ENGINEER'S ADDENDUM NO. 01
TO THE BID DOCUMENTS (PLANS AND SPECIFICATIONS) FOR
Beaver Creek Clean River Project Phase III – Beaver Creek Diversion Tunnel
AWB Contract # 3-G

City of Albany

Albany County, New York

October 14, 2020

The following changes and/or additions shall be made to the plans and/or specifications. All other requirements of the contract documents shall remain the same. Acknowledge receipt of this addendum by inserting its number and date in the Bid Proposal.

Changes/Additions to the Bid Documents:

THIS ADDENDUM is hereby made a part of the contract documents on the subject work as though originally included therein. The following amendments, additions and/or corrections shall govern this work.

This Addendum is in the following parts as follows:

Part I	- Pertaining to Drawings
Part II	- Pertaining to Technical Specifications
Part III	- Clarifications/responses to Contractor Questions
Part IV	- List of Attachments

PART I - PERTAINING TO DRAWINGS

C-101 – WORKING SHAFT SUPPORT OF EXCAVATION DESIGN REQUIREMENTS

1. DETAIL A, MAXIMUM PRESSURE BELOW BOTTOM OF EXCAVATION
    a. Passive pressure nomenclature typographical error corrected for the variable Kp. It now read $Kp^{0.5}$ instead of $KP^{0.5}$.
    b. Leader pointing position adjusted for the note "EXISTING GROUND SURFACE (EL. VARIES)"

2. GENERAL NOTES
    a. Added Note 6. It reads "CONTRACTOR SHALL USE THE DESIGN PARAMETERS SPECIFIED, OR VALUES INTERPRETED BY CONTRACTOR'S ENGINEER, WHICHEVER IS MORE CONSERVATIVE, TO DEVELOP THE DRIVING AND RESISTING PRESSURES."
    b. Added Note 7. It reads "CONTRACTOR SHALL REFER TO THE GEOTECHNICAL BASELINE REPORT AND THE GEOTECHNICAL DATA REPORT FOR SUBSURFACE STRATA INFORMATION."

C-102 – TUNNEL/PIPE PLAN AND PROFILE

1. GENERAL
    a. Drawing storage location, x-reference storage locations, etc. delete – on left of drawing border.

2. PLAN
    a. Added location of probe P-6.
    b. Added location of probe P-7.
    c. Leader “MIN. LIMIT OF GROUND IMPROVEMENT” modified to read “MIN. LIMIT OF GROUND IMPROVEMENT SEE NOTE 5”.
    d. Added leader “PROPOSED DIVERSION STRUCTURE (NOT IN CONTRACT)”.
    e. Added leader “PROPOSED FACILITY (NOT IN CONTRACT)”

3. NOTES
    a. Note 3 “VERTICAL SCALE EXAGERATED BY A FACTOR OF 4.0”, replaced with “PHASE III LIMITS ARE BETWEEN STA. 0+00 AND STA. 5+29.85.”
    b. Note 5, second sentence modified from “SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.” to read “SEE DWG C-105 AND SPECIFICATIONS FOR ADDITIONAL INFORMATION.”

4. PROFILE
    a. Breakline added at right end of the profile.

PART II - PERTAINING TO TECHNICAL SPECIFICATIONS

Table of Contents:

1. Reference to **31 22 13 MICROTUNNELING** is hereby revised to **31 22 13 TUNNEL EXCAVATION.**

2. Added **31 25 00 EROSION AND SEDIMENT CONTROL**. This section shall now be part of the contract documents.

Sections:

1. Section **312213 TUNNEL EXCAVATION**
    a. The entire section is replaced with updated version.

2. Section **312230 GRANULAR MATERIALS**
    a. Footer is revised formatted to reflect the correct section number.

3. Section **312319 DEWATERING**
    a. Item 1.3.C – Definition of Professional Engineer is updated to reflect registration specific to the State of New York.

4. Section **312340 TUNNEL SUPPORT SYSTEM**
    a. Item 2.01 D.4 is revised to read “Ensure complete mixing during installation. The materials shall have thixotropic and viscous properties to permit adequate mixing of the materials by rotation of the bar and to prevent the mixture form running out of the hole or joints after mixing.”

5. Section **312500 EROSION AND SEDIMENT CONTROL**
    a. The attached Section has been added to the contract documents.

6. Section **334420 FIBERGLASS REINFORCED POLYMER MORTAR PIPE (FRPMP)**

a. Item 1.01.A – acronym "FRPM" is revised to "FRPMP".
b. Footer is formatted to be consistent.

Appendix A – Geotechnical Baseline Report

The Geotechnical Baseline Report is re-issued.

