utah

**Date:** 11/18/2021

**By:** BRR

**Grooving tool type:** Plastic

**Liquid limit device:** Mechanical

**Rolling method:** Hand

**Boring No.:** 1B-21-5

**Sample:**

**Depth:** 12.5'

**Description:** Grey lean clay

**Preparation method:** Wet

**Liquid limit test method:** Multipoint

**Screened over No.40:** Yes

**Larger particles removed:** Wet sieved

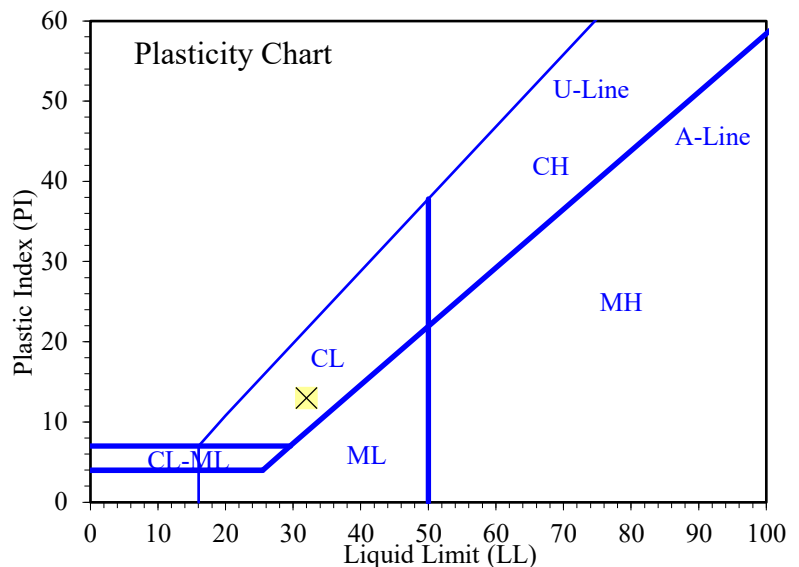
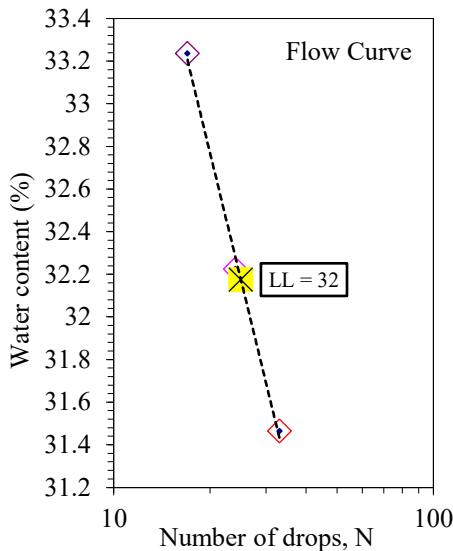
**Plastic Limit**

Determination No	1	2				
Wet Soil + Tare (g)	14.36	13.93				
Dry Soil + Tare (g)	13.29	12.88				
Water Loss (g)	1.07	1.05				
Tare (g)	7.70	7.43				
Dry Soil (g)	5.59	5.45				
Water Content, w (%)	19.14	19.27				

**Liquid Limit**

Determination No	1	2	3			
Number of Drops, N	33	24	17			
Wet Soil + Tare (g)	15.78	17.04	16.97			
Dry Soil + Tare (g)	13.76	14.62	14.69			
Water Loss (g)	2.02	2.42	2.28			
Tare (g)	7.34	7.11	7.83			
Dry Soil (g)	6.42	7.51	6.86			
Water Content, w (%)	31.46	32.22	33.24			
One-Point LL (%)		32				

<b>Liquid Limit, LL (%)</b>	<b>32</b>
<b>Plastic Limit, PL (%)</b>	<b>19</b>
<b>Plasticity Index, PI (%)</b>	<b>13</b>



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Liquid Limit, Plastic Limit, and Plasticity Index of Soils**  
(ASTM D4318)

**Project:** Magna Sewer Line

**No:** 00599-014

**Location:** Magna, Utah

**Date:** 11/18/2021

**By:** BRR

**Grooving tool type:** Plastic

**Liquid limit device:** Mechanical

**Rolling method:** Hand

**Boring No.:** 1B-21-5

**Sample:**

**Depth:** 18.5'

**Description:** Grey lean clay

**Preparation method:** Wet

**Liquid limit test method:** Multipoint

**Screened over No.40:** Yes

**Larger particles removed:** Wet sieved

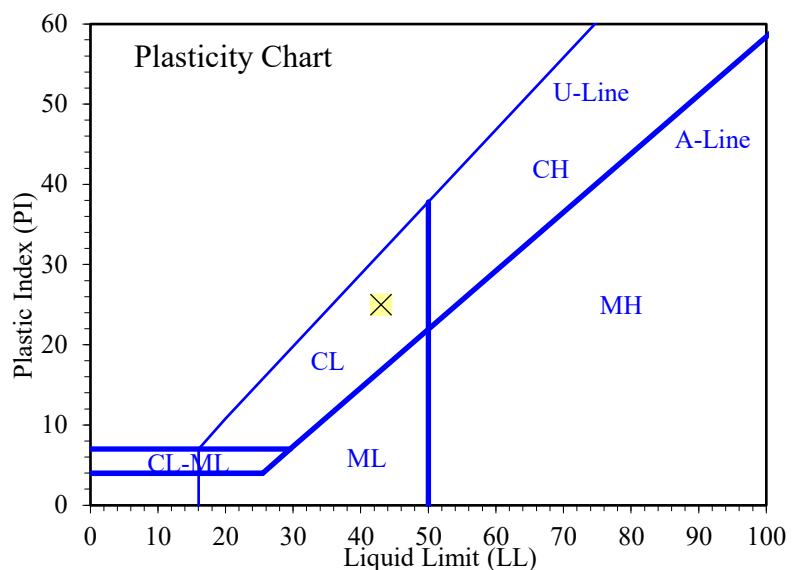
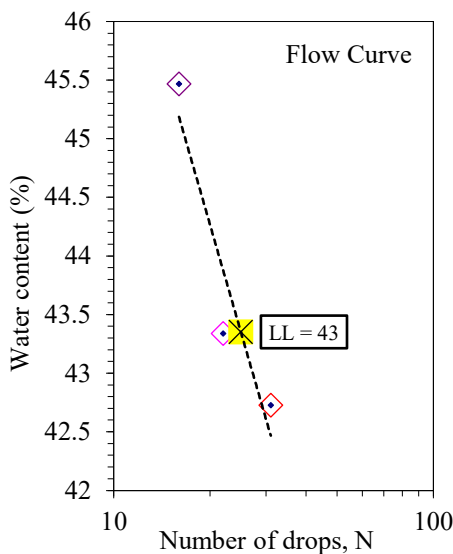
**Plastic Limit**

Determination No	1	2				
Wet Soil + Tare (g)	14.61	13.54				
Dry Soil + Tare (g)	13.53	12.55				
Water Loss (g)	1.08	0.99				
Tare (g)	7.52	7.06				
Dry Soil (g)	6.01	5.49				
Water Content, w (%)	17.97	18.03				

**Liquid Limit**

Determination No	1	2	3			
Number of Drops, N	31	22	16			
Wet Soil + Tare (g)	13.72	15.82	16.67			
Dry Soil + Tare (g)	11.84	13.25	13.66			
Water Loss (g)	1.88	2.57	3.01			
Tare (g)	7.44	7.32	7.04			
Dry Soil (g)	4.40	5.93	6.62			
Water Content, w (%)	42.73	43.34	45.47			
One-Point LL (%)		43				

<b>Liquid Limit, LL (%)</b>	<b>43</b>
<b>Plastic Limit, PL (%)</b>	<b>18</b>
<b>Plasticity Index, PI (%)</b>	<b>25</b>



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

# Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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**Project:** Magna Sewer Line

**No:** 00599-014

**Location:** Magna, Utah

**Date:** 11/17/2021

**By:** BFS

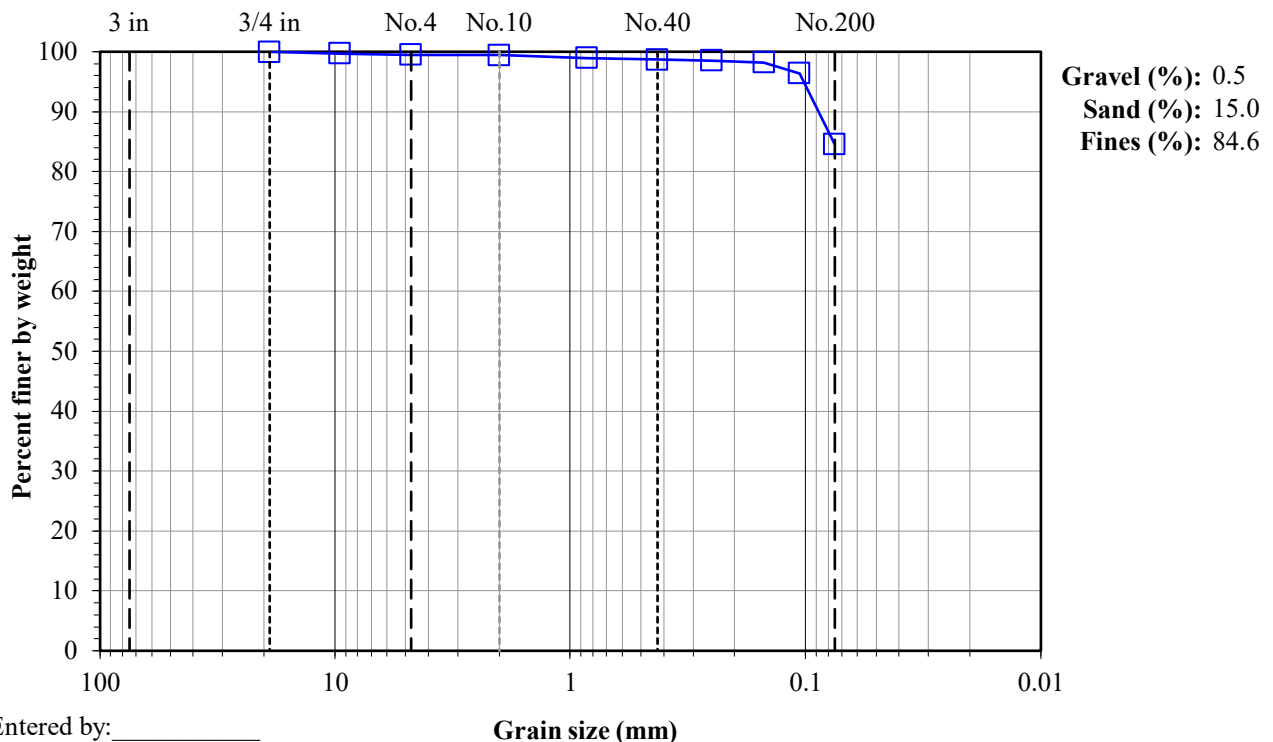
**Boring No.:** 1B-21-2

**Sample:**

**Depth:** 15.0'

**Description:** Grey clay with sand

<p>Split: Yes</p> <p>Split sieve: No.4</p> <p>Moist Dry</p> <p>Total sample wt. (g): 581.23 452.79</p> <p>+No.4 Coarse fraction (g): 2.44 2.20</p> <p>-No.4 Split fraction (g): 577.37 449.48</p> <p>Split fraction: 0.995</p>				<p>Water content data C.F.(+No.4) S.F.(-No.4)</p> <p>Moist soil + tare (g): 230.45 1041.44</p> <p>Dry soil + tare (g): 230.07 913.55</p> <p>Tare (g): 226.59 464.07</p> <p>Water content (%): 10.9 28.5</p>	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	100.0		
3/8"	1.40	9.5	99.7		
No.4	2.20	4.75	99.5		
No.10	0.40	2	99.4		
No.20	2.47	0.85	99.0		
No.40	3.60	0.425	98.7		
No.60	4.45	0.25	98.5		
No.100	5.96	0.15	98.2		
No.140	14.08	0.106	96.4		
No.200	67.54	0.075	84.6		



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

# Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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**Project:** Magna Sewer Line

**No:** 00599-014

**Location:** Magna, Utah

**Date:** 11/17/2021

**By:** FB

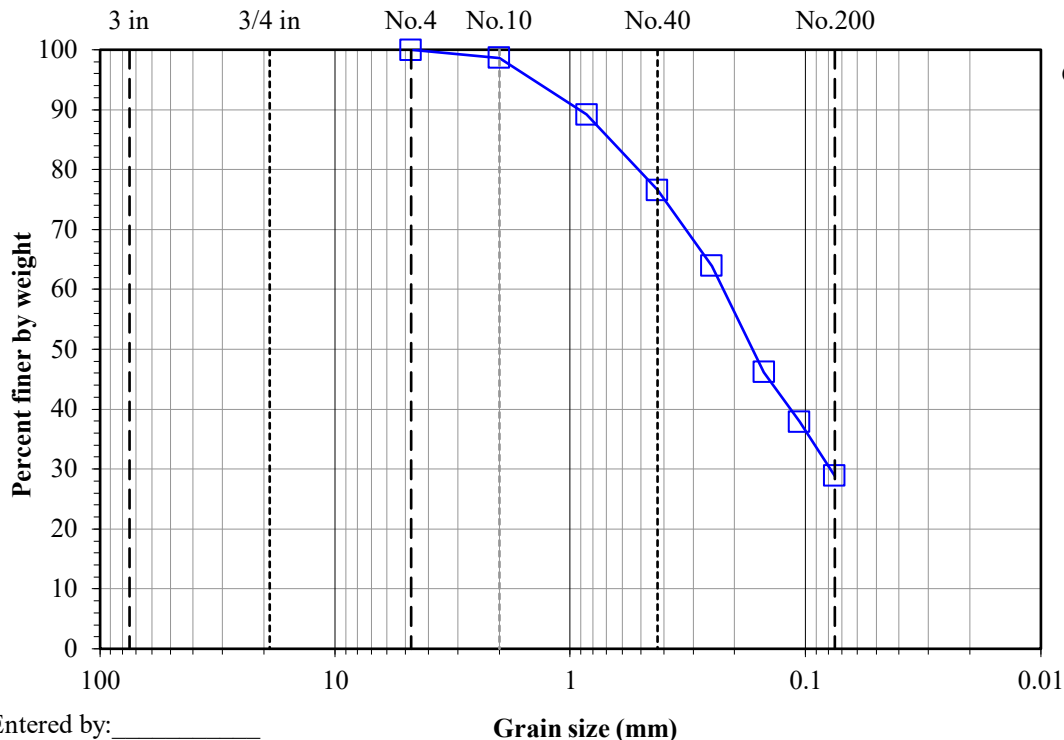
**Boring No.:** 1B-21-4

**Sample:**

**Depth:** 17.5'

**Description:** Grey silty sand

Split: No				Water content data	
Moist				Moist soil + tare (g):	- 316.36
Dry				Dry soil + tare (g):	- 275.08
Total sample wt. (g): 194.90				Tare (g):	- 121.46
-				Water content (%):	0.0 26.9
Split fraction: 1.000					
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	-		
3/8"	-	9.5	-		
No.4	-	4.75	100.0		
No.10	2.06	2	98.7		
No.20	16.58	0.85	89.2		
No.40	35.96	0.425	76.6		
No.60	55.43	0.25	63.9		
No.100	82.68	0.15	46.2		
No.140	95.40	0.106	37.9		
No.200	109.16	0.075	28.9		



Gravel (%): 0.0  
Sand (%): 71.1  
Fines (%): 28.9

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

# Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



© IGES 2004, 2021

**Project:** Magna Sewer Line

**No:** 00599-014

**Location:** Magna, Utah

**Date:** 11/17/2021

**By:** FB

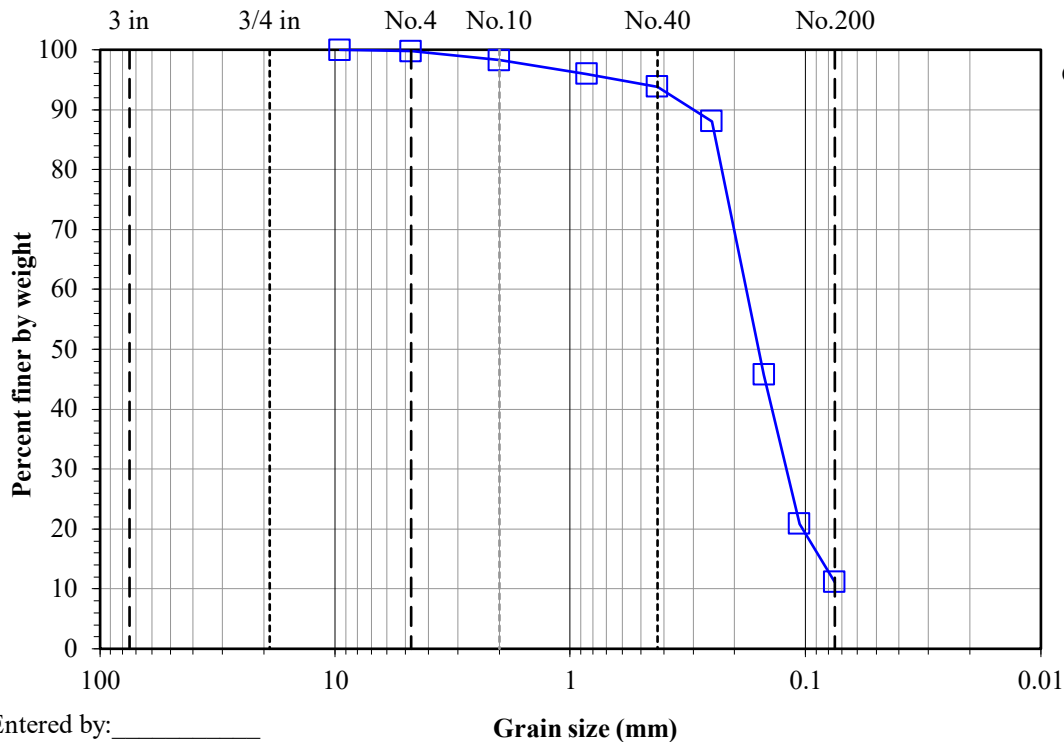
**Boring No.:** 1B-21-4

**Sample:**

**Depth:** 20.0'

**Description:** Grey sand with silt

Split: No Moist Dry Total sample wt. (g): 295.44 222.71 - Split fraction: 1.000				<u>Water content data</u> Moist soil + tare (g): - 416.15 Dry soil + tare (g): - 343.42 Tare (g): - 120.71 Water content (%): 0.0 32.7	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	-		
3/8"	-	9.5	100.0		
No.4	0.51	4.75	99.8		
No.10	3.89	2	98.3		
No.20	9.03	0.85	95.9		
No.40	13.70	0.425	93.8		
No.60	26.56	0.25	88.1		
No.100	120.85	0.15	45.7		
No.140	176.24	0.106	20.9		
No.200	197.87	0.075	11.2		



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

# Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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**Project:** Magna Sewer Line

**No:** 00599-014

**Location:** Magna, Utah

**Date:** 11/22/2021

**By:** BSS

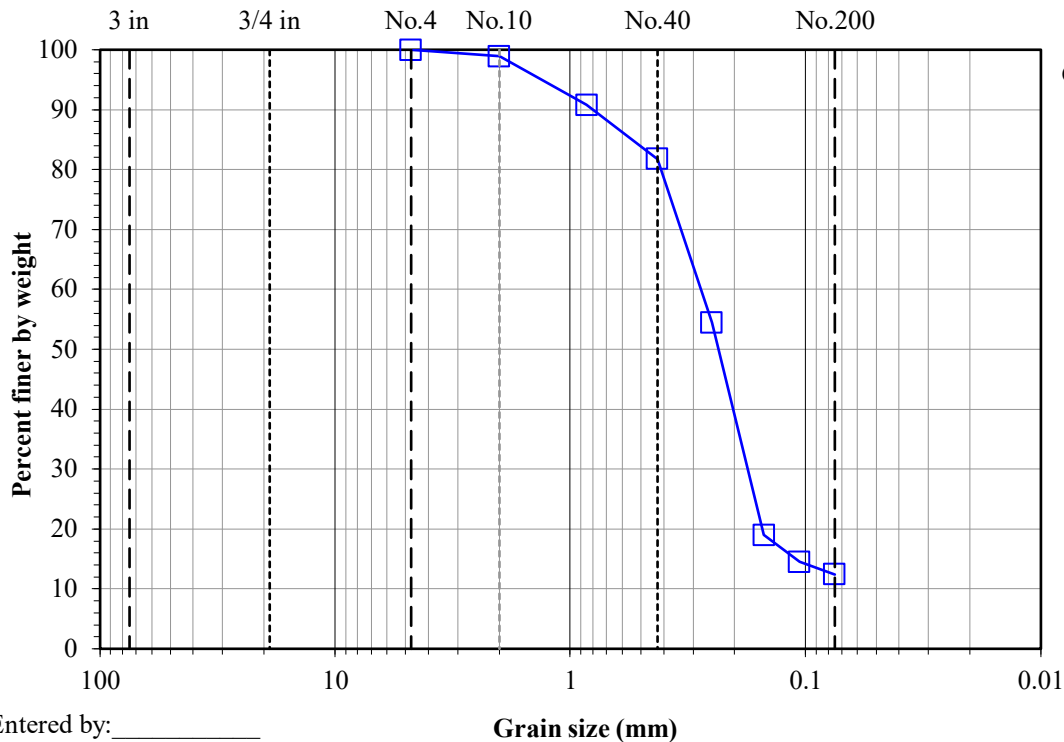
**Boring No.:** 1B-21-5

**Sample:**

**Depth:** 15.0'

**Description:** Grey silty sand

Split: No				Water content data	
Moist				Moist soil + tare (g):	- 389.93
Dry				Dry soil + tare (g):	- 324.02
Total sample wt. (g): 263.33				Tare (g):	- 126.60
-				Water content (%):	0.0 33.4
Split fraction: 1.000					
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	-		
3/8"	-	9.5	-		
No.4	-	4.75	100.0		
No.10	2.21	2	98.9		
No.20	18.17	0.85	90.8		
No.40	36.01	0.425	81.8		
No.60	89.91	0.25	54.5		
No.100	159.94	0.15	19.0		
No.140	168.75	0.106	14.5		
No.200	172.81	0.075	12.5		



Gravel (%): 0.0  
Sand (%): 87.5  
Fines (%): 12.5

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_



# Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: **Magna Water**

No: **00599-015**

Location: **Magna, Utah**

Date: **4/13/2022**

By: **BRR**

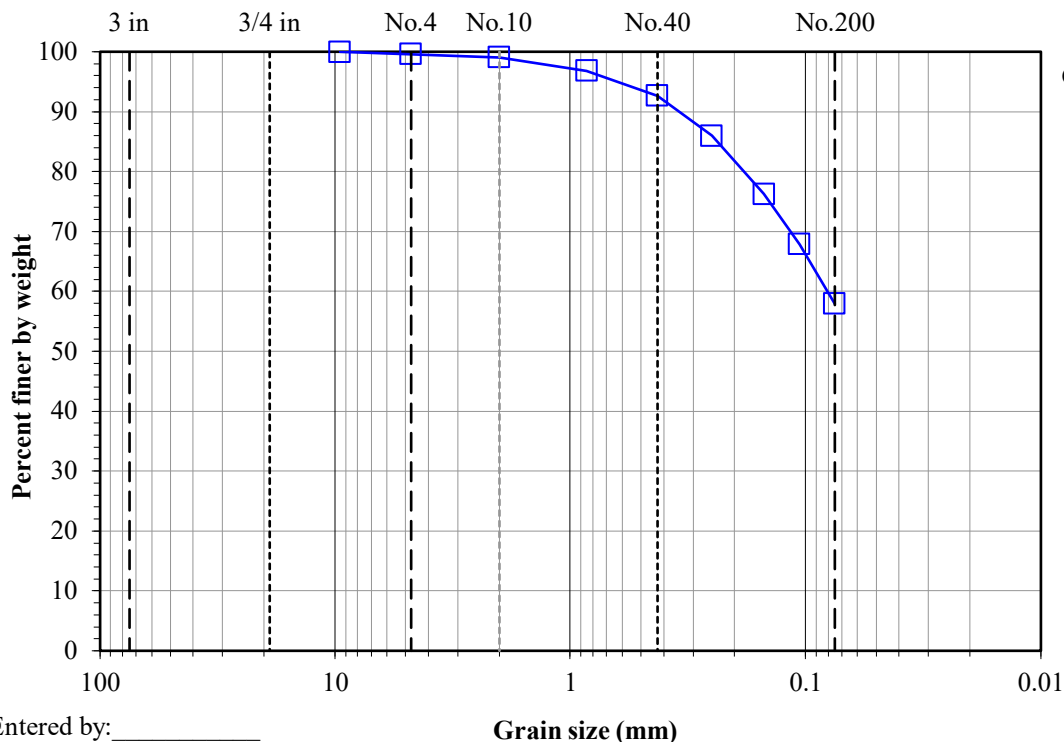
Boring No.: **1B-22-PZ5**

Sample:

Depth: **15.0'**

Description: **Brown sandy silt**

Split: <b>Yes</b>				Water content data C.F.(+No.4) S.F.(-No.4)		
Split sieve: <b>No.4</b>				Moist soil + tare (g):	<b>39.71</b>	<b>347.58</b>
Moist				Dry soil + tare (g):	<b>39.59</b>	<b>319.88</b>
Dry				Tare (g):	<b>37.96</b>	<b>213.87</b>
Total sample wt. (g): <b>533.91</b>				Water content (%):	<b>7.4</b>	<b>26.1</b>
+No.4 Coarse fraction (g): <b>1.75</b>						
-No.4 Split fraction (g): <b>213.87</b>						
Split fraction: <b>0.996</b>						
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer			
6"	-	150	-			
4"	-	100	-			
3"	-	75	-			
1.5"	-	37.5	-			
1"	-	25	-			
3/4"	-	19	-			
3/8"	-	9.5	100.0			
No.4	<b>1.63</b>	4.75	99.6	← Split		
No.10	<b>0.96</b>	2	99.1			
No.20	<b>4.72</b>	0.85	96.8			
No.40	<b>11.82</b>	0.425	92.7			
No.60	<b>23.19</b>	0.25	86.0			
No.100	<b>39.77</b>	0.15	76.3			
No.140	<b>54.06</b>	0.106	67.9			
No.200	<b>70.88</b>	0.075	58.0			



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Amount of Material in Soil Finer than the No. 200 (75µm) Sieve**

(ASTM D1140)



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**Project:** Magna Water**No:** 00599-015**Location:** Magna, Utah**Date:** 4/13/2022**By:** BRR

Sample Info.	Boring No.	1B-22-3						
	Sample							
	Depth	12.5						
	Split	No						
	Split Sieve*							
	Method	B						
Specimen soak time (min)		270						
Moist total sample wt. (g)		310.35						
Moist coarse fraction (g)								
Moist split fraction + tare (g)								
Split fraction tare (g)								
Dry split fraction (g)								
Dry retained No. 200 + tare (g)		298.26						
Wash tare (g)		124.38						
No. 200 Dry wt. retained (g)		173.88						
Split sieve* Dry wt. retained (g)								
Dry total sample wt. (g)		233.95						
Coarse Fraction	Moist soil + tare (g)							
	Dry soil + tare (g)							
	Tare (g)							
	Water content (%)							
Split Fraction	Moist soil + tare (g)	434.73						
	Dry soil + tare (g)	358.33						
	Tare (g)	124.38						
	Water content (%)	32.66						
Percent passing split sieve* (%)								
Percent passing No. 200 sieve (%)		25.7						

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Amount of Material in Soil Finer than the No. 200 (75µm) Sieve**

(ASTM D1140)



© IGES 2010, 2021

**Project: Magna Sewer Line****No: 00599-014****Location: Magna, Utah****Date: 11/17/2021****By: BFS**

Sample Info.	Boring No.	1B-21-4	1B-21-5	1B-21-5					
	Sample								
	Depth	18.5'	12.5'	20.5'					
	Split	No	No	No					
	Split Sieve*								
	Method	B	B	B					
Specimen soak time (min)		330	360	380					
Moist total sample wt. (g)		239.20	253.98	250.53					
Moist coarse fraction (g)									
Moist split fraction + tare (g)									
Split fraction tare (g)									
Dry split fraction (g)									
Dry retained No. 200 + tare (g)		191.06	219.21	151.07					
Wash tare (g)		119.95	151.69	124.60					
No. 200 Dry wt. retained (g)		71.11	67.52	26.47					
Split sieve* Dry wt. retained (g)									
Dry total sample wt. (g)		193.08	188.39	198.31					
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Split Fraction	Moist soil + tare (g)	359.15	405.67	375.13					
	Dry soil + tare (g)	313.03	340.08	322.91					
	Tare (g)	119.95	151.69	124.60					
	Water content (%)	23.89	34.82	26.33					
Percent passing split sieve* (%)									
Percent passing No. 200 sieve (%)		63.2	64.2	86.7					

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils**  
(ASTM D2850)

**Project:** Magna Water  
**No:** 00599-015  
**Location:** Magna, Utah  
**Date:** 4/14/2022  
**By:** JAB

**Boring No.:** 1B-22-1

**Sample:**

**Depth:** 15.5'

**Sample Description:** Grey clay with sand

**Sample type:** Undisturbed-trimmed from ring

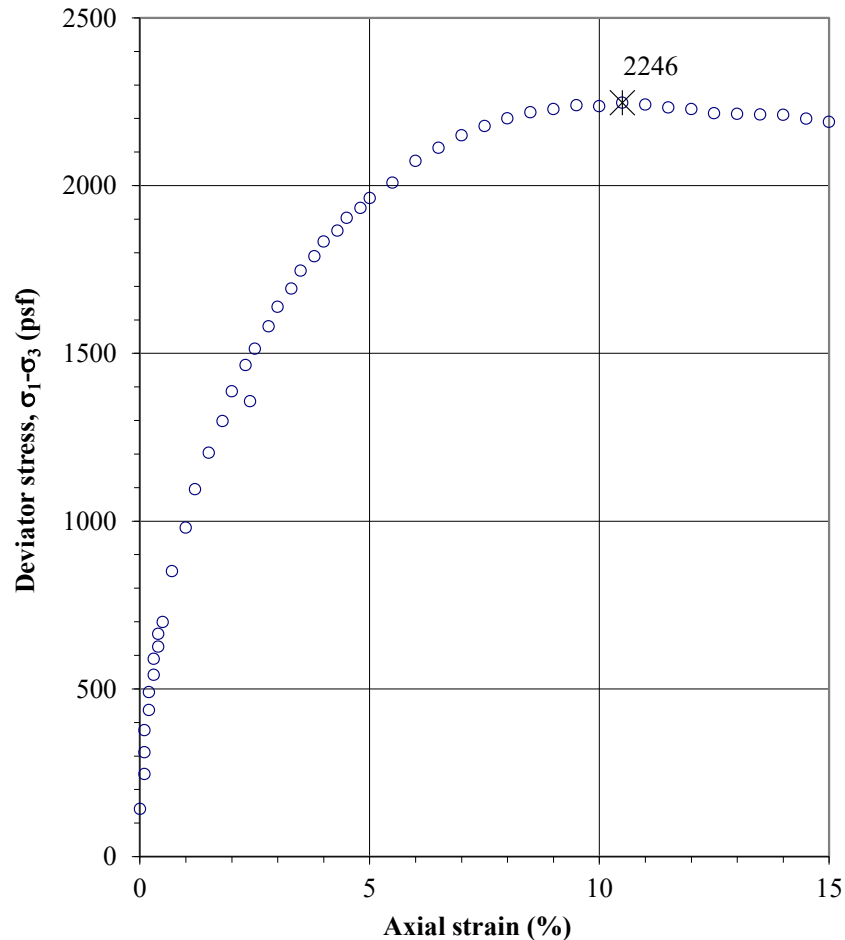
Specific gravity,  $G_s$  2.70  
Sample height,  $H$  (in.) 5.960  
Sample diameter,  $D$  (in.) 2.408  
Sample volume,  $V$  (ft<sup>3</sup>) 0.0157  
Wt. rings + wet soil (g) 849.81  
Wt. rings/tare (g) 0.00  
Moist soil,  $W_s$  (g) 849.81  
Moist unit wt.,  $\gamma_m$  (pcf) 119.3  
Dry unit wt.,  $\gamma_d$  (pcf) 90.7  
Saturation (%) 98.7  
Void ratio,  $e$  0.86

Assumed



Wet soil + tare (g) 971.80  
Dry soil + tare (g) 769.48  
Tare (g) 126.90  
Water content,  $w$  (%) 31.5  
Confining stress,  $\sigma_3$  (psf) 1779  
Shear rate (in/min) 0.0179  
Strain at failure,  $\epsilon_f$  (%) 10.50  
Deviator stress at failure,  $(\sigma_1 - \sigma_3)_f$  (psf) 2246  
Shear stress at failure,  $q_f = (\sigma_1 - \sigma_3)_f / 2$  (psf) 1123

Axial Strain	$\sigma_d$	$Q$
	$\sigma_1 - \sigma_3$	$1/2 \sigma_d$
0.00	141.2	70.6
0.10	245.4	122.7
0.10	310.7	155.3
0.10	375.6	187.8
0.20	436.0	218.0
0.20	489.8	244.9
0.30	541.4	270.7
0.30	588.5	294.3
0.40	624.6	312.3
0.40	663.4	331.7
0.50	698.0	349.0
0.70	850.1	425.1
1.00	979.9	489.9
1.20	1094.6	547.3
1.50	1202.9	601.5
1.80	1297.4	648.7
2.00	1386.2	693.1
2.30	1464.5	732.3
2.40	1356.1	678.1
2.50	1512.5	756.3
2.80	1579.8	789.9
3.00	1637.7	818.8
3.30	1692.2	846.1
3.50	1745.5	872.8
3.80	1788.8	894.4
4.00	1832.0	916.0
4.30	1864.8	932.4
4.50	1902.6	951.3
4.80	1933.0	966.5
5.00	1962.3	981.1
5.50	2008.3	1004.1
6.00	2073.0	1036.5
6.50	2111.6	1055.8
7.00	2149.4	1074.7
7.50	2176.8	1088.4
8.00	2199.6	1099.8
8.50	2218.1	1109.0
9.00	2227.6	1113.8
9.50	2238.6	1119.3
10.00	2235.8	1117.9
10.50	2246.2	1123.1
11.00	2240.5	1120.3
11.50	2232.0	1116.0
12.00	2227.1	1113.6
12.50	2214.5	1107.2
13.00	2213.4	1106.7
13.50	2210.6	1105.3
14.00	2210.2	1105.1
14.50	2198.3	1099.2
15.00	2188.7	1094.4



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils**  
(ASTM D2850)

**Project:** Magna Water  
**No:** 00599-015  
**Location:** Magna, Utah  
**Date:** 4/14/2022  
**By:** JAB

**Boring No.:** 1B-22-3

**Sample:**

**Depth:** 15.5'

**Sample Description:** Grey sandy clay

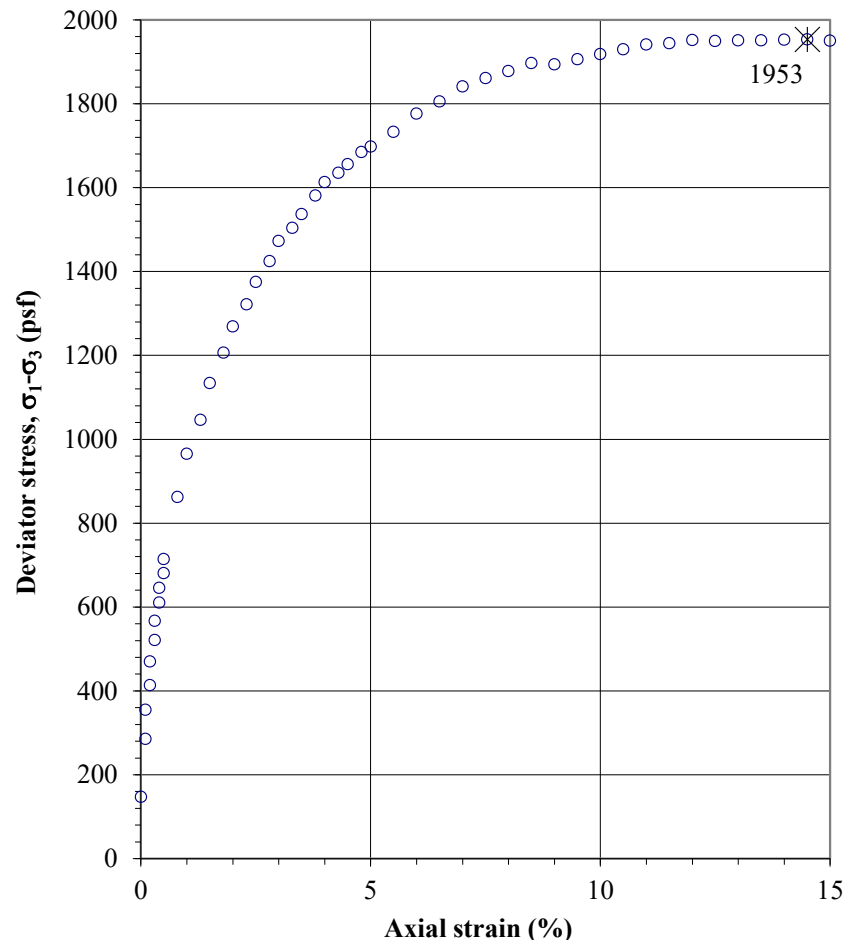
**Sample type:** Undisturbed-trimmed from ring

Specific gravity,  $G_s$  2.70 Assumed  
Sample height,  $H$  (in.) 6.005  
Sample diameter,  $D$  (in.) 2.404  
Sample volume,  $V$  (ft<sup>3</sup>) 0.0158  
Wt. rings + wet soil (g) 2159.87  
Wt. rings/tare (g) 1345.43  
Moist soil,  $W_s$  (g) 814.44  
Moist unit wt.,  $\gamma_m$  (pcf) 113.8  
Dry unit wt.,  $\gamma_d$  (pcf) 81.5  
Saturation (%) 100.0  
Void ratio,  $e$  1.07



Wet soil + tare (g) 950.18  
Dry soil + tare (g) 720.18  
Tare (g) 141.47  
Water content,  $w$  (%) 39.7  
Confining stress,  $\sigma_3$  (psf) 1801  
Shear rate (in/min) 0.0180  
Strain at failure,  $\epsilon_f$  (%) 14.50  
Deviator stress at failure,  $(\sigma_1 - \sigma_3)_f$  (psf) 1953  
Shear stress at failure,  $q_f = (\sigma_1 - \sigma_3)_f / 2$  (psf) 976

Axial Strain	$\sigma_d$	$Q$
	$\sigma_1 - \sigma_3$	$1/2 \sigma_d$
0.00	146.7	73.4
0.10	284.9	142.5
0.10	354.2	177.1
0.20	412.8	206.4
0.20	469.5	234.8
0.30	520.3	260.1
0.30	566.4	283.2
0.40	609.5	304.8
0.40	644.6	322.3
0.50	680.2	340.1
0.50	713.4	356.7
0.80	861.7	430.9
1.00	964.8	482.4
1.30	1045.4	522.7
1.50	1133.6	566.8
1.80	1206.0	603.0
2.00	1267.9	634.0
2.30	1321.1	660.6
2.50	1374.2	687.1
2.80	1424.0	712.0
3.00	1472.0	736.0
3.30	1503.3	751.6
3.50	1536.0	768.0
3.80	1580.7	790.4
4.00	1612.2	806.1
4.30	1634.4	817.2
4.50	1655.5	827.8
4.80	1684.3	842.2
5.00	1697.0	848.5
5.50	1731.9	865.9
6.00	1775.8	887.9
6.50	1805.0	902.5
7.00	1840.3	920.2
7.50	1860.7	930.4
8.00	1877.5	938.7
8.50	1896.5	948.2
9.00	1892.9	946.5
9.50	1905.6	952.8
10.00	1917.3	958.6
10.50	1929.0	964.5
11.00	1940.4	970.2
11.50	1943.9	972.0
12.00	1951.1	975.6
12.50	1948.5	974.3
13.00	1950.4	975.2
13.50	1950.3	975.1
14.00	1951.8	975.9
14.50	1952.9	976.4
15.00	1949.9	974.9



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils**  
(ASTM D2850)

**Project:** Magna Water  
**No:** 00599-015  
**Location:** Magna, Utah  
**Date:** 4/14/2022  
**By:** JAB

**Boring No.:** 1B-22-4A  
**Sample:**  
**Depth:** 18.0'  
**Sample Description:** Grey clay  
**Sample type:** Undisturbed-trimmed from ring

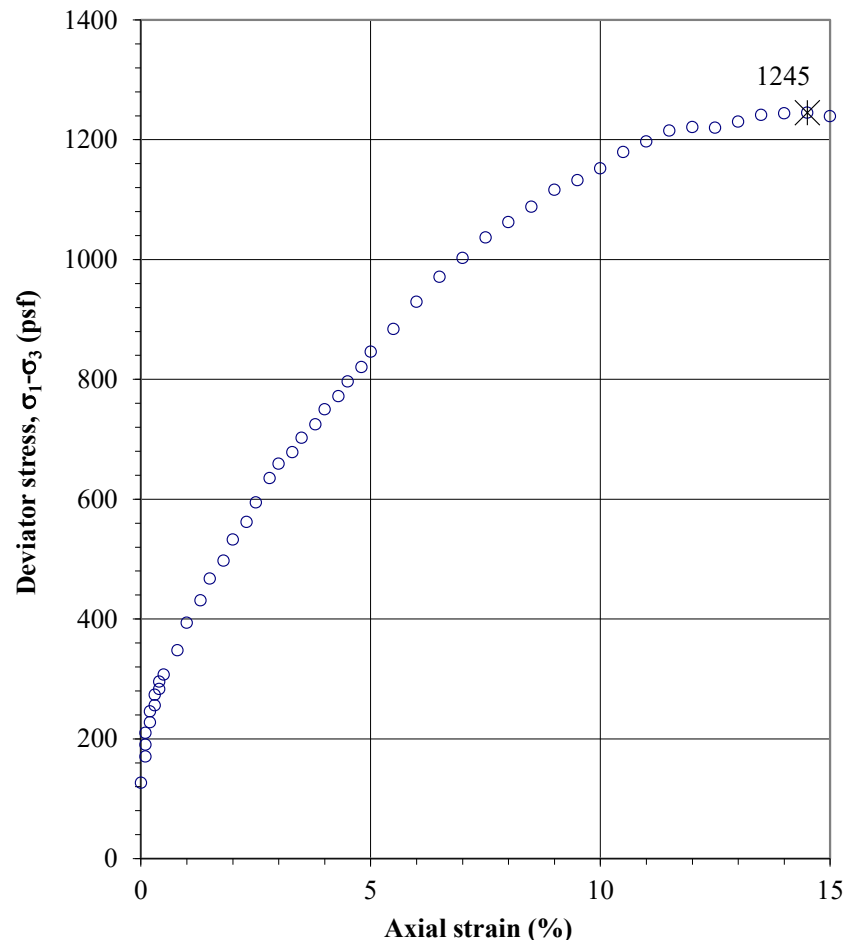
Specific gravity,  $G_s$  2.70  
Sample height,  $H$  (in.) 5.981  
Sample diameter,  $D$  (in.) 2.393  
Sample volume,  $V$  (ft<sup>3</sup>) 0.0156  
Wt. rings + wet soil (g) 774.13  
Wt. rings/tare (g) 0.00  
Moist soil,  $W_s$  (g) 774.13  
Moist unit wt.,  $\gamma_m$  (pcf) 109.6  
Dry unit wt.,  $\gamma_d$  (pcf) 74.8  
Saturation (%) 100.0  
Void ratio,  $e$  1.26