The specific changes are:

1. **Section 1.1 Introduction**
    a. 2nd paragraph, 1st sentence modified to "This GBR is specifically related to the construction of tunnels and open cut segments to install …".
    b. 2nd paragraph, last sentence modified to "The remaining, approximately, 365 feet will be constructed by open cut."
    c. 3rd paragraph, 2nd sentence modified "This GBR also covers the micro-tunnel and open cut alignment …".
2. **Section 1.2 Project Description**
    a. 1st paragraph, last sentence modified to "A second tunnel segment and an open cut segment will be required …".
    b. 2nd paragraph, list sentence modified to "This second tunnel segment and the open cut segment will be referred to as the 30-inch tunnel and 30-inch open cut respectively".
3. **Section 1.6 Organization of GBR**, 4th bullet, 3rd sentence, "and open cut" is added after "the proposed tunnel".
4. **Section 2.5.2 Clay**, revised.
5. **Section 2.5.3 Hard Clay with Sand Gravel**, modified to read "**Section 2.5.3 Very Stiff to Hard Clay with Sand and Gravel**".
6. **Section 2.5.3**
    a. 1st sentence modified to "The Very Stiff to Hard Clay …".
    b. 2nd sentence modified to "This layer typically consisted of very stiff to hard gray, silty …".
7. **Section 2.5.7 Groundwater**, 1st paragraph, 1st sentence modified to read "Along the open cut segment and along both tunnel segments, the Contractor can anticipate encountering groundwater near the top of the clay stratum or within the fill."
8. The sentence "Fracture spacings of less than 0.3 feet are anticipated." is added to:
    a. **Section 3.1.1 72-in Tunnel Working Shaft**, 2nd paragraph, 2nd to last sentence
    b. Each shaft description for Shaft at Station 0+00, Manhole Structure #2, and Manhole Structure #3 within **Section 3.1.2 30-in Tunnel Shafts**
    c. **Tables 3-3** and **3-4**.
9. Station numbering updated for Shaft - Manhole Structure #4 through Shaft - Manhole Structure #6.
10. **Section 3.4 Open cut Segment – Station 24+57 to Station 26+96** added.
11. **Section 3.4 Tunnel Support System** renumbered to **Section 3.5**; all subsequent section numbers renumbered accordingly.
12. **Section 3.8 Bulkhead** (previously Section 3.7 Bulkhead) revised.
13. **Table 3-9 Open Cut Reach Groundwater Inflow Quantities** added.
14. **Figure 3-8**, Note 1 deleted; Notes 2 and 3 renumbered to Notes 1 and 2.
15. Missing **Figure 3-3** added.
16. **Section 4.1 General**
    a. 1st paragraph, last sentence modified to read "The selection of the Contractor's construction methods and equipment for each tunnel segment shaft location and the open

cut segment should:".

b. Bullet 8 added.

17. **Section 4.3.2, 30-inch Tunnel Segment**, last sentence revised.
18. **Section 4.3.3 Open Cut Segment** added.
19. **Section 4.4.1 Selection of Excavation method for 30-inch Tunnel**, last sentence revised.
20. **Section 4.5 Adjacent Structures Protection**
    a. 2nd sentence revised to "The allowable ground movements (settlement/heave/deflection) during tunneling, and shaft and open cut excavations operations are provided in the Contract Documents."
    b. 3rd sentence revised to "The Contractor is responsible for selecting and implementing means and methods to perform the tunnel, shaft and open cut and shaft work as specified in these Contract Documents …".
21. **Section 4.5.1 72-inch Tunnel**, deleted.
22. Figure 3-1 updated and included as part of the GBR document. See separate attached figure that show clouds where the modifications were made.
23. Figure 3-2 updated and included as part of the GBR document. See separate attached figure that show clouds where the modifications were made.
24. Figure 3-3 updated and included as part of the GBR document. See separate attached figure that show clouds where the modifications were made.

While the ENGINEER has attempted to capture all modifications, all modifications may not have been fully identified in the GBR narrative above. CONTRACTOR/BIDDER shall be responsible for fully reviewing and understanding the revised GBR.