Assumed



Wet soil + tare (g) 892.70  
Dry soil + tare (g) 649.50  
Tare (g) 127.02  
Water content,  $w$  (%) 46.5  
Confining stress,  $\sigma_3$  (psf) 2032  
Shear rate (in/min) 0.0179  
Strain at failure,  $\epsilon_f$  (%) 14.50  
Deviator stress at failure,  $(\sigma_1 - \sigma_3)_f$  (psf) 1245  
Shear stress at failure,  $q_f = (\sigma_1 - \sigma_3)_f / 2$  (psf) 622

Axial Strain	$\sigma_d$	$Q$
	$\sigma_1 - \sigma_3$	$1/2 \sigma_d$
0.00	126.4	63.2
0.10	170.2	85.1
0.10	189.6	94.8
0.10	209.6	104.8
0.20	227.3	113.6
0.20	245.3	122.7
0.30	255.3	127.7
0.30	273.0	136.5
0.40	282.9	141.4
0.40	295.1	147.6
0.50	306.6	153.3
0.80	347.5	173.8
1.00	393.0	196.5
1.30	430.5	215.3
1.50	467.2	233.6
1.80	496.9	248.4
2.00	531.9	265.9
2.30	561.5	280.8
2.50	594.0	297.0
2.80	634.6	317.3
3.00	658.6	329.3
3.30	677.6	338.8
3.50	702.2	351.1
3.80	724.1	362.1
4.00	749.3	374.6
4.30	771.4	385.7
4.50	795.8	397.9
4.80	820.2	410.1
5.00	845.9	422.9
5.50	883.3	441.6
6.00	929.0	464.5
6.50	970.7	485.4
7.00	1002.3	501.2
7.50	1036.4	518.2
8.00	1061.7	530.9
8.50	1087.4	543.7
9.00	1115.8	557.9
9.50	1131.8	565.9
10.00	1151.6	575.8
10.50	1178.7	589.3
11.00	1196.4	598.2
11.50	1214.9	607.5
12.00	1220.6	610.3
12.50	1219.4	609.7
13.00	1229.8	614.9
13.50	1240.8	620.4
14.00	1243.8	621.9
14.50	1244.8	622.4
15.00	1238.6	619.3



Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

**Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and****Ions in Water by Chemically Suppressed Ion Chromatography** (AASHTO T 288, T 289, ASTM D4327, and C1580)

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**Project: Magna Water****No: 00599-015****Location: Magna, Utah****Date: 4/14/2022****By: FB**

Sample info.	Boring No.	1B-22-1				1B-22-3			
	Sample								
	Depth	12.5'				13.0'			
Water content data	Wet soil + tare (g)	50.39				20.62			
	Dry soil + tare (g)	46.35				19.86			
	Tare (g)	23.59				12.51			
	Water content (%)	17.8				10.3			
Chem. data	pH*	9.3				8.8			
	Soluble chloride* (ppm)	239				98			
	Soluble sulfate** (ppm)	102				91			
Resistivity data	Pin method	2				2			
	Soil box	Miller Small				Miller Small			
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As is	3323	0.67	2226	As is	8422	0.67	5643
		+3%	1939	0.67	1299	+3%	4967	0.67	3328
		+6%	1248	0.67	836	+6%	4059	0.67	2720
		+9%	922	0.67	618	+9%	2372	0.67	1589
		+12%	910	0.67	610	+12%	2389	0.67	1601
		+15%	892	0.67	598				
		+18%	930	0.67	623				
	Minimum resistivity (Ω-cm)	598				1589			

\* Performed by AWAL using EPA 300.0

\*\* Performed by AWAL using ASTM C1580

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

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**Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and  
Ions in Water by Chemically Suppressed Ion Chromatography** (AASHTO T 288, T 289, ASTM D4327, and C1580)



Project: **Magna Sewer Line**

No: **00599-014**

Location: **Magna, Utah**

Date: **11/22/2021**

By: **RT**

Sample info.	Boring No.	1B-21-2							
	Sample								
	Depth	10.0'							
Water content data	Wet soil + tare (g)	55.19							
	Dry soil + tare (g)	51.22							
	Tare (g)	23.38							
	Water content (%)	14.3							
Chem. data	pH*	8.80							
	Soluble chloride* (ppm)	156							
	Soluble sulfate** (ppm)	371							
Resistivity data	Pin method	2							
	Soil box	Miller Small							
	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)					
		As Is	5931	0.67	3974				
		+3	3457	0.67	2316				
		+6	2122	0.67	1422				
		+9	1591	0.67	1066				
		+12	1680	0.67	1126				
Minimum resistivity (Ω-cm)	1066								

\* Performed by AWAL using EPA 300.0

\*\* Performed by AWAL using ASTM C1580

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_



**Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and****Ions in Water by Chemically Suppressed Ion Chromatography** (AASHTO T 288, T 289, ASTM D4327, and C1580)

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**Project: Magna Water****No: 00599-015****Location: Magna, Utah****Date: 4/14/2022****By: FB**

Sample info.	Boring No.	1B-22-4A							
	Sample								
	Depth	15.0'							
Water content data	Wet soil + tare (g)	36.13							
	Dry soil + tare (g)	34.66							
	Tare (g)	23.37							
	Water content (%)	13.0							
Chem. data	pH*	8.8							
	Soluble chloride* (ppm)	425							
	Soluble sulfate** (ppm)	92							
Resistivity data	Pin method	2							
	Soil box	Miller Small							
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As is	11200	0.67	7504				
		+3%	5766	0.67	3863				
		+6%	4543	0.67	3044				
		+9%	1790	0.67	1199				
		+12%	968	0.67	649				
		+15%	773	0.67	518				
		+18%	768	0.67	514				
		+21%	744	0.67	498				
		+24%	732	0.67	490				
		+27%	783	0.67	525				
	Minimum resistivity (Ω-cm)		490						

\* Performed by AWAL using EPA 300.0

\*\* Performed by AWAL using ASTM C1580

Entered by: \_\_\_\_\_

Reviewed: \_\_\_\_\_

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## **APPENDIX B**

### **Raven Manhole Coating Specifications**

## Process Description For Manhole Coating

Step By step breakdown of manhole lining operation:

1. Stack up new manhole – complete, base to cone
2. Sandblast MH interior – Prep. Surface for installation of Cementitious trowel coat (Raven 705 CA)
3. Apply Cementitious trowel coat (Raven 705 CA) to all interior manhole surfaces, this product will go on 1/8" thick (125 mil) – This product will fill in the manhole stack joints as well as fill any voids or imperfections in the manhole interior. This product will minimize pinholes and seal the manhole and give a complete surface that is ready to accept primer.
4. Apply primer – (Raven 155 Primer) - Spray primer on the cementitious trowel coat – The Primer penetrates the surface and allows for better adhesion of top coat - It also prevents air pinholes as the top coat is applied – Primer goes on 10 mils thick
5. Apply Raven Epoxy Lining System – (Raven 405) – This 100% Solids ultra-high build epoxy coating will be applied ~~125~~ mils thick over the entire interior of the manhole.  
**150 mils required on new manholes. 250 mils required on existing manholes.**

The Raven Primer and Raven 405 Epoxy will both be applied by Airless spray method, as per manufactures recommendation.

Note: With the Raven Lining System a bonus to the system is small touch-ups can be completed with a brush or roller

SHOP DRAWING / SUBMITTAL REVIEW	
<input type="checkbox"/> REVIEWED	<input checked="" type="checkbox"/> REVIEWED WITH CHANGES NOTED
<input type="checkbox"/> REVISE AND RESUBMIT	<input type="checkbox"/> REJECTED _____
<small>This review is for general conformance with plans and specifications only. Approvals are subject to subcontractors performance within the confines of the contract documents. Review of dimensions will not serve to relieve the subcontractor of contractual responsibility for any deviation from the contract requirements.</small>	
By: <u>Clint Dilley</u> Date: <u>09/30/19</u>	
Magna Water District	



# Raven 705CA

## Technical Data Sheet

### MANUFACTURER

Raven Lining Systems  
13105 E. 61<sup>st</sup> Street, Suite A  
Broken Arrow, OK 74012  
(918) 615-0020

### DESCRIPTION

Raven® 705CA is a reinforced calcium aluminate cementitious product for use on concrete and masonry structures as a repair mortar. Designed as a reinforced stand-alone product or as an underlayment for Raven coatings, 705CA's properties allow it to be efficiently spray applied to rehabilitate substrates providing a suitable surface for the application of a polymer topcoat.

### PHYSICAL PROPERTIES (Typical)

<u>Description</u>	<u>Method</u>	<u>Result</u>
Compressive Strength	ASTM C 109, 28 days	> 9,200 psi
Flexural Strength	ASTM C 293	> 1,650 psi
Tensile Strength	ASTM C 496	> 685 psi
Shrinkage @ 90% R. H.	ASTM C 596	0%
Freeze/Thaw	ASTM C 666, 100 cycles	no visible damage
Bond	ASTM C 882	> 4,000 psi
Applied Density		135 + 5 lbs/ft <sup>3</sup>

### TYPICAL USES

Surfaces where rehabilitation of an existing structure requires enhancement of the structural integrity and where exposure to concentrated acids and caustics may be expected, including:

- Tunnels and pipelines
- Digesters
- Secondary containment
- Wastewater facilities
- Clarifiers
- Tanks
- Manholes
- Floors and walls

### COVERAGE & APPLICATION THICKNESS

Theoretical coverage is 13.7 square feet per 65-pound bag at ½" nominal thickness (yielding 0.57 cubic feet per bag). Actual surface coverage will depend upon substrate roughness and irregularities.

Raven 705CA is designed for applications from ½" to 1". Additional thickness may be applied in successive applications as necessary.

### SURFACE PREPARATION

Prior to application surfaces shall be damp but free of flowing or excess water; a Saturated, Surface Dry (SSD) condition. Follow standard practices: the substrate must be prepared in a manner that provides a uniform, clean, sound, and neutralized surface with all active leaks stopped. The substrate must be free of all contaminants, such as oil, grease, rust, scale, or deposits. Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer, chisel, and/or scraper.

**Concrete and Masonry** surfaces must be sound and contaminant-free with a surface profile equivalent to a minimum of CSP 5 in accordance with ICRI Technical Guideline No. 310.2R-2013. This can generally be achieved by abrasive blasting, shot blasting, high pressure water cleaning, water jetting, or a combination of methods.

### APPLICATION

Apply with trowel, cementitious spray system or other suitable method. Optimal mixing and application is achieved with the use of a Raven approved low velocity cementitious spray system (such as SPRAYMATE 35C, 35D or MINIMATE® MACHINE).

### APPLICATION TEMPERATURES

No application shall be made when ambient temperature is 40°F or less or when substrate temperatures are (or may become within 24 hours of application) less than 35°F. Precautions shall be taken to keep the mix temperature at time of application below 90°F. Water temperature shall not exceed 80°F. Chill with ice if necessary.

### COMPONENTS AND MIXING

Dry cement powder, 65 pounds per bag, is to be mixed with 1.0 to 1.3 gallons of clean, potable water (or as recommended by Raven based upon application conditions).

### CLEAN UP

To clean tools and equipment flush with water. To clean skin, wash immediately and thoroughly with soap and water. Refer to the MSDS for additional information on health and safety.

### CURE TIME

Caution should be taken to minimize exposure of applied product to sunlight and air movement. If time between applications of additional product is to be longer than 15 minutes, place cover over structure to restrict air movement. At no time should the finished product be exposed to sunlight or air movement for longer than 15 minutes. In extremely hot and arid climates surfaces shall be shaded.

## Raven 705CA

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while application is in process. In environments where humidity level is below 70% the finished product shall be kept damp for 72 hours.

At 72°F, working time is 45 minutes, initial set time is 20 hours and cure 24 hours before surface preparation for polymer topcoat.

### AVAILABLE PACKAGES

Available in 65 pound bags with 40 bags per pallet. Raven 705CA is available through Raven Certified Applicators.

### SHELF LIFE AND STORAGE

Product shelf life is 1 year from purchase date in sealed bags, stored in a sheltered area between 40°F and 110°F. Materials are to be kept dry and protected from weather.

### SAFETY

SDS's are available on the website ([www.ravenlining.com](http://www.ravenlining.com)) or upon request. All personnel should read and understand the safety recommendations as set forth in the MSDS. Keep uncured product away from children at all times.

Warranty and Disclaimer: Raven Lining Systems, Inc. ("Raven") warrants its products to be free of manufacturing defects in accord with applicable Raven quality control procedures and that they meet the formulation standards of Raven. To the best of our knowledge the technical data contained herein is true and accurate on the date of publication and is subject to change without prior notice. If, within one year from purchase, any product is proven defective, Raven, at its sole option, will either replace the defective product or refund the purchase price. This warranty is void if the product is used contrary to Raven's written directions.

**THE AFORESAID IS THE EXCLUSIVE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES SHALL RAVEN BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OR FOR LOST PROFITS.**



# Raven 155

## Technical Data Sheet

### MANUFACTURER

Raven Lining Systems  
13105 E. 61<sup>st</sup> Street, Suite A  
Broken Arrow, OK 74012  
(918) 615-0020

### DESCRIPTION

Raven® 155 is a two component waterborne epoxy with ultra-low viscosity.

### PHYSICAL PROPERTIES (Typical)

Description	Method	Result
Hardness, Shore D	ASTM D 2240	70
Adhesion, Concrete	ASTM D 7234	Substrate Failure
Solids by Volume, as Supplied	Calculated	76% (in water)
VOC's	Calculated	0.0 lbs/gal

### TYPICAL USES

Use as a penetrating primer/sealer for new and existing concrete and as a polymer additive with high-early strength repair mortars. This product is particularly suitable to prevent out-gassing through topcoats and Raven Lining Systems recommends using Raven 155 to prime concrete exhibiting a moisture vapor emission rate greater than 3 lbs./1,000 ft.<sup>2</sup>/24 hours, when tested according to ASTM F 1869.

### COLOR

The Part A Resin is clear; the Part B Curing Agent is amber. When mixed the product is a milky color which dries to a transparent film.

### FILM THICKNESS

Dry film thickness (DFT) or wet film thickness (WFT) may be calculated with this formula:  $DFT = WFT \times \% \text{ solids} / 100$  A maximum of 8 mils per coat is recommended to prevent sagging. Recommended thickness when used as a primer or sealant is one or two coats at 8 mils each to saturate the substrates surface.

### COVERAGE

When applied at 40% solids, coverage is 200 square feet per gallon at 8 mils wet film thickness, providing 3 mils DFT. Actual surface coverage will depend on substrate porosity and roughness. Good painting practices suggest application of two coats for quality assurance. Generally, a wet film thickness gauge may be used to determine actual coating coverage. However, this material is a penetrating primer and

will be rapidly absorbed into the substrate making WFT measurement inaccurate.

### APPLICATION

Apply with brush, roller, airless or air-assisted spray or other suitable method. For best results, apply this product to concrete when its temperature is stable or falling.

**Green Concrete:** Freshly applied Portland concrete surfaces should be lightly troweled and allowed to cure until it may be walked on without leaving a mark. Apply Raven 155 diluted to 40% solids by brush, roller or spray application. Raven 155 meets the ASTM C309 requirement for use as a concrete curing compound (water loss <0.113 lbs/ft<sup>2</sup>).

**Polymer Additive:** As a starting point, use 2 gallons of Raven 155 diluted to 40% solids as polymer additive liquids with 60 pounds of high-early strength repair mortar.

### THINNING

Thin only with potable water; suggested field use level at 40% solids is accomplished by adding water to the mix. Part A Resin: Part B Curing Agent: Water mix ratio is 1:1:2 by volume.

### COMPONENTS AND MIX RATIO

Part A Resin: Part B Curing Agent mix ratio is 1:1 by volume. To attain the suggested field use level of 40% solids, add 2 parts potable water.

### POWER MIXING

Individually power mix both Part A and Part B containers prior to measuring out 1 part of Part A to 1 part of Part B by volume into a clean disposable pail. Power mix combined A & B for a minimum of three minutes. Dilute by adding water while mixing another minute. Transfer contents to a clean pail and continue mixing at least another minute. Scrape the sides and bottom to obtain a thorough mix before application. Properly mixed material will be a uniform color without light or dark spots.

Example: Mix a 2-gallon kit at 40% solids. In a 5-gallon pail, add 1-gallon part A to 1-gallon part B and power mix three minutes. Dilute by adding 2 gallons' water while mixing. Transfer to a clean pail and mix another minute before use.

### CLEAN UP

To clean tools, use soap and water. For clean-up of part A only, use acetone, MEK or xylene. To clean skin, wash immediately and thoroughly with soap and water. Refer to the Safety Data Sheet for additional information on health and safety.

## POT LIFE

The pot life is 45 minutes for one gallon at 72°F. Longer pot life is possible by mixing smaller amounts and/or cooling down the part A & B before mixing.

## CURE TIME

This is a waterborne epoxy and humidity levels below 90% relative humidity are required for the water to evaporate and the coating to cure. Thin film set time varies with substrate temperature and application thickness. Environmental controls and/or additional ventilation may be required to lower the humidity level. Generally, the coating will be tack-free in 1 hour at 72°F and dry-hard in about 4 hours.

When used as a polymer additive, reference the repair mortar's data sheet for cure and recoat times.

## RECOAT TIME

This product may be recoated with itself as soon as it becomes tacky but does not transfer to the finger. Minimum topcoat time is when it cures to a dry-through state, generally 2 - 4 hours at 72°F substrate temperature. Maximum recoat/topcoat time is 72 hours at 72°F substrate temperature; higher temperatures will shorten these windows. Before recoating; inspect, clean and dry surface thoroughly to remove all contamination, including amine blush or condensation. If the recoat/topcoat time is missed, abrade and clean surfaces prior to recoating.

## SUBSTRATE TEMPERATURE

Minimum recommended substrate temperature: 40°F  
Maximum recommended substrate temperature: 120°F

## TEMPERATURE RESISTANCE

Maximum recommended dry temperature: 200°F. Wet temperature resistance depends on chemical concentration and exposure time.

## SURFACE PREPARATION

Prior to coating, the substrate must be prepared in a manner that provides a uniform, clean, sound, neutralized surface suitable for the specified coating. The substrate must be free of all contaminants, such as oil, grease, rust, scale or deposits. In general, coating performance is proportional to the degree of surface preparation.

**Concrete and Masonry** surfaces must be sound and contaminant-free with a surface profile equivalent to a CSP3 to CSP5 in accordance with ICRI Technical Guideline No. 310.2R-2013. This can generally be achieved by abrasive blasting, shot blasting, high pressure water cleaning, water jetting, or a combination of methods.

## AVAILABLE PACKAGES

Available in pints (1-quart kit) and one gallon pails (2-gallon kit). Kits are supplied in the correct proportions of A & B; these two components must be mixed together before use. Raven 155 is available through Raven Certified Applicators.

## SHELF LIFE AND STORAGE

Product shelf life is 1 year from purchase date in original unopened containers, stored in sheltered area between 60°F and 80°F (15°C and 27°C).

## SAFETY

SDS's are available on the website ([www.ravenlining.com](http://www.ravenlining.com)) or upon request. All personnel should read and understand the safety recommendations as set forth in the SDS. Keep uncured product away from children at all times.

Warranty and Disclaimer: Raven Lining Systems, Inc. ("Raven") warrants its products to be free of manufacturing defects in accord with applicable Raven quality control procedures and that they meet the formulation standards of Raven. To the best of our knowledge the technical data contained herein is true and accurate on the date of publication and is subject to change without prior notice. If, within one year from purchase, any product is proven defective, Raven, at its sole option, will either replace the defective product or refund the purchase price. This warranty is void if the product is used contrary to Raven's written directions.

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# Raven 155 Primer Technical Bulletin

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## MANUFACTURER

Raven Lining Systems  
13105 E. 61<sup>st</sup> Street, Suite A  
Broken Arrow, OK 74012  
(918) 615-0020

## DESCRIPTION

Raven 155 is a water borne epoxy primer that can be utilized to penetrate and seal concrete substrates. The unique formulation allows the primer to create a breathable membrane that has the ability to penetrate deep into substrates which may be exhibiting high volumes of moisture vapor emissions, such as green concrete. In situations where new concrete is to be top coated it is recommended that Raven 155 be used to both treat the prepared substrate. Raven 155 will not only help reduce moisture vapor emissions, but will also improve adhesion and reduce the occurrence of pinholes in the topcoat. Substrates treated with Raven 155 may also be primed with Raven 171 or 171FS 100% solids epoxy primer for maximum pinhole reduction.

Raven 155 epoxy is a two part epoxy that is mixed with water. The Raven 155 epoxy consists of a Part A resin and a specialty curing agent Part B. The two components are blended together and then mixed with potable water per the specified mix ratio.

*Note: While Raven Lining Systems has found these materials and methods to be successful in treating concrete substrates with high moisture vapor emission and pinholing issues, there are many variables which may cause adhesion problems and/or induce pinholes in coatings applied to concrete substrates. Standard good coating practices should be observed to reduce the effect of substrate temperature and moisture content/transmission when possible. Proper proportioning, mixing, application and curing is also vital in all material applications. Consult with Raven Lining Systems technical personnel.*

## RAVEN 155 PRIMER APPLICATION

For use as a concrete or masonry primer, the recommended WFT of Raven 155 to be applied will vary depending upon the porosity of the substrate but coverage can be estimated 200 square feet per gallon. A minimum of two successive applications at this coverage rate is recommended to fully saturate the substrate. Additional coats may be required for very porous substrates.

### MIXING RATIO (A:B:Water):

1:1:2 by volume Example: 1 gallon of Part A + 1 gallon of Part B + 2 gallons of water

Water content may be lowered to reduce cure time or for application to wet or sweating substrates.

### COVERAGE:

Minimum Recommended WFT of 8 mils: 200 Square Feet/Gallon. Typical 10' x 4' manhole requires approximately a 1/2 gallon mix (including mix water).

### MIXING:

Add (1) unit of Part A into (1) unit of Part B and mix thoroughly for one minute using a power mixer and suitable mixing blade such as a Hanson mixer. Add (2) units of potable water and mix thoroughly. It is recommended to maintain coating material and water temperature below 75F to maximize working time. In high heat conditions, utilize storage in ice chilled cooler and use chilled water for mixing. Clean up of Raven 155 can be performed using warm, soapy water. Cleaning Part A alone will require a solvent such as acetone or MEK.

### POT LIFE FOR 1/2 GALLON MIX:

Material temp of 75F: 45-50 minutes

Material temp of 90F: 10-15 minutes



### **APPLICATION:**

Raven 155 is recommended to be sprayed (or hand applied for small areas) to dry concrete/cement until the substrate is saturated (it is recommended to work the primer into the surface using a natural bristle masonry brush or roller). Hand application should be made using a natural bristle masonry brush or medium nap roller. Spray applications should be made using an airless sprayer (.015-.019" tip), conventional spray gun or a pump-up Hudson type sprayer followed by working into the surface with a saturated brush or roller. Drips, runs and pooled primer should be removed with clean rags or sponge to promote thorough curing.

### **Typical cure time at 72 F with less than 90% relative humidity:**

Tack free in 1 hour; dry to touch in 3-4 hours. Raven 155 should be allowed to cure to a "set-to-touch" state (no transfer to finger when touched) prior to applying additional Raven 155. Curing to a tack free state (primer can be touched and is not tacky) is recommended prior to applying other primers or topcoat. Cure time is dependent upon temperature, relative humidity and air movement. High temperature and low humidity will decrease cure time. Low temperature or high humidity will increase cure time.

It is also strongly recommended to fill all surface voids and honeycombs with a cementitious product or a polymer modified cement prior to the primer application and top coating to reduce the occurrence of outgassing pinholes.

### **RAVEN 155 KITS**

Standard kit sizes are:

Quart Kit: consists of (1) pint of Part A and (1) pint of Part B

Two Gallon Kit: (1) gallon of Part A and (1) gallon of Part B

### **TOP COATING RAVEN 155 PRIMER**

Raven 155 primer may be used in combination with a 100% solids epoxy primer such as Raven 171 or 171FS to maximize outgassing pinhole reduction. Following proper cure of Raven 155, Raven 171 primers may be applied and should be allowed to cure to a tack free state, typically 1-2 hours at 72 F, prior to top coating.

# RAVEN 405

*Stands the Test of Time*

- Eco-friendly, 100% solids, zero VOCs
- Superior adhesion and corrosion protection
- 25 Year history of proven performance
- Solid network of Certified Applicators

**PROTECT WITH CONFIDENCE**



800.324.2610 | [www.ravenlining.com](http://www.ravenlining.com)

13105 East 61st Street, Suite A, Broken Arrow, OK 74012

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## Raven 405



**Raven 405** is our most widely used product and is formulated to provide structural renewal for severely deteriorated wastewater infrastructure. It is a solvent-free 100% solids, ultra high build epoxy coating formulated with exceptionally high physical strengths and broad range chemical resistance. Raven 405 exhibits superior bond to concrete, steel, masonry, fiberglass and other surfaces. Designed for operating temperatures up to 200°F, 405's unique ultra high-build ability allows it to be spray applied on vertical and overhead surfaces. The surface tolerance and high physical strengths of 405 allow it to be designed as a structural lining in manholes, pipelines, tanks and other deteriorated structures.

Typical uses of 405 are surfaces where rehabilitation of an existing structure requires enhancement of the structural integrity and where exposure to concentrated acids and caustics may be expected, including:

- Clarifiers
- Tunnels and pipelines
- Digesters
- Tanks
- Secondary containment
- Manholes
- Wastewater facilities

Floors and walls  
[Raven 405 TDS](#)

[Raven 405 TDS Spanish](#)

[Raven 405 SDS](#)

Raven 405 Tech Bulletin

Raven 405 Ad

Case Study: Scott Air Force Base

Case Study: History Never Looked So Good: How Proper Application Stands the Test of Time; Raven's Manhole Rehabilitation is 'Proven, True & Blue!

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# Raven 405

## Technical Data Sheet

### MANUFACTURER

Raven Lining Systems  
13105 E. 61<sup>st</sup> Street, Suite A  
Broken Arrow, OK 74012  
(918) 615-0020

### DESCRIPTION

Raven® 405 is a solvent-free 100% solids, ultra high build epoxy coating formulated with exceptionally high physical strengths and a broad range of chemical resistance. 405 exhibits superior bond to steel, ductile or cast iron, fiberglass, dry or damp concrete and masonry. Designed for operating temperatures up to 200°F (93°C), 405's unique ultra high-build ability allows it to be spray applied on vertical and overhead surfaces. 405's surface tolerance and high physical strength also allows it to be utilized as a structural protective lining on and in buried pipelines, tanks and other cathodic protected structures as well as concrete and masonry structures where heavy corrosion is present.

### PHYSICAL PROPERTIES (Typical)

<u>Description</u>	<u>Method</u>	<u>Result</u>
Tensile Strength	ASTM D 638	7,600 psi
Tensile Elongation	ASTM D 638	3.5%
Compressive Strength	ASTM D 695	18,000 psi
Flexural Strength	ASTM D 790	13,000 psi
Hardness, Shore D	ASTM D 2240	87
Taber Abrasion, CS-17 wheel	ASTM D 4060, 1 kg load/1,000 cycles	<112 mg loss
Adhesion, Steel (SSPC-10)	ASTM D 4541	>1,400 psi
Adhesion, Concrete	ASTM D 7234	Substrate Failure

### TYPICAL USES

Surfaces where rehabilitation of an existing structure requires enhancement of the structural integrity and where exposure to concentrated acids and caustics may be expected, including:

- Buried Pipes
- Sheet Piling
- Steel Structures
- Wastewater Facilities
- Secondary Containment
- Utility Vaults
- Tank Linings
- Concrete Structures
- Floors and Walls
- Troughs and Sumps

### COLOR

The Part A Resin is white; the Part B Curing Agent is blue. When mixed the product is light blue. Limited special colors are available on request.

### FILM THICKNESS

Raven 405 is a 100% solids epoxy with zero shrinkage. Wet film thickness and dry film thickness are the same (i.e. 80mils WFT = 80mils DFT). Depending on substrate type and profile, a maximum of 200 mils per coat is recommended to prevent sagging. Recommended thickness will vary from 40 - 250 mils+ based on service conditions.

### COVERAGE

Theoretical coverage is 20 square feet per gallon at 80 mils (0.5m<sup>2</sup> per L at 2mm) wet film thickness. Actual surface coverage will depend on substrate porosity and roughness. Good painting practices suggest application of two coats for quality assurance. A wet film thickness gauge may be used to determine actual coating coverage.

### APPLICATION

Apply with brush, roller, airless or air-assisted spray or other suitable method. Optimal proportioning and mixing is achieved with the use of a Raven approved plural component airless spray system. For best results, apply this product to concrete when its temperature is stable or falling.

### THINNING

**Do not thin with solvents.** If lower viscosity is needed, heat unmixed material by placing the containers in hot tap water until the desired flow properties are obtained. To heat larger quantities, drum heaters or inline heaters on specialized spray equipment may be used. Unmixed material should not be heated above 150°F (66°C).

### COMPONENTS AND MIX RATIO

Part A Resin: Part B Curing Agent mix ratio is 3:1 by volume.

### POWER MIXING

Individually power mix both Part A and Part B containers prior to measuring out 3 parts of Part A to 1 part of Part B by volume into a clean disposable pail. Completely mix combined A & B for a minimum of one minute before transferring contents to a clean pail. Continue mixing at least another minute, scraping the sides and bottom, to obtain a thorough mix before application. Properly mixed material will be a uniform color without light or dark spots.



### CLEAN UP

To clean tools, use acetone, MEK or xylene. To clean skin, wash immediately and thoroughly with soap and water. Refer to the Safety Data Sheet for additional information on health and safety.

### POT LIFE

The pot life is 20 minutes for one gallon at 72°F (22°C). Longer pot life is possible by mixing smaller amounts and/or cooling down the part A & B before mixing.

### CURE TIME

Thin film set time varies with substrate temperature and application thickness. Generally, the coating will be tack-free in 3 ½ hours at 72°F (22°C) and dry-hard in about 5 hours.

### RECOAT TIME

This product may be recoated as soon as it becomes tacky but does not transfer to the finger. When applying multiple coats, do not allow more than 12 hours at 72°F (22°C) substrate temperature to pass between coats, higher temperatures will shorten this window. Before recoating; inspect, clean and dry surface thoroughly to remove all contamination, including amine blush or condensation. If the recoat time is missed, abrade and clean surfaces prior to recoating.

### SUBSTRATE TEMPERATURE

Minimum recommended substrate temperature: 40°F (4°C)  
Maximum recommended substrate temperature: 120°F (49°C)

### TEMPERATURE RESISTANCE

Maximum recommended dry temperature: 150°F (66°C). May be post-cured for service up to 200°F (93°C). Wet temperature resistance depends on chemical concentration and exposure time.

### SURFACE PREPARATION

Prior to coating, the substrate must be prepared in a manner that provides a uniform, clean, sound, neutralized surface suitable for the specified coating. The substrate must be free of all contaminants, such as oil, grease, rust, scale or deposits. In general, coating performance is proportional to the degree of surface preparation.

*Steel* surfaces may require “Solvent Cleaning” (SSPC-SP 1) to remove oil, grease and other soluble contaminants. Chemical contaminants may be removed according to SSPC-SP 12/NACE No. 5. Identification of the contaminants along with their concentrations may be obtained from laboratory and field tests as described in SSPC-TU 4 “Field Methods for Retrieval and Analysis of Soluble Salts on Substrates”. Surfaces to be coated should then be prepared according to SSPC-SP 5/NACE No.1 “White Blast Cleaning” for immersion service or SSPC-SP 10/NACE No. 2 “Near White Blast Cleaning” for all other service. In certain situations, an alternate procedure may be to use high (>5,000 psi) or ultrahigh (>10,000 psi) pressure water cleaning or water cleaning with sand injection. The resulting anchor profile shall be 2.5-5.0 mils and be relative to the coating thickness specified.

*Concrete and Masonry* surfaces must be sound and contaminant-free with a surface profile equivalent to a minimum CSP3 to CSP5 in accordance with ICRI Technical Guideline No. 310.2R-2013. This can generally be achieved by abrasive blasting, shot blasting, high pressure water cleaning, water jetting, or a combination of methods.

### AVAILABLE PACKAGES

Available in 5 gallon (19L) pails as a 20 gallon (76L) kit, 30 gallon (113.5L) drums as a 120 gallon (454L) kit and 55 gallon (208L) drums as a 220 gallon (832L) kit. Kits are supplied in the correct proportions of A & B; these two components must be mixed together before use. Raven 405 is available through Raven Certified Applicators.

### SHELF LIFE AND STORAGE

Product shelf life is 1 year from purchase date in original unopened containers, stored in a sheltered area between 60°F (16°C) and 80°F (27°C).

### SAFETY

SDS's are available on the website ([www.ravenlining.com](http://www.ravenlining.com)) or upon request. All personnel should read and understand the safety recommendations as set forth in the SDS. Keep uncured product away from children at all times.

Warranty and Disclaimer: Raven Lining Systems, Inc. (“Raven”) warrants its products to be free of manufacturing defects in accord with applicable Raven quality control procedures and that they meet the formulation standards of Raven. To the best of our knowledge the technical data contained herein is true and accurate on the date of publication and is subject to change without prior notice. If, within one year from purchase, any product is proven defective, Raven, at its sole option, will either replace the defective product or refund the purchase price. This warranty is void if the product is used contrary to Raven's written directions.

**THE AFORESAID IS THE EXCLUSIVE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES SHALL RAVEN BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OR FOR LOST PROFITS.**

# Raven 405



## DESCRIPTION

Raven® 405 is a solvent-free 100% solids, ultra high build epoxy coating formulated with exceptionally high physical strengths and broad range chemical resistance. 405 exhibits superior bond to concrete, steel, masonry, fiberglass and other surfaces. Designed for operating temperatures up to 200°F, 405's unique ultra high-build ability allows it to be spray applied on vertical and overhead surfaces. The surface tolerance and high physical strengths of 405 allow it to be designed as a structural lining in manholes, pipelines, tanks and other deteriorated structures.

## TYPICAL USES

Surfaces where rehabilitation of an existing structure requires enhancement of the structural integrity and where exposure to concentrated acids and caustics may be expected, including:

- Tunnels and pipelines
- Digesters
- Secondary containment
- Wastewater facilities
- Clarifiers
- Tanks
- Manholes
- Floors and walls

## COLOR

The Part A Resin is white; the Part B Curing Agent is blue. When mixed the product is light blue. Limited special colors are available on request.

## SOLIDS BY VOLUME

100% solids by volume

Volatile Organic Compounds: 0.0 pounds per gallon

## FILM THICKNESS

Raven 405 is a 100% solids epoxy with zero shrinkage. Wet film thickness and dry film thickness are the same (i.e. 80mils WFT = 80mils DFT). Depending on substrate type and profile, a maximum of 200 mils per coat is recommended to prevent sagging. Recommended thickness will vary from 40 - 250 mils+ based on service conditions.

## COVERAGE

Theoretical coverage is 20 square feet per gallon at 80 mils wet film thickness. Actual surface coverage will depend on substrate porosity and roughness. Good painting practices suggest application of two coats for quality assurance. A wet film thickness gauge may be used to determine actual coating coverage.

## APPLICATION

Apply with brush, roller, airless or air-assisted spray or other suitable method. Optimal proportioning and mixing is achieved with the use of a Raven approved plural component

airless spray system. For best results, apply this product to concrete when its temperature is stable or falling.

## THINNING

**Do not thin with solvents.** If lower viscosity is needed, heat unmixed material by placing the containers in hot tap water until the desired flow properties are obtained. To heat larger quantities, drum heaters or inline heaters on specialized spray equipment may be used. Unmixed material should not be heated above 150°F.

## COMPONENTS AND MIX RATIO

Part A Resin:Part B Curing Agent mix ratio is 3:1 by volume.

## POWER MIXING

Individually power mix both Part A and Part B containers prior to measuring out 3 parts of Part A to 1 part of Part B by volume into a clean disposable pail. Completely mix combined A & B for a minimum of one minute before transferring contents to a clean pail. Continue mixing at least another minute, scraping the sides and bottom, to obtain a thorough mix before application. Properly mixed material will be a uniform color without light or dark spots.

## CLEAN UP

To clean tools, use acetone, MEK or xylene. To clean skin, wash immediately and thoroughly with soap and water. Refer to the Material Safety Data Sheet for additional information on health and safety.

## POT LIFE

The pot life is 20 minutes for one gallon at 72°F. The working life varies depending on the amount and temperature of epoxy mixed and the ambient temperature.

## CURE TIME

Thin film set time varies with substrate temperature and application thickness. Generally, the coating will be tack-free in 3 ½ hours at 72°F and dry-hard in about 5 hours.

## RECOAT TIME

This product may be recoated as soon as it becomes tacky but does not transfer to the finger. When applying multiple coats, do not allow more than 12 hours at 72°F substrate temperature to pass between coats, higher temperatures will shorten this window. Before recoating; inspect, clean and dry surface thoroughly to remove all contamination, including amine blush or condensation. If the recoat time is missed, clean and abrade surfaces prior to recoating.

## Raven 405

### SUBSTRATE TEMPERATURE

Minimum recommended substrate temperature: 40°F  
Maximum recommended substrate temperature: 120°F

### TEMPERATURE RESISTANCE

Maximum recommended dry temperature: 150°F. May be post-cured for service up to 200°F. Wet temperature resistance depends on chemical concentration and exposure time.

### SURFACE PREPARATION

Prior to coating, the substrate must be prepared in a manner that provides a uniform, clean, sound, neutralized surface suitable for the specified coating. The substrate must be free of all contaminants, such as oil, grease, rust, scale or deposits. In general, coating performance is proportional to the degree of surface preparation.

**STEEL** surfaces may require "Solvent Cleaning" (SSPC-SP 1) to remove oil, grease and other soluble contaminants. Chemical contaminants may be removed according to SSPC-SP 12/NACE No. 5. Identification of the contaminants along with their concentrations may be obtained from laboratory and field tests as described in SSPC-TU 4 "Field Methods for Retrieval and Analysis of Soluble Salts on Substrates". Surfaces to be coated should then be prepared according to SSPC-SP 5/NACE No.1 "White Blast Cleaning" for immersion service or SSPC-SP 10/NACE No. 2 "Near White Blast Cleaning" for all other service. In certain situations, an alternate procedure may be to use high (>5,000 psi) or ultrahigh (>10,000 psi) pressure water cleaning or water cleaning with sand injection. The resulting anchor profile

shall be 2.5-5.0 mils and be relative to the coating thickness specified.

**CONCRETE AND MASONRY** surfaces must be sound and contaminant-free with a surface profile equivalent to a CSP2 to CSP5 in accordance with ICRI Technical Guideline No. 03732. This can generally be achieved by abrasive blasting, shot blasting, high pressure water cleaning, water jetting, or a combination of methods.

### AVAILABLE PACKAGES

Available in 5 gallon pails (20 gallon kit), 30 gallon drums (120 gallon kit) and 55 gallon drums (220 gallon kit). Kits are supplied in the correct proportions of A & B; these two components must be mixed together before use. Raven 405 is available through Raven Certified Applicators.

### SHELF LIFE AND STORAGE

Product shelf life is 1 year from purchase date in sealed, unmixed containers, stored in a sheltered area between 60°F and 80°F (15°C and 27°C).

### SAFETY

Consult the Material Safety Data Sheet for this product concerning health and safety information before using. Strictly follow all notices on the Material Safety Data Sheet and container label. If you do not fully understand the notices and procedures provided on the MSDS or if you cannot strictly comply with them, do not use this product. Actual safety measures are dependent on application methods and work environment. Contact Raven Lining Systems to obtain a copy of the Material Safety Data Sheet at 800-324-2810.

## TYPICAL PROPERTIES<sup>(1)</sup>

DESCRIPTION	METHOD	RESULT
Tensile Strength	ASTM D 638	7,600 psi
Tensile Ultimate Elongation	ASTM D 638	1.5%
Compressive Strength	ASTM D 695	18,000 psi
Flexural Strength	ASTM D 790	13,000 psi
Hardness, Shore D	ASTM D 2240	88
Taber Abrasion, CS-17 wheel	ASTM D 4060, 1 kg load/1,000 cycles	<112 mg loss
Adhesion, Concrete	ASTM D 7234	Substrate Failure

(1) Typical properties are to be considered as representative of current production and should not be construed as specifications.

Warranty and Disclaimer: Raven Lining Systems, Inc. ("Raven") warrants its products to be free of manufacturing defects in accord with applicable Raven quality control procedures and that they meet the formulation standards of Raven. To the best of our knowledge the technical data contained herein is true and accurate on the date of publication and is subject to change without prior notice. If, within one year from purchase, any product is proven defective, Raven, at its sole option, will either replace the defective product or refund the purchase price. This warranty is void if the product is used contrary to Raven's written directions.

**THE AFORESAID IS THE EXCLUSIVE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES SHALL RLS SOLUTIONS INC. BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OR FOR LOST PROFITS. NO ACTION AGAINST RAVEN MAY BE COMMENCED MORE THAN ONE YEAR AFTER THE CLAIM ARISES.**



# MATERIAL SAFETY DATA SHEET

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**Trade Name: Raven 405 - Part A**

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## SECTION I: COMPANY INFORMATION

**Company:** RLS  
13105 East 61<sup>st</sup> Street South, Suite A  
Broken Arrow, OK 74012

**Emergency Telephone #:** 800-424-9300  
Chemtrec

**Revision Date:** 10/10/07

**Information Telephone #:** 918-615-0020  
800-324-2810

## SECTION II: INGREDIENT INFORMATION

<u>INGREDIENT</u>	<u>CAS NUMBER</u>	<u>PERCENT</u>	<u>PEL</u>	<u>TLV</u>
Epoxy Resin	25085-99-8	> 70%	N/E	N/E
Silica, Amorphous, Fumed, Crystalline-free	67762-90-7	0 - 5%	*6 mg/m <sup>3</sup>	*3 mg/m <sup>3</sup>

N/E indicates "not established"

SARA Title III, Section 313 ingredients: None

All ingredients are TSCA inventory listed.