PART III – CLARIFICATIONS/RESPONSES TO CONTRACTOR QUESTIONS

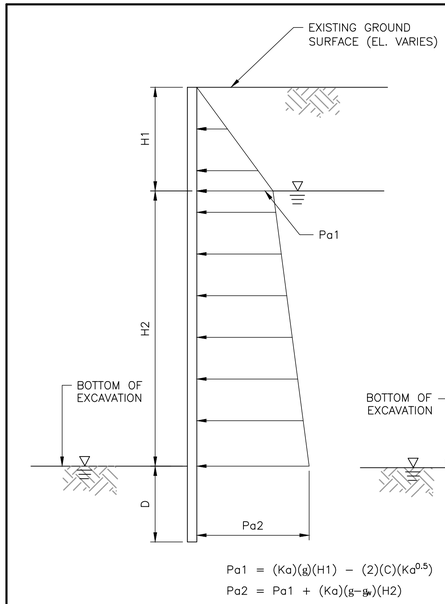
None

PART IV – LIST OF ATTACHMENTS

- Plan Sheet C-101 – WORKING SHAFT SUPPORT OF EXCAVATION DESIGN REQUIREMENTS
- Plan Sheet C-102 – TUNNEL/PIPE PLAN AND PROFILE
- Section 31 22 13 – TUNNEL EXCAVATION
- Section 31 25 00 – EROSION AND SEDIMENT CONTROL
- Appendix A – Geotechnical Baseline Report

END OF ENGINEER'S ADDENDUM

Date: October 14, 2020
Submitted by: Greg Bold, P.E., CDM Smith.