\*Note: The PEL and TLV for this ingredient are the TWA for respirable dust levels only. In this product, it is pre-dispersed and not available as a dust. Therefore, under normal use conditions it is not considered a hazard.

## SECTION III: PHYSICAL DATA

**Boiling Point:** > 200 deg F

**Vapor Pressure:** Not determined

**Vapor Density:** Not determined

**Solubility in Water:** Negligible

**Appearance and Odor:** White liquid with heavy paint consistency - mild epoxy odor

**Specific Gravity:** 1.4

**Melting Point:** Not determined

**Evaporation Rate:** Not determined

**% Volatile by Volume:** <1%

## SECTION IV: FIRE & EXPLOSION HAZARD DATA

**Flash Point:** >200 deg F, PMCC Method

**Extinguishing Media:** Foam, CO<sub>2</sub>, Dry Chemical, Water Spray

**Special Fire Fighting Procedures:** The use of self-contained breathing apparatus is recommended for firefighters. Water may be helpful in keeping adjacent containers cool. Avoid spreading burning liquids with water used for cooling purposes.

**Unusual Fire and Explosion Hazards:** Keep work areas free of hot metal surfaces and other source of ignition.

**NFPA classification:** Health: 2      Flammability: 1      Reactivity: 0

**OSHA/NFPA Fire Hazard Classification:** Class III B

**LFL:** Not determined      **UFL:** Not determined

## SECTION V: REACTIVITY DATA

**Stability:** Stable, will react with amines.

**Incompatibility:** Strong acids and bases, selected amines and oxidizing agents.

**Hazardous Decomposition or Byproducts:** Thermal decomposition in the presence of air may yield carbon monoxide, carbon dioxide, phenolics, acids, aldehydes and other unidentified toxic and/or irritating compounds.

**Hazardous Polymerization:** Will not occur.

## **SECTION VI: HEALTH HAZARD DATA**

### **Primary Routes of Entry:**

**EYES:** May cause moderate eye irritation. Corneal injury is possible.

**SKIN:** May cause allergic skin reaction in susceptible individuals. Prolonged exposure likely to cause skin irritation. Repeated exposure may cause skin irritation. A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts.

**INHALATION:** Vapors are unlikely due to physical properties.

**INGESTION:** Moderately toxic, may be harmful if swallowed. No hazards anticipated from ingestion incidental to industrial exposure.

**SYSTEMIC and OTHER EFFECTS:** Except for skin sensitization, repeated exposures to low molecular weight epoxy resins of this type are not anticipated to cause any significant adverse effects.

**Carcinogenicity:** Contains no ingredient listed as a potential carcinogen or as a carcinogen per OSHA, ACGIH, NTP or IARC at concentrations equal to or greater than 0.1%.

### **Emergency and First Aid Procedures:**

**EYES:** Flush with large quantities of water for at least 15 minutes. Consult a physician.

**SKIN:** Wash thoroughly with soap and flowing water. Remove and wash contaminated clothing before reuse.

**INHALATION:** Remove to fresh air if effects occur. Consult a physician.

**INGESTION:** Seek immediate medical attention. Do not induce vomiting unless directed to do so by a physician.

## **SECTION VII: PRECAUTIONS FOR SAFE HANDLING AND USE**

**Steps to Be Taken in Case Material is Released or Spilled:** Keep sources of ignition and hot metal surfaces isolated from the spill. Material may flow slowly. Scrape into containers for disposal.

**Waste Disposal Methods:** Dispose of according to all local, state and federal regulations.

**Precautions to Be Taken in Handling and Storing:** Keep containers closed when not in use. Avoid prolonged or repeated contact with skin. Do not handle or store near flame, heat or strong oxidants. Do not store in direct sunlight. Avoid prolonged storage above 38 deg C (100 deg F).

## **SECTION VIII: CONTROL MEASURES**

**RESPIRATORY:** Respiratory protection should not be needed. If exposure may or does exceed occupational exposure limits, respiratory irritation is experienced, or during spray application, use a properly fitted MSHA/NIOSH approved respirator fitted with organic vapor cartridges. In addition, spray application may require the use of paint pre-filters. If sanding or grinding on cured material, use above respirator fitted with HEPA filters or a dust mask.

**VENTILATION:** General mechanical ventilation is sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.

**EYES:** Use chemical safety glasses, splash-proof eye goggles or goggles with full faceshield.

**CLOTHING/GLOVES:** Use nitrile or other impermeable chemical resistant gloves to prevent skin irritation. If potential for skin contact is present, wear impervious, long-sleeved, body covering clothing and rubber boots.

**OTHER PROTECTIVE EQUIPMENT:** The availability of eye washes and safety showers in work areas is recommended.

## **SECTION IX: TRANSPORT DATA**

**Proper Shipping Name:** Not regulated

**Hazard Class:** Not regulated by D.O.T. regulations

**Identification Number:** None

**Packing Group:** None

## **SECTION X: DISCLAIMER**

RLS MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO ANY INFORMATION PRESENTED HEREIN, ALL OF WHICH IS PROVIDED "AS IS". TO THE MAXIMUM EXTENT PERMITTED BY LAW, RLS EXPRESSLY EXCLUDES ALL WARRANTIES, OBLIGATIONS, REPRESENTATIONS, LIABILITIES, TERMS AND CONDITIONS (WHETHER THEY ARE EXPRESS OR IMPLIED, OR ARISE IN CONTRACT, STATUTE, OR OTHERWISE, AND IRRESPECTIVE OF THE NEGLIGENCE OF RLS, ITS EMPLOYEES OR AGENTS) IN CONNECTION WITH THE INFORMATION PRESENTED HEREIN. RLS MAKES NO REPRESENTATIONS OR WARRANTIES AS TO MERCHANTABILITY, FITNESS FOR PURPOSE, NONINFRINGEMENT OR CONFORMITY WITH DESCRIPTION OR SAMPLE.

# MATERIAL SAFETY DATA SHEET

Trade Name: **Raven 405 - Part B**

## SECTION I: COMPANY INFORMATION

**Company:** RLS  
13105 East 61<sup>st</sup> Street South, Suite A  
Broken Arrow, OK 74012

**Emergency Telephone #:** 800-424-9300  
Chemtrec

**Revision Date:** 4/29/08

**Information Telephone #:** 918-615-0020  
800-324-2810

## SECTION II: INGREDIENT INFORMATION

<u>INGREDIENT</u>	<u>CAS NUMBER</u>	<u>PERCENT</u>	<u>PEL</u>	<u>TLV</u>
Aliphatic Amine	1477-55-0	20 - 30%	N/E	0.1 mg/m <sup>3</sup> skin
Alkylphenol	84852-15-3	15 - 20%	N/E	N/E
Polyoxypropylene Diamine	trade secret	7 - 12%	N/E	N/E
Silica, Amorphous, Fumed, Crystalline-free	67762-90-7	7 - 12%	*6 mg/m <sup>3</sup>	*3 mg/m <sup>3</sup>
Isophorone Diamine	2855-13-2	5 - 10%	N/E	N/E
Diethylenetriamine	111-40-0	5 - 10%	4 mg/m <sup>3</sup>	1 ppm TWA
4,4'-Methylenebiscyclohexanamine	1761-71-3	1 - 5%	N/E	N/E
Mixed Cycloaliphatic Amines	trade secret	1 - 5%	N/E	N/E
2,2-bis(4-hydroxyphenyl)propane	80-05-7	0 - 5%	N/E	N/E
Phenol	108-95-2	1 - 3%	5 ppm (skin)	5 ppm (skin)

N/E indicates "not established"

SARA Title III, Section 313 ingredients: 2,2-bis(4-hydroxyphenyl)propane      All ingredients are TSCA inventory listed.

\*Note: The PEL and TLV for this ingredient are the TWA for respirable dust levels only. In this product, it is pre-dispersed and not available as a dust. Therefore, under normal use conditions it is not considered a hazard.

## SECTION III: PHYSICAL DATA

**Boiling Point:** > 200 deg F      **Specific Gravity:** 1.1  
**Vapor Pressure:** Not determined      **Melting Point:** Not determined  
**Vapor Density:** Not determined      **Evaporation Rate:** Not determined  
**Solubility in Water:** Negligible      **% Volatile by Volume:** <1%  
**Appearance and Odor:** Gel consistency with characteristic ammonia odor

## SECTION IV: FIRE & EXPLOSION HAZARD DATA

**Flash Point:** >200 deg F, Setaflash Method      **OSHA/NFPA Fire Hazard Classification:** Class III B  
**Extinguishing Media:** Foam, CO<sub>2</sub>, Dry Chemical, Water Spray      **LFL:** Not determined      **UFL:** Not determined  
**Special Fire Fighting Procedures:** The use of self-contained breathing apparatus is recommended for firefighters. Water may be helpful in keeping adjacent containers cool.  
**Unusual Fire and Explosion Hazards:** Keep work areas free of hot metal surfaces and other source of ignition. Sudden reaction and fire may result if product is mixed with an oxidizing agent.  
**NFPA classification:**      Health: 3      Flammability: 1      Reactivity: 0

## SECTION V: REACTIVITY DATA

**Stability:** Stable  
**Incompatibility:** Strong acids and bases, selected epoxy resins and strong oxidizing agents.  
**Hazardous Decomposition or Byproducts:** Thermal decomposition in the presence of air may yield carbon monoxide, carbon dioxide, ammonia, aldehydes, ketones, nitrogen oxides and other unidentified toxic and/or irritating compounds.  
**Hazardous Polymerization:** Will not occur.

## **SECTION VI: HEALTH HAZARD DATA**

### **Primary Routes of Entry:**

**EYES:** Severe eye irritant. May cause burns. Vapors may be irritating.

**SKIN:** Severe skin irritant. May cause injury to skin following prolonged or repeated contact. Repeated exposure may cause sensitization of the individual.

**INHALATION:** Vapors/mists may be corrosive to the upper respiratory tract. Repeated or prolonged exposure can result in lung damage. May cause respiratory tract sensitization and/or irritation of mucous membranes.

**INGESTION:** Not expected to be a relevant route of exposure. However, the material is corrosive and may cause permanent damage to the mouth, throat and stomach.

**SYSTEMIC and OTHER EFFECTS:** Product can be alkaline, corrosive and irritating to skin, ears, eyes and mucous membranes. Aliphatic amines can cause changes in the lungs, liver, kidneys and heart. May cause injury upon prolonged contact and repeated contact.

**Carcinogenicity:** Contains no ingredient listed as a potential carcinogen or as a carcinogen per OSHA, ACGIH, NTP or IARC at concentrations equal to or greater than 0.1%.

### **Emergency and First Aid Procedures:**

**EYES:** Flush with large quantities of water for at least 15 minutes. Seek immediate medical attention.

**SKIN:** Wash immediately with soap and water. If irritation or sensitization occurs, remove individual from further contact with material. Remove and wash contaminated clothing before reuse.

**INHALATION:** Remove to fresh air if effects occur. Consult a physician.

**INGESTION:** If this product is swallowed, administer one glass of water. Do not induce vomiting. Seek medical attention immediately.

## **SECTION VII: PRECAUTIONS FOR SAFE HANDLING AND USE**

**Steps to Be Taken in Case Material is Released or Spilled:** Keep sources of ignition and hot metal surfaces isolated from the spill. Material may flow slowly. Scrape into containers for disposal.

**Waste Disposal Methods:** Dispose of according to all local, state and federal regulations.

**Precautions to Be Taken in Handling and Storing:** Keep containers closed when not in use. Avoid breathing vapors and prolonged or repeated contact with skin. Do not handle or store near flame, heat or strong oxidants. Do not store in direct sunlight. Avoid prolonged storage above 38 deg C (100 deg F).

## **SECTION VIII: CONTROL MEASURES**

**RESPIRATORY:** Respiratory protection should not be needed. If exposure may or does exceed occupational exposure limits, respiratory irritation is experienced, or during spray application, use a properly fitted MSHA/NIOSH approved respirator fitted with ammonia & methylamine cartridges. In addition, spray application may require the use of paint pre-filters. If sanding or grinding on cured material, use above respirator fitted with HEPA filters or a dust mask.

**VENTILATION:** General mechanical ventilation is sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.

**EYES:** Use chemical safety glasses, splash-proof eye goggles or goggles with full faceshield.

**CLOTHING/GLOVES:** Use nitrile or other chemical resistant gloves. Wear clean, long-sleeved, body covering clothing and rubber boots.

**OTHER PROTECTIVE EQUIPMENT:** The availability of eye washes and safety showers in work areas is recommended.

## **SECTION IX: TRANSPORT DATA**

**Proper Shipping Name:** Amines, liquid, corrosive, N.O.S. (aliphatic amines)

**Hazard Class:** Corrosive Material - 8

**Identification Number:** UN 2735

**Packing Group:** III

## **SECTION X: DISCLAIMER**

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## ***Raven 405 Third Party Testing, Evaluations and Municipal Approvals***

### **Third Party Physical Property and Chemical Resistance Testing**

Attached documentation of physical property and coating performance testing from accredited, independent testing laboratories:

Weldon Laboratories, Imperial, PA, Sherry Laboratories, Tulsa, OK, Charter Coating Service Ltd., Calgary, Alberta, KTA-Tator, Inc., Pittsburgh, PA

### **Municipal Product Evaluations**

County Sanitation Districts of Los Angeles County; Evaluation of Protective Coatings for Concrete a.k.a “The Redner Report”, 2004 Final Report (Successful pass as Coating System C-69 at 60 mils)

CIGMAT/UH 98-3 Greater Houston Wastewater Program, City of Houston; Evaluating Raven Lining Systems Product for Coating Wastewater Concrete and Clay Brick Facilities in the City of Houston, May 1993 (Successful pass of application, hydrostatic and chemical exposure testing)

City of Los Angeles; SSPWC Section 210-2.3.3 Chemical Resistance Test a.k.a. “Pickle Jar Test”, 2003 (Successful pass of chemical exposure and subsequent physical property testing)

City of Phoenix/Peoria; City of Phoenix/Peoria Supplement to Maricopa Association of Governments Uniform Standard Specifications (MAG SPEC) Product Approval List, 2008

King County, WA; King County Wastewater Treatment Division Qualification Testing, 2006/2009

### **Municipal Approvals**

City of Austin; City of Austin Water and Wastewater Utility Standards Committee Approval, 1992

Baton Rouge, LA; East Baton Rouge Parish Department of Public Works Approved Materials List, 2008

County of Berkeley, SC; Berkeley County Water and Sanitation Approved List of Manhole Liners

City of Dallas; Dallas Water Utilities Standard Technical Specification for Corrosion Protection Epoxy Liners Approval, 2004



**Raven 405 Municipal Approvals cont'd.**

County of Clark, NV; Clark County Water Reclamation Materials Committee - Approved Materials List, 2009

City of Escondido, CA; Escondido Utilities Approved Materials List – Manhole Lining, 2008

City of Goodyear, AZ; Public Works Department Approved Materials List for Wastewater Collection, 2009

City of Henderson, NV; Department of Utility Services Approved Materials List – Manhole Lining Systems, 2006

City of Houston; Product Approval Committee-Wastewater Subcommittee Approval, 2008

City of Loveland, CO; Water and Wastewater Development Standards Approved Materials List – Manhole Linings, 2007

City of Mesa, AZ; Approved List of Wastewater Manhole Corrosion Protective Coating Systems, 2009

City of Phoenix/Peoria; City of Phoenix/Peoria Supplement to Maricopa Association of Governments Uniform Standard Specifications (MAG SPEC) Product Approval List, 2008

City of San Diego, CA; Metropolitan Wastewater Departments Approved Materials List – Sewer Rehab Products, 2003

City of Virginia Beach; Department of Public Utilities, Engineering Division Product Selection Committee Approval, 2009

**Inclusion in Municipal Standard Specifications**

Charleston, SC  
Charlotte County, FL  
Chandler, AZ  
Humble, TX  
Daphne, AL  
Fayetteville, AR  
Gainesville, FL  
Knoxville, TN  
Lafayette, LA  
Lake Havasu, CA  
Lakehaven, WA

Laredo, TX  
Marina Coast, CA  
Nashville, TN  
Oklahoma City, OK  
Pearland, TX  
Peoria, AZ  
Phoenix, AZ  
Pittsboro, NC  
Port Orange, FL  
Queen Creek, AZ  
Rogers, AR

Roswell, NM  
San Antonio, TX  
Savannah, GA  
Scottsdale, AZ  
Tampa, FL  
Texas DOT, TX  
Thornton, CO  
Tulsa, OK  
Whitehouse, TN  
Yolo County, CA  
Many others...



TESTING TODAY, PROTECTING TOMORROW

WWW.SHERRYLABS.COM

Sherry Laboratories  
3100 North Hemlock Circle  
Broken Arrow, OK 74012-1115

Tel: 918-258-6066  
800-982-8378  
Fax: 918-258-1154

## LABORATORY REPORT

Attn: David Stanley  
Raven Lining Systems  
13105 East 61st Street South, Suite A  
Tulsa, OK 74012

Report No.: 11010341-001-v1  
Date Received: 1/4/2011  
Date Reported: 1/11/2011  
P.O. No.: 316280

Sample Description: P/N: Raven 405  
Specification: Tensile testing per ASTM D638

### Tensile Strength of Plastics per ASTM D638-10

Specimen Preparation: As-Received  
Specimen Type: Type I  
Test Rate, in/min.: 0.2  
Test Temperature, °F: 76°  
Test Humidity, %: 23

Specimen	Thickness, in.	Width, in.	Ultimate Load, lbs.	Tensile Strength, psi	Modulus of Elasticity, psi	Elongation, %
T1	0.098	0.507	431.4	8,680	706,000	1.63
T2	0.097	0.506	427.2	8,710	747,000	1.47
T3	0.101	0.507	409.3	7,990	719,000	2.23
T4	0.098	0.507	393.5	7,920	707,000	1.31
T6	0.098	0.507	426.1	8,580	760,000	1.42
Average	---	---	---	8,380	728,000	1.61

Approved by:

Blake Minton, Nonmetallics Project Leader  
Sherry Laboratories

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## LABORATORY REPORT

Attn: David Stanley  
Raven Lining Systems  
13105 East 61st Street South, Suite A  
Tulsa, OK 74012

Report No.: 11010341-002-v1  
Date Received: 1/4/2011  
Date Reported: 1/11/2011  
P.O. No.: 316280

Sample Description: P/N: Raven 405  
Specification: Compression testing per ASTM D695

### Compression Strength of Plastics per ASTM D695-10

Method of Preparing Specimens: As-Received  
Specimen Type: Cylinder  
Test Rate, in./min.: 0.05  
Test Temperature, °F: 76°  
Test Humidity, %: 24

S/N	Height, in.	Diameter, in.	Max. Load, lbs.	Strength at Break, psi	Modulus of Elasticity, psi
C1	0.991	0.604	5128	17,900	311,000
C2	0.989	0.602	5180	18,200	323,000
C3	0.989	0.604	5179	18,100	320,000
C4	0.990	0.603	5155	18,100	320,000
C5	0.992	0.601	5192	18,300	325,000
Average	---	---	---	18,100	320,000

Approved by:

Blake Mimon, Nonmetallics Project Leader  
Sherry Laboratories

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## LABORATORY REPORT

Attn: David Stanley  
Raven Lining Systems  
13105 East 61st Street South, Suite A  
Tulsa, OK 74012

Report No.: 11010341-003-v1  
Date Received: 1/4/2011  
Date Reported: 1/11/2011  
P.O. No.: 316280

Sample Description: P/N: Raven 405  
Specification: Flexural testing per ASTM D790

### Flexural Properties of Plastics per ASTM D790-10, Procedure A

Specimen Preparation: Molded, As-Received  
Span to Depth Ratio: 16:1  
Test Rate, in./min.: 0.05  
Test Temperature, °F: 76°  
Test Humidity, %: 23

S/N	Thickness, in.	Width, in.	Load, lbs.	Strength at Break, psi	Modulus of Elasticity, psi
F1	0.108	0.505	29.07	12,800	707,000
F2	0.108	0.506	27.07	11,900	689,000
F3	0.111	0.507	34.17	14,200	664,000
F4	0.109	0.508	34.63	14,900	734,000
F5	0.106	0.506	31.37	14,300	724,000
Average	---	---	---	13,600	704,000

Approved by:

Blake Miron, Nonmetallics Project Leader  
Sherry Laboratories

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## COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY

1 Workman Mill Road, Whittier, CA 90601-4998  
ng Address: P.O. Box 4998, Whittier, CA 90607-4998  
phone: (310) 699-7411, FAX: (310) 695-6139

CHARLES W. CARRY  
*Chief Engineer and General Manager*

February 22, 1994

### Evaluation of Raven 405 Epoxy Coating for Concrete Protective Characteristics

Raven Chemicals' Raven 405 epoxy coating system was evaluated for its concrete protective characteristics in the Districts Concrete Coating and Liner Testing facilities in Compton for approximately one year of acid service. The coating system was well bonded to the concrete substrate. No indication of corrosion to the liner or the underlying concrete was observed.

As a result of this evaluation, Raven Chemicals' Raven 405 epoxy coating system will be included as an alternative coating product in specifications that we prepare in the future for concrete coating systems. Information contained in this letter is not for publication or advertisement. No endorsement is intended for this coating system. Prior written approval of the Sanitation Districts is required for any advertisement or promotion that involves this agency.

Thank you for your continued cooperation and interest in the Districts' evaluation program for concrete coatings. If you have any questions or need additional information, please contact Edward Esfandi at (310) 638-1161 ext. 222.

Very truly yours

Charles W. Carry

Edward J. Esfandi  
Senior Engineer

EE:lg

## EVALUATION OF PROTECTIVE COATINGS FOR CONCRETE

December, 2004 Final Report

John A. Redner, Sewerage Departmental Engineer, Randolph P. Hsi, Associate Engineer,  
Edward J. Esfandi, Senior Engineer, Roger Sydney, Civil Engineer, Robin M. Jones,  
Associate Engineer, Donna Won, Senior Engineer, James Andraska, Supervising Civil Engineer

County Sanitation Districts of Los Angeles County, Whittier, California

### SCOPE

This report summarizes the results of a testing program to evaluate protective coatings for concrete conducted by the County Sanitation Districts of Los Angeles County (Districts). The testing was conducted at the Districts' Compton Field Office in the City of Compton. The program started in 1983 and ended in 2004. Results for 96 protective coating and lining system tests are reported.

### INTRODUCTION

Concrete is the most widely used construction material in wastewater collection and treatment systems. Unfortunately, significant corrosion can occur to unprotected concrete when sulfide generation in wastewater is not controlled. Sources of sulfide in wastewater include degradation of sulfur containing organic matter, the microbiological reduction of sulfate or other oxidized forms of sulfur, and unregulated and/or uncontrolled industrial discharges. The construction of regional collection and treatment systems has increased wastewater travel time in collection systems, culminating in anaerobic wastewater and consequently increased sulfide generation. Odors from manholes or wastewater treatment facilities create significant nuisance problems for most agencies. A major cause of odors is hydrogen sulfide, a gas detectable at extremely low concentrations. Hydrogen sulfide is notorious for its toxicity, as well as its ability to corrode a number of materials used in construction of sewers and treatment plants, including concrete. Concrete corrosion is caused by the aerobic microbial oxidation of hydrogen sulfide to sulfuric acid and the subsequent chemical reaction of the acid with the cement binder in the concrete. Most agencies are particularly sensitive to the nuisances created by the odor releases. Many agencies are often unaware of the significant corrosion occurring to their concrete facilities.

The Districts have utilized different types of protective systems in its history to minimize concrete corrosion. In the mid 1920's the use of vitrified clay liner plates in the construction of large poured-in-place concrete sewers and inlet facilities proved unsuccessful. By the mid 1960's many epoxy coating systems were being tried. Inspections documented coating failure wherever exposure to significant sulfuric acid attack occurred, often within just a few years. This same experience was reported in the 1969 Manual of Practice No. 17, Paints and Protective Coatings for Wastewater Treatment Facilities, "... few, if any, coatings have been effective in preventing the corrosion of concrete under highly corrosive conditions..."<sup>1</sup>. A considerable amount of marketing has occurred for high solids, fast cure coating systems. First hand experiences with these coating systems have resulted in widely different opinions from different agencies. One agency reports nothing but success, while another reports nothing but failure. Figures 1A and 1B illustrate the failure that occurred, after only two years of service, to a urethane coating applied to a drop manhole in 1980.



TABLE 1  
Description of Protective Coating Systems Evaluated

CODE NUMBER (Yr tested)	GENERIC TYPE	COATING DESIGNATION	MANUFACTURER
C-67	Epoxy Mortar	Sauereisen-210	Refer to C-34 (Sauereisen)
C-68 (1992)	Polyurea	Structural Seal Polyurea (formerly Sprayseal)	Structural Seal Polyurea Manholes 2652-D North Southport Avenue Chicago, IL 60614
C-69 (1992)	Epoxy Mortar	Raven 405	Refer to C-25 (Raven Lining Systems)
C-70 (1993)	PVC-Liner + Urethane Foam	Linabond Structural Polymer System	Refer to C-35 (Linabond, Inc.)
C-71 (1993)	Urethane	Endura-flex EF1988	Global Eco Technologies P.O. Box 767 Pittsburgh, CA 94565-0767
C-72 (1994)	PVC Liner	Danby PVC Liner	Refer to C-63 (Danby of North America, Inc.)
C-73 (1994)	Fiberglass and PVC Liner	Poly-Triplex Liner	Poly-Triplex Technologies, Inc. 1701 Wynkoop, Suite 250 Denver, CO 80202
C-74 (1994)	Epoxy Mortar	AquataPoxy A-6	Refer to C-25 (formerly from American Chemical Corp.)
C-75 (1994)	Polyurea	ThoRoc IC-2480 and Sonneborn TF30 (formerly Polyquick P300)	Refer to C-2 (Degussa Building Systems, formerly from Willamette Valley Company)
C-76 (1995)	Polymer Concrete	Meyer Polycrrete	Meyer Rohr + Schacht GmbH <a href="http://www.meyer-polycrrete.com/en/">http://www.meyer-polycrrete.com/en/</a>
C-77 (1996)	Polymer Concrete	iNTERpipe (formerly ICOM)	Polymer Pipe Technology, LLC 500 E. Locust, 5 <sup>th</sup> Floor Des Moines, IA 50309
C-78 (1997)	PVC Liner	PVC 500	Roundeau Phelps Ventures 6603 San Leandro Street Oakland, CA 94621
C-79 (1998)	Polyethylene-coated CMP	SRP (Steel Ribbed Polyethylene Pipe)	Pacific Corrugated Pipe Co. P.O. Box 2450 Newport Beach, CA 92658-8972
C-80 (1998)	PVC Liner	Arrow-Lock	Refer to C-56 (Ameron Protective Coatings)
C-81 (1998)	HDPE Liner	Agru Sure Grip	Agru <a href="http://www.agru.at">www.agru.at</a>
C-82 (1999)	HDPE Liner	GSE StudLiner	GSE Lining Technology, Inc. 19103 Gundle Road Houston, TX 77073
C-83 (2000)	GRP Liner	Channeline GRP Liner	Channeline Sewer Systems (N.A.) Inc. 125 Half Mile Road, Suite 200 Red Bank, NJ 07701
C-85 (1999)	Fiberglass and PVC Liner	Multiplexx Liner System	Terre Hill Composites 485 Weaverland Valley Road Terre Hill, PA 17581



TABLE 2  
Application Data - Protective Coating Systems Evaluated

Code No.	Surface Preparation <sup>1</sup>	Surface Repair	Primer	Application Method	Coating Thickness Tank Walls mm (mils)	Coating Thickness Tank Base mm (mils)
C-42	WB	No	Yes	Spray	3.2 (125)	9.6 (375)
C-43	WB	No	No	Spray	3.8 (150)	3.8 (150)
C-44	SB	No	Yes	Spray	3.2 (125)	3.2 (125)
C-45	SB	No	Yes	Trowel	6.4 (250)	9.6 (375)
C-46	CH, WRB	No	Yes	Form	85 (3350)	85 (3350)
C-47	WB	Yes <sup>2</sup>	<sup>3</sup>	Spray	3.8 (150)	3.8 (150)
C-48	SB	No	Yes	Spray	2.3 (90)	2.3 (90)
C-49	SB	No	Yes	Trowel/Brush	3.2 (125)	9.6 (375)
C-50	SB	No	Yes	Trowel	3.2 (125)	9.6 (375)
C-51	SB	No	Yes	Trowel/Brush	1.6 (60)	1.6 (60)
C-52	SB	No	Yes	Spray	3.3 (130)	3.3 (130)
C-53	SB	No	Yes	Trowel	-	-
C-54	SB	Yes	<sup>9</sup>	Spray	1.0 (40)	1.0 (40)
C-55	SB	No	No	Spray	1.6 (60)	1.6 (60)
C-56	WB	No	Yes	Trowel	3.8 (150)	15.9 (625)
C-57	SB	No	Yes	Brush/Roll	1.0 (40)	1.0 (40)
C-58	SB	No	Yes	Shot	12 (480)	25 (1000)
C-59	SB	No	Yes	Form	60 (2400)	60 (2400)
C-60	SB	No	Yes	Spray	2.0 (80)	2.0 (80)
C-61	WB	No	No	Trowel	3.3 (130)	4.0 (160)
C-62	-	No	No	Manufactured liner	2.0 (80)	2.0 (80)
C-63	WB	No	No	Interlocking PVC liner	1.5 (60)	1.5 (60)
C-64	WB	No	Yes	Spray foam and hand lay up of liner	20 (800) Foam 0.8 (30) PVC	20 (800) Foam 0.8 (30) PVC
C-65	-	No	No	Manufactured pipe	-	-
C-66	WB	No	No	Brush	1.5 (60)	1.5 (60)
C-67	WB	No	No	Trowel	2 (80)	3 (120)
C-68	WB	No	No	Spray	1.5 (60)	1.5 (60)
C-69	WB	No	No	Spray	1.5 (60)	1.5 (60)
C-70	SB	No	No	Spray foam and hand lay up of liner	3.2 (125) Foam 0.8 (30) PVC	3.2 (125) Foam 0.8 (30) PVC
C-71	SB	No	No	Spray	10 (400)	10 (400)
C-72	WB	No	No	Interlocking PVC liner	1.5 (60)	1.5 (60)
C-73	WB	No	No	Cured in place	1.5 (60)	2 (80)
C-74	WB	Yes <sup>10</sup>	No	Spray	1.5 (60)	1.5 (60)
C-75	WB	No	No	Spray	2.5 (100)	2.5 (100)
C-76	-	-	-	Manufactured pipe	-	-
C-77	-	-	-	"	-	-
C-78	WB	No	No	Interlocking PVC liner	1.5 (60)	1.5 (60)
C-79	-	-	-	Manufactured pipe	-	-
C-80	SB	No	Yes	Trowel epoxy gel, hot air weld liner	12.7 (500) gel 1.6 (62) PVC	12.7 (500) gel 1.6 (62) PVC



As stated earlier, the objective of the test is to evaluate the coating's application requirements, concrete bonding characteristics, and acid resistance for one full year of acid service. For each coating system evaluated, data was obtained for the exposure time to failure or completion of the test, and in categories dealing with the relative ease or difficulties of application, the acid resistance, and bonding characteristics demonstrated. The following numerical score (rating system) is used to classify the results for ease and speed in interpretation:

1. No application problems; excellent resistance to acid; and good bond to concrete.
2. Some application problems that are attributed to the applicator and not a reflection of a coating material problem; some reaction with the acid, such as a color change or surface sheen change, but no coating failure; and an adequate, but not necessarily tenacious, bond to the concrete substrate. None of these problems are judged to be significant during the evaluation.
3. Significant problems developed during the application or during the evaluation phase; the material did not bond adequately to the concrete, indicating that the coating could not reliably protect the concrete.
4. A failure in the coating system as a result of serious application problems; a reaction of the acid with the coating; or failure of the coating to protect the concrete during the evaluation period.

Two additional abbreviations are also used:

N/E: Not evaluated due to early failure in other categories.

N/A: This category is not applicable to the particular product being tested.

Table 3 contains the evaluation results. Data include: the coating or lining system's code number; the exposure time in days; the assigned numerical score for relative ease of application, acid resistance (concrete protection), and concrete bond; and the total score for each coating system that progressed well into or completed the one year evaluation period. Comments are also included in Table 3 in an effort to pinpoint specific problems and to describe the coating's ability to protect concrete from sulfuric acid attack.

The total score is simply the sum of the category scores. The lower the "application" score, the easier the system is to apply. The lower the "acid resistance" score, the more acid resistant the system is. The lower the "concrete bond" score, the stronger the system bonds to the concrete substrate. The lowest assigned score for each component is one; therefore, the lowest possible total score for a coating system that is assigned a score in all categories is 3, unless one or more of the scores are not applicable to a coating system. For instance, if a liner is applied in the manufacturers' facilities and is subsequently transferred to the Districts' testing facilities, we are unable to score this system for ease of application. Consequently, such a system is not assigned a score for the ease of application category. This may lead to a total score of less than 3. A total score of "Failed" is assigned to those products that either received a total score of 6 or greater, and/or received a score of 3 or 4 in any of the categories.

TABLE 3  
Test Results for Protective Coating Systems Evaluated

Code No.	Exposure Time (Days)	Application	Acid Resistance	Concrete Bond	Total Score	Comments
C-58	539	2	2	3	Failed	Bonding problems in uncorroded surfaces of the test tank.
C-59	539	1	2	3	Failed	Blistering of the coating; coating separated from concrete; bonding problems; pinholes.
C-60	106	4	N/E	33	Failed	Corroded concrete found underneath coating in bottom half of tank; pinholes; separation of coating from concrete.
C-61	393	2	3	1	Failed	Acid penetration.
C-62	369	N/A	1	N/A	1	No problems observed.
C-63	371	2	1	N/A	3	No problems observed.
C-64	414	3	4	2	Failed	Reaction with acid.
C-65	2223	N/A	1	N/A	1	No problems observed.
C-66	375	2	1	2	5	No problems observed.
C-67	369	2	1	1	4	No problems observed.
C-68	385	1	1	2	4	No problems observed.
C-69	375	2	1	1	4	No problems observed.
C-70	365	2	1	1	4	No problems observed.
C-71	365	2	1	1	4	No problems observed.
C-72	394	1	1	N/A	2	No problems observed.
C-73	410	2	2	1	5	Acid penetrated the outer layer of fiberglass. Middle PVC layer prevented acid penetration to concrete.
C-74	463	2	1	2	5	Poor adhesion of the coating to the bottom of the tank. No acid penetration.
C-75	404	1	1	1	3	No problems observed.
C-76	445	N/A	1	N/A	1	No problems observed.
C-77	503	N/A	1	N/A	1	Coupons are acid resistant. Pipe product currently available.
C-78	127	4	N/A	N/A	Failed	Acid penetrated joints above grout level due to faulty installation.
C-79	373	N/A	1	N/A	1	Pipe is corrosion resistant.
C-80	363	1	1	1	3	No problems observed.
C-81	349	1	1	N/A	2	No problems observed.
C-82	369	3	1	2	Failed	Acid penetrated welded joint.
C-83	364	1	1	1	3	No problems observed.
C-85	390	1	4	2	Failed	Acid penetrated liner at seam.
C-86	390	1	4	2	Failed	Acid penetrated liner at seam.
C-87	383	2	1	1	4	Liner not embedded at bottom.
C-88	365	2	2	1	5	Slight discoloration, pinholes but no acid penetration.
C-89	365	1	2	1	4	Slight discoloration.



**TABLE 3**  
**Test Results for Protective Coating Systems Evaluated**

Code No.	Exposure Time (Days)	Application	Acid Resistance	Concrete Bond	Total Score	Comments
C-91	365	2	2	1	5	Poor surface prep at bottom. Liner slightly discolored & sticky.
C-92	370	1	2	2	5	Variable bond. Shallow pinholes, but no acid penetration.
C-93	180	1	4	1	Failed	Corrosion at pinhole. Odorous brown liquid emitted by coating.
C-94	99	2	N/E	3	Failed	20% disbonded in large bubbles.
C-95	430	1	2	1	4	No problems observed except surface discoloration.
C-96	365	3	4	2	Failed	Coating delaminated. Coating over aggregate broke at several locations and allowed concrete corrosion.
C-97	365	1	1	1	3	No problems observed.
C-98	366	1	2	1	4	No problems observed except slight surface discoloration.

**Explanation of Rating System:**

1. No application problems; excellent resistance to acid; and good bond to concrete
2. Some application problems that are attributed to the applicator and not a reflection of a coating material problem; some reaction with the acid, such as a color change or surface sheen change, but no coating failure; and an adequate, but not necessarily tenacious, bond to the concrete substrate. None of these problems are judged to be significant during the evaluation.
3. Significant problems developed during the application or during the evaluation phase; the material did not bond adequately to the concrete, indicating that the coating could not reliably protect the concrete.
4. A failure in the coating system as a result of serious application problems; a reaction of the acid with the coating; or failure of the coating to protect the concrete during the evaluation period.

N/E: Not evaluated due to early failure in other categories.

N/A: This category is not applicable to the particular product being tested.

Failed: A total score of "Failed" is assigned to those products that either received a total score of 6 or greater, and/or received a score of 3 or 4 in any of the categories.



Figure 7 illustrates the coating failure that occurred after only a short time period to one epoxy coating (C-7). Preliminary tests with ingots of one system (C-23) looked promising, but the manufacturer decided to use a non-epoxy coating system in the evaluation. Lack of sufficient acid resistance and inability to protect the concrete from corrosion plagued the other systems (C-14, C-19, and C-21).



Figure 7. Epoxy coating failure.

#### Epoxy Mortar

For the epoxy mortars only 9 of the 16 systems (C-25, C-45, C-49, C-50, C-53, C-67, C-69, C-74, and C-95) survived the test. Most of these successful systems involve the application of a thick, inert material filled version of the coating as an intermediate step prior to application of finish coat with the neat epoxy. Minimum thickness of the intermediate coat is 2.2-3.2 mm (90-125 mils). However, C-95 was installed with two thick coats of the epoxy mortar without the filler due to weather concerns. Other epoxy mortar systems (C-15, C-22, C-41, C-42, C-51, C-56, and C-61) failed mostly due to pinholes and application problems. C-67 was applied by a manufacturer's representative after the same system (C-61) failed after being applied by an inexperienced applicator. C-74 is a later version of C-25. Both C-25 and C-74 made extensive use of a gel or filler version of its coating for surface repair and for plugging bug/pinholes in between applications. C-25 was brush applied while C-74 was spray applied. C-25 had almost no problems while C-74 had poor adhesion to the bottom of the tank with no acid penetration.



## CONCLUSIONS

Most coating manufacturers will point, and in many cases with justification, to application problems as being the cause of coating failure. It is certainly true that surface preparation and conditions under which the coating is applied are extremely critical. It is difficult to determine the reasons why so many coating systems, advertised to provide protection in wastewater industry, have failed in the test facility, but it really is of little consequence. The purpose of the evaluation facility was to provide a non-laboratory environment to evaluate the coatings. To survive the test, a coating system not only had to be acid proof and able to bond to the concrete substrate, but it also had to be applicator friendly. Ideal conditions for applying a protective coating probably never exist in wastewater collection and treatment facilities. Therefore, a successful coating system has to be one that can be applied under less than ideal conditions.

The predominant reason for failure of so many coating systems was the formation of pinholes or blowholes. In general, the mortar or filler extended coating systems had dramatic improvements in their survival rates versus their parent neat systems. The predominant reason for failure of the lining systems were poor bonding of the liner at the seams. The predominant reason for failure of the specialty concretes was insufficient acid resistance.

The purpose of this evaluation program was to develop a list of suitable coatings and specifications for application of the coatings. The program has fulfilled that purpose to some extent. Table 4 is a list of 39 coating systems that have successfully completed this test. Only successful coating systems that were assigned a score equal to or less than 5 are listed in Table 4. The successful coating systems include: one coal tar mortar (C-37); five epoxies (C-28, C-66, C-88, C-89, and C-97); nine epoxy mortars (C-25, C-45, C-49, C-50, C-53, C-67, C-69, C-74, and C-95); thirteen liners (C-40, C-62, C-63, C-70, C-72, C-73, C-79, C-80, C-81, C-83, C-87, C-91, and C-98); two polyester mortars (C-17 and C-44); two polyureas (C-68 and C-75); three specialty concretes (C-65, C-76 and C-77); three urethanes (C-10, C-71, and C-92); and one vinyl ester mortar (C-38).

The information developed should be of some assistance, but as previously indicated, does not address gas permeability and subsurface microbial acid generation<sup>3</sup>. When attempting to select a coating, don't be satisfied to deal with the manufacturer's sales representative alone. Contact the manufacturer directly and be sure to explain fully the conditions under which the coating will be applied and the environment it has to withstand. Don't hesitate to ask for a list of applications and consult with the owners, as well as the applicators. If application projects are inspected, try to categorize the applications by the exposure level to hydrogen sulfide. Never assume that a coating system that has performed well has been exposed to corrosive conditions unless you can substantiate it. It is recommended that only coatings with total scores of 5 or less be considered for corrosive environments (see Table 3 and 4).

It is suggested that coating manufacturers, recognized testing agencies, or technical organizations consider the development and use of an accelerated evaluation technique to screen coatings for application in the wastewater field. With such a technique, the advances in coating technology can be evaluated by the end user. A testing chamber and procedure was developed by Tnemec Company, Inc. that includes evaluation of permeability properties<sup>3</sup>.

**TABLE 4**  
**Successful Protective Coating Systems**

<b>CODE NUMBER</b>	<b>COATING DESIGNATION</b>	<b>TOTAL SCORE</b>	<b>MANUFACTURER</b>
C-67	Sauereisen-210	4	Sauereisen 160 Gamma Drive Pittsburgh, PA 15238 (412) 963-0303
C-69	Raven 405	4	Raven Lining Systems 1024 N. Lansing Avenue Tulsa, OK 74106 (800) 324-2810
C-74	A-6 AquataPoxy	5	Raven Lining Systems 1024 N. Lansing Avenue Tulsa, OK 74106 (800) 324-2810
C-95	Tnemec Series 434 Chembloc	4	Tnemec Company inc. 6800 Corporate Drive Kansas City, MO 64120-1372 (800) TNE MEC1
Generic Type – Liner Systems			
C-40	Linabond Mastic System (PVC)	4	Linabond, Inc 12960 Bradley Avenue Sylmar, CA 91342 (818) 362-7373
C-62	Con-plast Plastic Liner System	1 <sup>2</sup>	Southwest Concrete Products 519 S. Benson Avenue Ontario, CA 91762-4002 (909) 983-9789
C-63	Danby PVC Liner	3 <sup>1</sup>	Danby of North America, Inc. P.O. Box 5127 Cary, NC 27512-5127 (919) 467-7799
C-70	Linabond Structural Polymer System (PVC and polymer)	4	Linabond, Inc 12960 Bradley Avenue Sylmar, CA 91342 (818) 362-7373
C-72	Danby PVC Liner	2 <sup>1</sup>	Danby of North America, Inc. P.O. Box 5127 Cary, NC 27512-5127 (919) 467-7799
C-73	Poly-Triplex Liner (PVC and fiberglass)	5	Poly-Triplex Technologies, Inc. 1701 Wynkoop, Suite 250 Denver, CO 80202 (303) 893-3100
C-79	SRP (Polyethylene-coated CMP)	1 <sup>2</sup>	Pacific Corrugated Pipe Co. P.O. Box 2450 Newport Beach, CA 92658-8972 (949) 650-4555



#### Acknowledgments and Credits:

This paper was presented at the Water Environment Federations National Conferences in Los Angeles (1986) and Philadelphia (1987), at the California Water Pollution Control Association Annual Conference in Sacramento (1987), at the National Conference and Exposition of the Steel Structures Painting Council in Baltimore (1988) and in Long Beach (1991). Credit is given to all the coating manufacturers who not only agreed to submit their coatings for evaluation, but arranged for the installation of the coating system.

#### Authors

John A. Redner was the Sewerage Departmental Engineer, Randolph P. Hsi was an Associate Engineer, Edward J. Esfandi was a Senior Engineer, Roger Sydney was a Civil Engineer, Robin M. Jones was an Associate Engineer, Donna Won is a Senior Engineer, and James Andraska is a Supervising Civil Engineer of the County Sanitation Districts of Los Angeles County. Correspondence may be addressed to Mr. Andraska at 24501 S. Figueroa Street, Carson, CA 90745, or by email at [jandraska@lacsdsd.org](mailto:jandraska@lacsdsd.org).

## References

1. "Paints and Protective Coatings for Wastewater Treatment Facilities," WPCF Manual of Practice No. 17, Water Pollution Control Federation, Washington, D.C., 1969.
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Ms. Joanne Hughes  
Raven Linings  
13105 East 61<sup>st</sup> St., Suite A  
Broken Arrow, OK 74012

April 26, 2007  
Project J06137

Fax 918-615-0140

Subject -- Immersion Testing of Raven 405

Dear Ms. Hughes,

In accordance with your request, Weldon Laboratories, Inc. has performed immersion testing of several samples of concrete which were coated with Raven 405. The coated samples were rectangular and measured approximately 1  $\frac{3}{4}$ " x 1  $\frac{3}{4}$ " x 5  $\frac{3}{4}$ ". They were received on August 28, 2006.

The testing involved weighing the samples, and subsequently immersing them halfway in the following reagents:

Deionized water  
10% sulfuric acid  
30% sulfuric acid  
Grease (Crisco shortening)  
10% detergent (Tide)  
Gasoline

The specimen placed in gasoline was exposed for 7 days, with visual inspections on weekdays. The other specimens were exposed for 6 months, with visual inspections every month. At the end of the testing, the samples were weighed again, and also tested for adhesion (ASTM D 4541) using a Defelsko Positester.

Initially, problems were encountered with glue failures on some samples during the adhesion testing, and in the course of the testing it was found that glue failures could be eliminated if scoring was performed around the dollies. Therefore, some of the adhesion testing was repeated, after first scoring around the dollies. As the data in the following tables show, in every case the failures occurred in the concrete, but those dollies which were scored tended to exhibit substantially lower values than those which were not scored.

The test results are shown in the attached tables.

If you have any questions or comments, please do not hesitate to contact this office.

Sincerely,  
Dwight G. Weldon, President

**Table #1 – 6 Month Testing of Raven 405**

Property	DI Water	10% H <sub>2</sub> SO <sub>4</sub>	30% H <sub>2</sub> SO <sub>4</sub>	Grease	10% detergent	Unexposed control
Initial weight	627.7g	645.8g	642.5g	627.6g	651.0g	n/a
Final (6 month) weight	627.9g	646.2g	642.8	627.5g	651.2g	n/a
1 month	No visual effect	No visual effect	No visual effect	No visual effect	No visual effect	n/a
2 months	No visual effect	No visual effect	No visual effect	No visual effect	No visual effect	n/a
3 months	No visual effect	No visual effect	No visual effect	No visual effect	No visual effect	n/a
4 months	No visual effect	No visual effect	No visual effect	No visual effect	No visual effect	n/a
5 months	No visual effect	No visual effect	No visual effect	No visual effect	No visual effect	n/a
6 months	No visual effect	Very faint discoloration	Very faint discoloration	No visual effect	No visual effect	n/a
Adhesion, immersion	1590psi, failure in concrete	1510psi, failure in concrete	1600psi, failure in concrete	1280psi, failure in concrete	800psi, failure in concrete	1050psi, failure in concrete
Adhesion, vapor phase	1470psi, failure in concrete	900psi, failure in concrete	1060psi, failure in concrete	1800psi, failure in concrete	640psi, failure in concrete	1140psi, failure in concrete

**Table #2 – 1 Week Testing of Raven 405 in Gasoline**

Property	Result
Initial weight	589.4g
1 day	No visual effect
2 days	No visual effect
3 days	No visual effect
5 days	No visual effect
6 days	No visual effect
One week, plus final weight	No visual effect, final wt. = 589.4g
Adhesion, immersion	1260 psi, failure in concrete
Adhesion, vapor phase	900 psi, failure in concrete



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CITY ENGINEER

650 SOUTH SPRING ST., SUITE 200  
LOS ANGELES, CA 90014-1911

April 30, 2003

Joanne Hughes, Vice President  
Raven Lining Systems  
1024 North Lansing  
Tulsa, Oklahoma 74106

Dear Ms. Hughes:

Re: **CHEMICAL RESISTANCE TESTING OF RAVEN 405 EPOXY LINING**

Attached is Lab No. 2003-514-91, dated April 10, 2003, showing the results of chemical resistance testing for the above maintenance hole product. The lining system responded to chemical exposure as follows:

*Weight change: Excellent*

*Hardness change: Excellent*

*Tensile strength change: Excellent*

*Elongation: Satisfactory, with reactions to sulfuric acid, nitric acid, ferric chloride, detergent, biological and bleach exposures and a notable reaction to sodium hydroxide and ammonium hydroxide exposures.*

The lining system is identified as follows:

*Trade Name: Raven 405*

*Approved Use: Sanitary Sewer Maintenance Rehabilitation*

*Installation: SSPWC Section 500-2 as modified by City of Los Angeles Brownbook*

*Resin: Blue-colored solid epoxy*

The overall summary is that this material passed SSPWC Section 210-2.3 Chemical Resistance Test. To complete the evaluation process, a trail demonstration must be arranged where we may observe and verify an installation of the system. If you have any questions, please call me at (213)847-8776.

Sincerely,

Hugh S. Lee, Group Manager  
Design Standards and Investigations Group  
650 S. Spring Street, Suite 400  
Los Angeles, California 90014-1913

HSL:hl/raven4.wpd

Attachment (Lab No. 2003-514-91)

Chemical Resistance Test of  
Raven Lining Systems  
Raven 405 Blue  
Epoxy Resin

Project Title: Maintenance Shaft & Sewer Rehabilitation  
 Project Number: BD001748  
 Engineer: Hugh Lee  
 Source: Raven Lining Systems  
 Date Received: 10/16/2002  
 Specification: SSPWC 210-2.3.3, 1997  
 Description: Raven 405 Blue Epoxy Resin

SOLUTION	RESULTS CONDITIONED WEIGHT CHANGE % maximum				REQUIREMENTS CONDITIONED WEIGHT CHANGE %
	Days Immersion				
	28	56	84	112	
Sulfuric Acid, 20%	0.2239	0.3685	0.6617	0.6543	All Solutions  and Periods  ± 1.5% max
Sodium Hydroxide, 5%	-0.0435	0.0532	0.1263	0.1700	
Ammonium Hydroxide, 5%	0.0231	0.1234	0.2410	0.2754	
Nitric Acid, 1%	0.0706	0.1708	0.3070	0.3531	
Ferric Chloride, 1%	0.0382	0.1305	0.2120	0.2824	
Soap, 0.1%	0.0351	0.1289	0.2087	0.2865	
Detergent, 0.1%	0.0222	0.1260	0.2322	0.2694	
BOD, ≥ 700ppm	0.0230	0.1314	0.2179	0.2889	
Bleach, 1%	-0.0580	-0.0988	-0.3358	0.2835	
Sodium Hydroxide Buffer to PH 10	0.0203	0.1313	0.2182	0.2703	



Chemical Resistance Test of  
Raven Lining Systems  
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 Date Received: 10/16/2002  
 Specification: SSPWC 210-2.3.3, 1997  
 Description: Raven 405 Blue Epoxy Resin

SOLUTION	RESULTS	REQUIREMENTS
	CONDITIONED	
	HARDNESS CHANGE maximum 112 Days Immersion	
Sulfuric Acid, 20%	1	For  Information  Only
Sodium Hydroxide, 5%	1	
Ammonium Hydroxide, 5%	2	
Nitric Acid, 1%	2	
Ferric Chloride, 1%	1	
Soap, 0.1%	-1	
Detergent, 0.1%	-3	
BOD, $\geq$ 700ppm	2	
Bleach, 1%	-1	
Sodium Hydroxide Buffer to PH 10	-1	
PHYSICAL PROPERTY	INITIAL RESULTS	
Hardness, Shore "D" ASTM D2240	85	For Information Only

Chemical Resistance Test of  
Raven Lining Systems  
Raven 405 Blue  
Epoxy Resin

Project Title: Maintenance Shaft & Sewer Rehabilitation  
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 Engineer: Hugh Lee  
 Source: Raven Lining Systems  
 Date Received: 10/16/2002  
 Specification: SSPWC 210-2.3.3, 1997  
 Description: Raven 405 Blue Epoxy Resin

SOLUTION	RESULTS		REQUIREMENTS
	Tensile Strength, psi	Elongation %	
	112 Days Immersion		
<i>Sulfuric Acid, 20%, Type I</i>	8,974	1.7	For  Information  Only
<i>Sodium Hydroxide, 5%, Type I</i>	8,752	2.1	
<i>Ammonium Hydroxide, 5%, Type I</i>	8,428	1.8	
<i>Nitric Acid, 1%, Type I</i>	8,698	1.7	
<i>Ferric Chloride, 1%, Type I</i>	8,907	1.8	
<i>Soap, 0.1%, Type I</i>	8,615	1.6	
<i>Detergent, 0.1%, Type I</i>	8,568	1.7	
<i>BOD, <math>\geq</math> 700ppm, Type I</i>	8,668	1.7	
<i>Bleach, 1%, Type I</i>	8,395	1.7	
<i>Sodium Hydroxide Buffer to PH 10, Type I</i>	8,540	1.7	
PHYSICAL PROPERTIES	INITIAL RESULTS		
<i>Initial Tensile Strength, psi</i>	9,034		For Information  Only
<i>Initial Elongation, %</i>	1.5		

## Chemical Resistance



Raven 405 coating has been immersion tested for a minimum of six (6) months according to ASTM D543 (modified) Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents. The results indicate classification of Raven 405 as being suitable for constant immersion duty in the following reagents:

- Water
- Nitric Acid, 5%
- Phosphoric Acid, 10%
- Sulfuric Acid, 20%
- Sodium Hydroxide, 10%
- Unleaded Gasoline
- Vegetable Oil
- Detergent Solution, 0.1%
- Soap Solution, 0.1%

During the course of testing, none of the specimens exhibited weight loss, spalling, cracking or blistering. Immersion samples are “free” coatings without concrete or brick substrates, immersing over twice the area that would normally see service. Color change was a very slight orange surface coloration for the sample immersed in Nitric Acid and a slight darkening of the sample immersed in the Sulfuric Acid. No degradation was experienced.

For additional chemical resistance performance of Raven 405, see the Raven Chemical Resistance Chart or contact Raven with project details at 800-324-2810.





Ms. Joanne Hughes  
Raven Linings  
13105 East 61<sup>st</sup> St., Suite A  
Broken Arrow, OK 74012

April 26, 2007  
Project J06137

Fax 918-615-0140

Subject – Immersion Testing of Raven 405

Dear Ms. Hughes,

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10% sulfuric acid  
30% sulfuric acid  
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The test results are shown in the attached tables.

If you have any questions or comments, please do not hesitate to contact this office.

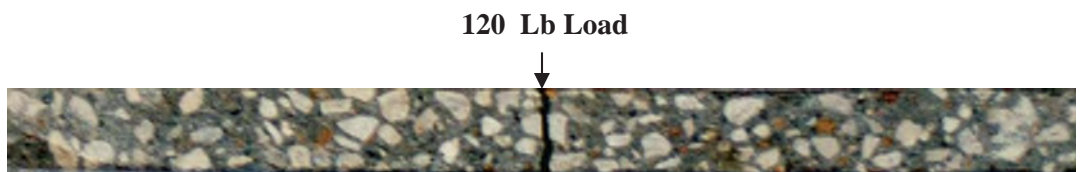
Sincerely,  
Dwight G. Weldon, President



## Flexural Strength Enhancement of Concrete Substrate

The additional flexural strength imparted to a concrete substrate via the application of an adhered high performance 100% solids epoxy is demonstrated by testing standard concrete with varying thickness of coating applied. As a baseline an uncoated sample was also tested. The results show that Raven 405 High Build Epoxy coating at 80 mils imparts a load capacity equal to three times that of bare concrete. The lateral deflection of the failure plane exhibits how adhesion of the coating distributes load thus enhancing the performance of the composite system. The total deflection at point of failure was also increased an average of 288%. At typical application thickness, Raven 405 can dramatically reinforce new or deteriorated substrates while also providing high levels of chemical resistance.

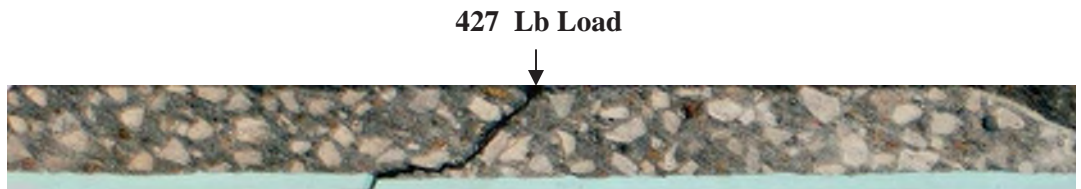
**Uncoated Concrete  
Failure at 120 Lbs  
Deflection of 0.013"**



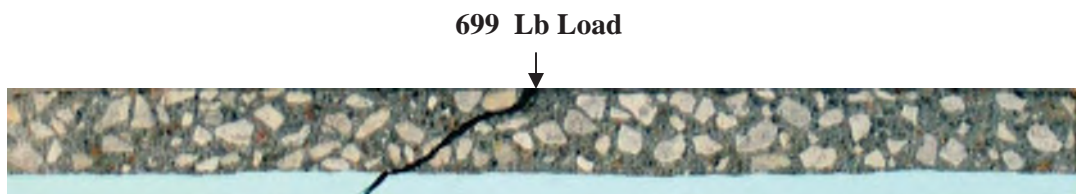
**Concrete w/80 mils  
Failure at 366 Lbs  
Deflection of 0.051"**



**Concrete w/125 mils  
Failure at 427 Lbs  
Deflection of 0.051"**



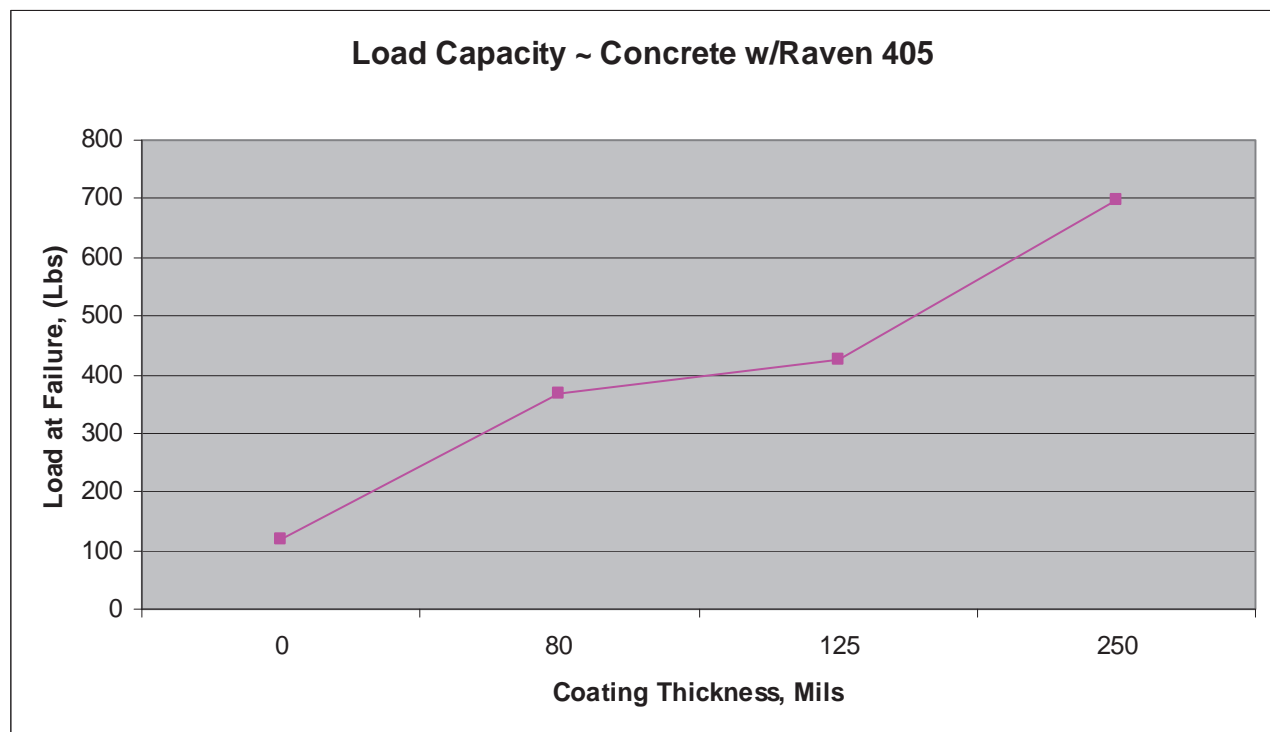
**Concrete w/250 mils  
Failure at 699 Lbs  
Deflection of 0.048"**





## Flexural Strength Enhancement of Concrete Substrate

Coating Thickness, mils (.001")	Average Load at Failure, Lbs	% Increase Load Capacity	Average Deflection, Inches	% Increase Deflection
0	120	-	0.013	-
80	366	205%	0.051	295%
125	427	256%	0.051	294%
250	699	483%	0.048	274%



*Testing performed according to ASTM test method by an independent testing laboratory.*

*Concrete samples cast in approximate 1" x 1" x 10" samples.*

*Coating spray applied via airless spray. Certified test results available upon request.*



## RAVEN 405 Ultra High-Build Epoxy vs. SPRAYROQ SprayWall

Standard	Methodology	Raven 405	SprayWall
<b>Tensile Strength</b>	ASTM D 638	7,600 psi	7,450 psi
<b>Flexural Strength</b>	ASTM D 790	13,000 psi	14,000 psi
<b>Flexural Modulus</b>	ASTM D 790	787,000 psi	735,000 psi
<b>Compressive Strength</b>	ASTM D 695	18,000 psi	18,000 psi
<b>Bond Strength to Concrete</b>	ASTM D 882	Concrete Fails	Concrete Fails
<b>Chemical Resistance</b>		Up to 50% Sulfuric Acid	Up to 40% Sulfuric Acid
	Both are well suited for municipal wastewater environments		
<b>Isocyanates</b>		No	Yes
<b>Fresh Air Req'd for CSE</b>		No	Yes
<b>Product Type</b>		Epoxy-Amine Cured	Polyurethane
<b>VOC's / % Solids</b>		0 / 100 % solids	0 / 100 % solids

Sprayroq markets SprayWall as a structural liner without reliance on a bond to the substrate. Abrasive blasting is preferred for surface preparation, evidently due to Spray Wall's intolerance to moisture. Raven utilizes high-pressure water blasting or abrasive blasting to prepare the manhole surfaces and can apply directly to concrete containing moderate amounts of moisture. Both products require the stoppage of active leaks prior to application.

Raven products such as Raven 405 deliver moisture tolerant bonding to cold, damp surfaces generally found in underground structures. Raven epoxies also exhibit better chemical and temperature resistance than typical urethane products. Both Raven 405 and SprayWall have the ability to improve the structural integrity of a structure if completely bonded to the host structure by applying their products at thicknesses from 125 mil to 250 mils in a single application. Raven and SprayWall offer premium long-term solutions for manhole rehabilitation/protection. However, due to constraining characteristics of SprayWall, it is consistently specified at thicknesses greater than necessary for reconstruction and requires completely *dry* surfaces for application.

## Raven Lining Systems – Standard Warranty Info.

We warrant that our products are manufactured correctly and suitable for the recommended services application. The installation of the coating must be warranted by the Certified installer. Joint product (by Raven) and installation (by the applicator) warranties are available on a case by case basis for 5 years or more.

**Warranty and Disclaimer:** Raven Lining Systems, Inc. (“Raven”) warrants its products to be free of manufacturing defects in accord with applicable Raven quality control procedures and that they meet the formulation standards of Raven. To the best of our knowledge the technical data contained herein is true and accurate on the date of publication and is subject to change without prior notice. If, within one year from purchase, any product is proven defective, Raven, at its sole option, will either replace the defective product or refund the purchase price. This warranty is void if the product is used contrary to Raven’s written directions.

**THE AFORESAID IS THE EXCLUSIVE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES SHALL RAVEN BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OR FOR LOST PROFITS.**

# DON CALVERT PAINTING & SPECIAL COATINGS

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## EXPERIENCE

8- 1980 – 4- 2019

**OWNER,**

I have been the owner of the company since it's inception. I started doing small commercial & custom homes, then moving forward to industrial and large commercial. At present it is mostly industrial coatings and abrasive and hydro blasting. We have worked in the waste and culinary water, and oil and gas pipeline industries for the past thirty years. All equipment is owned and operated by the company. All employees are trained & certified in SAFETY, CONFINED SPACE, LOCK OUT TAG OUT, FALL PROTECTION, AERIAL LIFTS & FORK LIFTS. We have been certified in H2s gas, chlorine gas, lead base paint removal, evaluator's for Veriforce, members of ISNET & NCMS.

8-1980 – 4-2019

**OWNER,** DON CALVERT PAINTING & SPECIAL COATINGS LLC

CEO, CFO

## EDUCATION

MAY 1977

**HIGH SCHOOL GRADUATE, KEARNS HIGH SCHOOL**

**GRADUTED WITH A 3.78 GPA & IN THE TOP 5% OF MY CLASS**

**HAD FULL RIDE SCHOLARSHIPS FOR WRESTLING, AND PARTIAL SCHOLARSHIPS FOR ACADEMIC, & CHEERLEADING . WAS THE VICE PRESIDENT OF MY JUNIOR HIGH SCHOOL.**

## SKILLS

- Waste water plants
- Man holes
- Lift stations
- Transfer vaults
- Regulator vaults
- Pipe linings
- Abrasive blasting & hydro blasting
- Chemical plants
- Natural gas pipeline & facilities
- Oil and gas plants and pipeline
- Tanks
- Buildings

- Tank linings
- Floors
- Welding & fabrication

- Bridges
- Power & light poles

## **ACTIVITIES**

Hunting, fishing, camping, outdoor sports, & traveling.

## **APPENDIX C**

### **SprayWall Specifications**

Over 1 Million SprayWall® Installations Since 1990

# SprayWall®

## SPECIFICATIONS

***SPRAYROQ***®  
Structural Protective  
LINING SYSTEMS

**Public safety is endangered by aging water, sewer and industrial infrastructure that is decaying.** SprayWall® self-priming polyurethane lining from Sprayroq® Inc. restores structural integrity and provides superior corrosion resistance.

**Avoid costly flow disruption with the quickest return-to-service and longest-lasting polymeric solution in the industry.**



Est. 1990

# Welcome to Sprayroq!



The coatings industry has heated up dramatically around the concept of spray applicator linings being truly “structural”. Many products on the market are clearly *not* structural. SprayWall® polyurethane lining system is third party tested and verified as 100% structural! This makes my mission as GM a real pleasure — *simply sharing a phenomenal product with good folks like you!*

Sprayroq® has become a trusted “structural rehabilitation” industry advisor. After more than 30 years and one million SprayWall® installations, Sprayroq® has the credentials, leadership, and professional applicators equipped for manhole, lift station, corrugated metal pipe, box culvert, large tank structure rehabilitation, *and much more.*

With so many underground assets in decay and in danger of catastrophic failure, our mission is to connect in an advisory role with decision-makers of DOT, cities, and municipalities nationwide.

**Thank you for submitting your contact information!** We will promptly send you more resources and a SprayWall® sample. I look forward to collaborating and connecting you with our expert engineers here at Sprayroq®.

**PS: Examine the SprayWall® specifications.** We'll connect and send you more resources to compare SprayWall® as the quickest return-to-service, long-term strength, and the best ROI in the industry.

**Jeremy Huckaby**



**Sprayroq, Inc.**  
General Manager



# TECHNICAL REQUIREMENTS AND SPECIFICATIONS

## REHABILITATION OF CONCRETE, METAL AND MASONRY STRUCTURES WITH A PROTECTIVE LINING FOR STRUCTURAL OR CORROSION PROTECTION

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### FOREWORD

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This specification covers work, materials and equipment required for protecting and/or rehabilitating concrete, metal and masonry structures and other underground vaults by monolithic spray-application of a high-build, rigid and solvent-free polyurethane coating to eliminate infiltration, provide corrosion protection, repair voids and enhance structural integrity as required. Procedures for surface preparation, cleaning, application and testing are described herein.

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### PART 1 - GENERAL

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#### 1.01 SECTION INCLUDES

- A. Requirements for surface preparation, repairs and solvent-free rigid polyurethane material application to specified surfaces.

#### 1.02 RELATED SECTIONS

- A. Concrete Repair.
- B. Environmental, Health and Safety.

#### 1.03 REFERENCES

- A. ASTM D638 - Tensile Properties of Plastics.
- B. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
- C. ASTM D695 - Compressive Properties of Rigid Plastics.
- D. ASTM D 7234 (Concrete) - Pull-off Strength of Coatings Using a Portable  
ASTM D 4541 (Steel) Adhesion Tester.
- E. ASTM D2584 - Volatile Matter Content.
- F. ASTM D2240 - Durometer Hardness, Type D.

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- G. ASTM D543 - Resistance of Plastics to Chemical Reagents.
- H. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
- I. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
- J. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- K. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
- L. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
- M. Los Angeles County Sanitation District – Evaluation of Protective Coatings for Concrete.
- N. ASTM F1216 (Including Appendix XI-X7): Design Parameters for Buried Structures (structural rehabilitation) utilizing the External Buckling Equation for thickness determination.
- O. ASTM D2990: Test Methods for Tensile, Compressive and Flexural Creep and Creep Rupture in Plastics
- P. SSPWC 210-2.3.3 - Chemical resistance testing published in the Standard Specifications for Public Works Construction, 1997 edition (otherwise known as “The Greenbook”).
- Q. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.

#### 1.04 SUBMITTALS

- A. The following items shall be submitted:
  - 1. Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
  - 2. Safety Data Sheets (SDS) for each product used.
  - 3. Project specific guidelines and recommendations.
  - 4. Applicator Qualifications:
    - a. Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used. Certification letter shall be dated within six months of bid date.

- b. The Manufacturer shall provide four (4) references which demonstrate previous successful projects completed for the specified structural protective coating system or comparable, during the last two (2) years.
- c. Certification that the equipment to be used for applying the products has been manufactured or approved by the protective coating manufacturer and Applicator personnel have been trained and certified for proper use of the equipment. Certification letter shall be dated within six months of bid date.
- d. Proof of any necessary federal, state or local permits or licenses necessary for the project.

## 5. Structural Design:

- a. Third party testing verifying the short term Modulus of Elasticity used on this project, minimum of 700,000 psi.
- b. Third party testing verifying long term Flexural Modulus of Elasticity, minimum of 350,000 psi. This third party testing will verify the long term reduction factor (Creep Analysis) of a minimum of 50%. This long term reduction factor verification shall be conducted utilizing ASTM D2990-01 via a third party, independently certified laboratory.

## 1.05 Design Conditions

The following design conditions shall be assumed for all structures being rehabilitated with the approved resin system:

<u>Parameter</u>	<u>Design Requirement</u>
1. Structure Condition	Partially/Fully Deteriorated, based on condition of the existing structure.
2. Design Thickness	ASTM 1216-09 or Two Way Flat Wall Beam Analysis
3. Ovality	Not greater than 5%
4. Soil Load	120 lbs/cu. ft.
5. Traffic Load	AASHTO-HS-20-44 Highway
6. Soil Modulus	>500 psi.<1000 psi.
7. Safety Factor	2.0
8. Soil Cover	Distance from grade to crown of conduit
9. Water Table	Distance from invert to water table

Wall thickness design calculations for each structure to be rehabilitated utilizing the specified resin technology systems must be submitted with all qualified bids, along with supporting formulas that

document that version of formula used. Additionally, product specific strength values, including the short term flexural modulus and the long term flexural modulus strength, must be substantiated by third party testing which will be submitted with all qualified bids. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long term test with respect to the initial flexural modulus and the long term reduction factor used in design.

## **1.06 QUALITY ASSURANCE**

- A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE and SSPC standards and the protective coating manufacturer's recommendations.
- B. (OPTIONAL) A NACE Certified Coating Inspector shall be provided by Owner. The Inspector will observe surface preparation, application and material handling procedures to ensure adherence to the specifications.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Materials are to be kept dry, protected from weather and stored under cover.
- B. Protective coating materials are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.
- C. Protective coating materials are to be handled according to their safety data sheets.

## **1.08 SITE CONDITIONS**

- A. Applicator shall conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- B. Method statements and design procedures are to be provided by Owner when confined space entry, flow diversion or bypass is necessary in order for Applicator to perform the specified work.

## **1.09 WARRANTY**

- A. Applicator shall warrant all work against defects in materials and workmanship for a period of three (3) years, unless otherwise noted, from the date of final acceptance of the project. Applicator shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said three (3) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner.

## PART 2 - PRODUCTS

### 2.01 EXISTING PRODUCTS

- A. Standard Portland cement or new concrete (not quick setting high strength cement) must be well cured prior to application of the protective coating. Generally, 28 days is adequate cure time for standard Portland. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. Engineer may require pull tests to determine suitability of concrete or metal for coating)
- B. Cementitious patching and repair materials should not be used unless their manufacturer provides information as to its suitability and procedures for topcoating with the approved coating. Project specific submittals should be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the approved coating.
- C. Remove existing coatings prior to application of the new protective coating. Applicator is to maintain strict adherence to applicable NACE and SSPC recommendations with regard to proper surface preparation and compatibility with existing coatings.

### 2.02 MANUFACTURER

- A. Sprayroq, Inc. or Approved Equal.

### 2.03 REPAIR MATERIALS

- A. Repair materials shall be used to; fill voids, bugholes, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the engineer and protective coating applicator. Repair materials must be compatible with the specified coating and shall be applied in accordance with the manufacturer's recommendations.
- B. The following products may be accepted and approved as compatible repair basecoat materials for approved topcoating for use within the specifications:
  - 1. 100% solids, solvent-free grout specifically formulated for approved topcoating compatibility. The grout manufacturer shall provide instructions for trowel or spray application and for approved topcoating procedures.
  - 2. Factory blended, rapid setting, high early strength, non-shrink cementitious or epoxy repair mortar that can be trowelled or pneumatically spray applied may be approved if specifically formulated to be suitable for approved topcoating. Such repair mortars should not be used unless their manufacturer provides information as to its suitability

for topcoating with the approved topcoating. Project specific submittals should be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the approved coating.

3. In the case of excessive infiltration, a hydraulic cement or plug may be used to stop the flow of the infiltration. Approved manufacturer's include Strong, or approved equal. The hydraulic cement shall be compatible with the spray applied resin coating.

#### 1.04 PROTECTIVE COATING MATERIAL

- A. The resin based material shall be used to form the sprayed structurally enhanced monolithic liner covering all interior surfaces of the structure, including benches and inverts of manholes. The finished liner shall be 100% Solids polyurethane and conform to the minimum physical requirements listed below. The physical requirements must be verified by an independent, certified, third party testing laboratory within the last five years and **must be submitted with the bid package. Any bid package not including the verifiable, independent third party testing shall be ruled non-responsive and will be rejected.**

<b>Compressive strength:</b>	ASTM D 695	> 15,000 psi
<b>Tensile strength:</b>	ASTM D 638	> 7,450 psi
<b>Bond (Concrete):</b>	ASTM D7234 Or Substrate Failure	> 200 psi
<b>Bond (Steel):</b>	ASTM D4541	> 1,200 psi
<b>Flexural Modulus (Initial):</b>	ASTM D 790	> 700,000 psi
<b>Flexural Modulus (Long Term):</b>	ASTM D 2990	> 350,000 psi
<b>Density:</b>		87 ± pcf
<b>Chemical Resistance:</b>	ASTM D543	
<b>Severe Municipal Sewer:</b>	All types of service	
<b>Successful Pass:</b>	Sanitation District of L.A. County Coating Evaluation Study or SSPWC 211-2	

- B. When the wall of the resin based liner is to be structurally designed to withstand the hydraulic load generated by the groundwater table the long term (50yr) value of the flexural modulus of elasticity will be utilized to calculate the thickness of the structural liner. The initial flexural modulus of elasticity (short term) of the submitted resin material will be utilized with the long term deformation percentage as determined by ASTM D2990 (see below) in the design equations outlined in ASTM 1216-09, Appendix X1-X7 (Circular Geometries) or Flat Wall Beam Analysis for walled structures. No adhesion to the substrate is assumed in structural calculations. The value of the long term flexural modulus of the proposed product will be certified by an independent, certified, third party testing lab, independent of the Manufacturer and submitted

with the bid package. **[The definition of long term value will be identified as initial flexural modulus of elasticity less the reduction in value caused by Creep over a fifty (50) year minimum period and verified by third party DMA testing (ASTM D2990).]** All design submittals will include this certified third party DMA testing (ASTM D2990) value in their respective design calculations for each structure being rehabilitated.

- C. When groundwater loading is not an issue and only a corrosion barrier is required, the rehabilitation lining shall be installed to the thickness necessary to qualify as a monolithic (void free) liner. The roughness of the substrate will dictate the thickness needed to create the monolithic liner and eliminate any opportunity for voids in the lining. The minimum value for coating thickness for corrosion protection for non-structural rehabilitation shall be 125 mils and structural shall be a minimum 250 mils.

## **2.05 PROTECTIVE COATING APPLICATION EQUIPMENT**

- A. Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective coating.

## **2.06 REPAIR MORTAR SPRAY APPLICATION EQUIPMENT (if spray applied)**

- A. Spray applied repair mortars shall be applied with manufacturer approved equipment.

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# **PART 3 - EXECUTION**

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## **3.01 ACCEPTABLE APPLICATORS**

- A. Repair mortar applicators shall be trained to properly apply the cementitious mortar according to manufacturer's recommendations.
- B. Protective coating must be applied by a Certified Applicator of the protective coating manufacturer and according to manufacturer specifications.

## **3.02 EXAMINATION**

- A. All structures to be coated shall be readily accessible to Applicator.
- B. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.
- C. Any active flows shall be dammed, plugged or diverted as required to ensure that the liquid flow is maintained below the surfaces to be coated. Flows should be totally plugged and/or diverted when coating the invert. All extraneous flows into the manhole or vaults at or above the area coated shall be plugged and/or diverted until the coating has set hard to the touch. As an option, hot air may be added to the manhole to accelerate set time of the coating.

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- D. (Optional) Pipe joint seals shall be installed by others. No leaks may be present prior to commencing and during work.
- E. Installation of the protective coating shall not commence until the concrete or metal substrate has properly cured in accordance with these specifications.
- F. Temperature of the surface to be coated should be maintained between 70 deg F and 110 deg F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated.

### 3.03 SURFACE PREPARATION

- A. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Applicator shall notify Owner of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.
- B. All contaminants including: oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.
- C. All concrete or metal that is not sound or has been damaged by chemical exposure shall be removed to a sound surface or replaced.
- D. Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the resin protective coating to be applied.
- E. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with profile to meet as a minimum ICRI CSP4 –CSP6 profile and porosity to provide a strong bond between the protective coating and the substrate. Generally, this can be achieved with a high pressure water cleaning using equipment capable of a minimum 2,500 psi at 3.5 gpm with a turbo head jet nozzle. Other methods such as high pressure water jetting (refer to SSPC-SP 13/NACE No.6), abrasive blasting, shotblasting, grinding, scarifying or acid etching may also be used. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound clean neutralized surface that is not excessively damaged.
- F. Infiltration shall be stopped by using a material which is compatible with the specified repair mortar and is suitable for topcoating with the specified protective coating.
- G. The area between the manhole and the manhole ring and any other area that might exhibit movement or cracking due to expansion and contraction, shall be grouted with a flexible grout or gel.



- H. (OPTIONAL) Castings can be abrasive blasted and coated to prevent corrosion if desired.
- I. Surfaces to receive protective coating shall be dry to the touch and or with no visible dampness. This is to insure maximum adhesion to the substrate. If required, drying may be accomplished by a minimum of 20 minutes of a heated, forced air blower. The drying shall be to the specification dictated by the resin manufacturer and its trained applicator.
- J. Surfaces to receive protective coating utilizing Flat Wall Beam Analysis design shall be prepared with a series of grooves cut into the substrate at a spacing and depth determined by the manufacturer to “key” or lock the protective coating to the substrate. All coating termination edges shall be “locked” in to the substrate with a termination groove “key” cut into the substrate. The “key” shall be a minimum ¼”w x ¼”d and cut at a 45 degree angle.
- K. All surfaces should be inspected by the Inspector during and after preparation and before the repair material is applied.

### **3.04 APPLICATION OF REPAIR MATERIALS**

- A. Areas where structural steel has been exposed or removed shall be repaired in accordance with the Project Engineer’s recommendations.
- B. Repair materials shall meet the specifications herein. The materials shall be trowel or spray applied utilizing proper equipment on to specified surfaces. The material thickness shall be specified by the Project Engineer according to Owner’s requirements and manufacturer’s recommendations.
- C. If using approved cementitious repair materials, such shall be trowelled to provide a smooth surface with an average profile equivalent to coarse 80 grit sandpaper or a 2 to 3 mil equivalent to optimally receive the protective coating. No bugholes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar.
- D. The repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds should not be used unless approved for compatibility with the specified protective coating.
- E. Application of the repair materials, if not performed by the coating certified applicator, should be inspected by the protective coating certified applicator to ensure proper finishing for suitability to receive the specified coating.
- F. After abrasive blast and leak repair is performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed by additional abrasive blast, shotblast or other approved method. If repair materials are used, refer to these specifications for surface preparation. Areas to be

coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the approved coating.

- G. All surfaces should be inspected during and after preparation and before the protective coating is applied.

### 3.05 APPLICATION OF PROTECTIVE LINING

- A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.
- B. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.
- C. The protective coating material must be spray applied by a Certified Applicator of the protective coating manufacturer.
- D. Specified surfaces shall be coated by spray application of a solvent-free, 100% solids, rigid structural lining as further described herein.
- E. Plural component spray application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating.
- F. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.
- G. When groundwater loading is not an issue and only a corrosion barrier is required, the rehabilitation lining shall be installed to the thickness necessary to qualify as a monolithic (void free) liner. The roughness of the substrate will dictate the thickness needed to create the monolithic liner and eliminate any opportunity for voids in the lining. The minimum value for coating thickness for corrosion protection for non-structural rehabilitation shall be 125 mils and structural shall be a minimum 250 mils.

### 1.06 TESTING AND INSPECTION

- A. **High Voltage Spark Test.** After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. **This test is critical when applied to corrosion protection applications (i.e. mil coatings less than 250 mils).** Surface shall first be dried, an induced holiday shall then be made on to the coated concrete or metal surface and shall serve to determine the minimum/maximum voltage to be used to test the coating

for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

- B. **Adhesion Testing.** The adhesion tests shall be performed on a minimum of one or 10% of all rehabilitated structures, which ever is greater, or as shown on the Plan and/or specified in the Special Provisions. Adhesion testing shall be conducted after the lining or coating system has cured per manufacturer instruction and in accordance with ASTM D4541(Steel) or ASTM 7234(Concrete). **Adhesion is critical for proper performance of a corrosion barrier (i.e. < 250 mils).** A minimum of one 20 mm dolly shall be affixed to the lined surface of the structure at the upper section or cone area, mid section and at the bottom, unless otherwise specified in the Special Provisions. Each testing location shall be identified by the Engineer. The adhesive used to attach the dollies to the liner shall be rapid setting with tensile strength in excess of the liner material and permitted to cure in accordance with manufacturer recommendations. The lining material and dollies shall be adequately prepared to receive the adhesive. Prior to pull test, the Contractor shall utilize a scoring device to cut through the coating until the substrate is reached. Extreme care shall be required while scoring to prevent micro cracking in the coating, since cracks may cause failures at diminished strengths. Failure due to improper dolly adhesive or scoring shall require retesting. The pull tests in each area shall meet or exceed 200 psi. and shall include subbase adhered to the back of the dolly or no visual signs of coating material in the test hole. Pull tests with results between a minimum 150 psi and 200 psi shall be acceptable if more than 50% of the subsurface is adhered to the back of the dolly. A test result can be discarded, as determined by the Engineer, if there is a valid nonstatistical reason for discarding the test results as directed by Sections 8.4 and 8.5 of ASTM D4541 and ASTM D7234. If any test fails, a minimum of three additional locations in the section of the failure shall be tested, as directed by the Engineer. If any of the retests fail, all loosely adhered or unadhered liner in the failed area, as determined by the Engineer, shall be removed and replaced at the Contractor's expense. If a structure fails the adhesion test, one additional structure or 10% of the initial number of structures selected for testing shall be tested at the discretion of the Engineer and/or as specified in the Special Provisions.

**NOTE: The mil thickness will be measured and confirmed with the scored and pulled test samples. In structural repairs (partially or fully deteriorated design assumptions), it is critical to confirm the design thickness with the pulled sample as adhesion is not assumed in the ASTM 1216-09 design. The primary purpose of the pull test in structural rehabilitation is to confirm applied thickness, not adhesion. Any derived adhesion is further enhancement to the final installation strength of the rehabilitated structure.**

- C. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator.
- D. The municipal sewer system may be put back into non-severe operational service as soon as the final inspection has taken place. However, for severe corrosion duty such as high concentrations of acids, bases or solvents, 4 to 8 hours may be necessary prior to returning to service. Consult coating manufacturer for further details.



# ***SPRAYROQ***®

Structural Protective  
***LINING SYSTEMS***

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