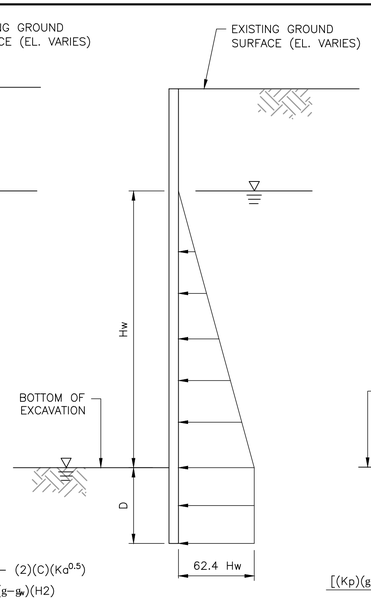


$Pa1 = (Ka)(g)(H1) - (2)(C)(Ka^{0.5})$

$Pa2 = Pa1 + (Ka)(g-g_w)(H2)$

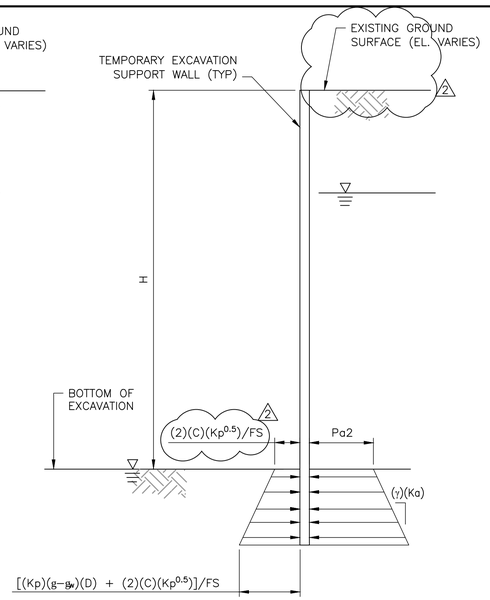
MINIMUM EARTH PRESSURE

NTS



MINIMUM HYDROSTATIC PRESSURES

NTS



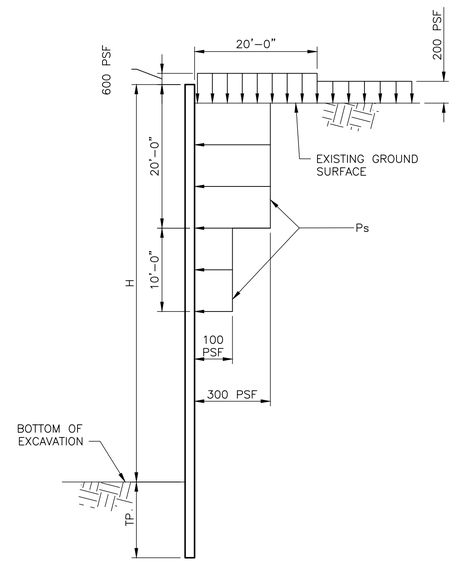
MAXIMUM PRESSURE BELOW BOTTOM OF EXCAVATION

NTS

LATERAL EARTH AND WATER PRESSURES – SOIL

DETAIL A

NTS



SURCHARGE PRESSURES

DETAIL C

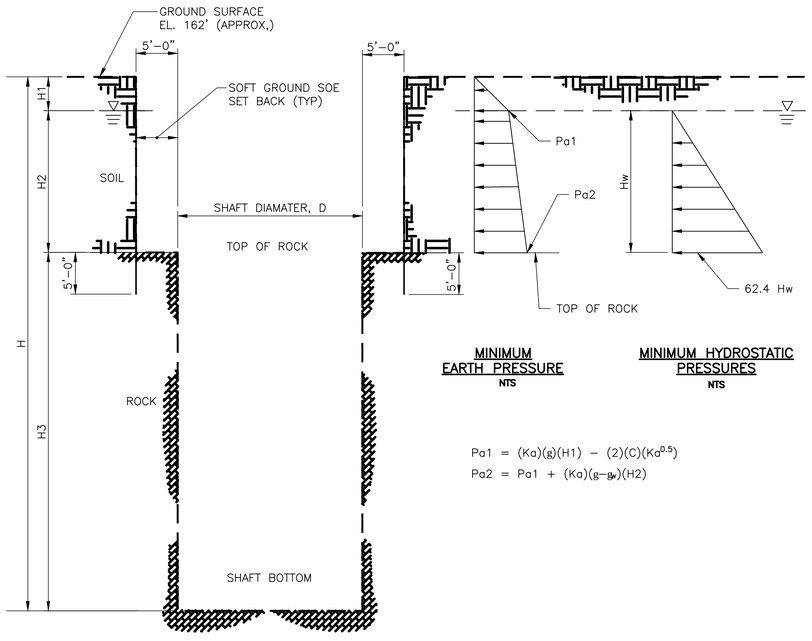
NTS

LEGEND:

SYMBOLS:	DEFINITIONS:
g	SOIL UNIT WEIGHT
g_w	BOUYANT SOIL UNIT WEIGHT
C	COHESION
FS	FACTOR OF SAFETY (2.0)
GWT	GROUNDWATER TABLE
H	DEPTH OF EXCAVATION TOTAL
H1	DEPTH OF EXCAVATION IN SOIL ABOVE GWT
H2	DEPTH OF EXCAVATION IN SOIL BELOW GWT
H3	DEPTH OF EXCAVATION IN ROCK
Hw	GROUNDWATER HEAD
Ka	ACTIVE CONDITION EARTH PRESSURE COEFFICIENT
Kp	PASSIVE CONDITION EARTH PRESSURE COEFFICIENT
Pa	LATERAL EARTH PRESSURE
Ps	LATERAL SURCHARGE PRESSURE
▽	MINIMUM DESIGN WATER LEVEL

NOTES ON APPLYING DIAGRAMS

1. PRESSURES ARE FOR TEMPOR EXCAVATION SUPPORT SYSTEMS WITH MULTIPLE LEVELS OF BRACING.
2. LATERAL PRESSURES ARE MINIMUM VALUES TO BE USED FOR DESIGN. ADDITIONAL LOAD SHALL BE INCLUDED AS REQUIRED.
3. LATERAL PRESSURES ON ALL TEMPORARY EXCAVATION SUPPORT WALLS SHALL INCLUDE EARTH, AND WATER PRESSURES PLUS TRAFFIC AND EQUIPMENT SURCHARGE. IN ADDITION, FOUNDATION AND STOCKPILING SURCHARGE SHALL BE ADDED AS APPLICABLE TO INDIVIDUAL SECTIONS.
4. PASSIVE TOE PRESSURE USED IN THE DESIGN SHALL NOT EXCEED THE MAXIMUM ALLOWABLE PRESSURE INDICATED, HOWEVER, IT SHALL BE REDUCED AS REQUIRED BY UNIQUE CONDITIONS OR SPECIFIC DETAILS OF THE CONTRACTOR'S DESIGN.
5. REFER TO SPECIAL PROVISIONS FOR BORING LOGS.



MINIMUM EARTH PRESSURE

NTS

MINIMUM HYDROSTATIC PRESSURES

NTS

$Pa1 = (Ka)(g)(H1) - (2)(C)(Ka^{0.5})$

$Pa2 = Pa1 + (Ka)(g-g_w)(H2)$

LATERAL EARTH AND WATER PRESSURES – ROCK

DETAIL B

NTS

GENERAL NOTES:

1. TEMPORARY EXCAVATION SUPPORT SYSTEMS SHALL BE DESIGNED AND PROVIDED BY THE CONTRACTOR'S ENGINEER IN ACCORDANCE WITH THE CONTRACT DRAWINGS AND SPECIFICATIONS TO THE FINAL DEPTHS AND CONFIGURATIONS AS REQUIRED BY THE CONSTRUCTION CONTRACT, (INCIDENTAL).
2. TEMPORARY EXCAVATION SUPPORT SYSTEMS SHALL BE DESIGNED FOR ALL CONDITIONS THAT CAN OCCUR DURING THE VARIOUS STAGES OF CONSTRUCTION. AMONG OTHERS, THESE CONDITIONS INCLUDE: INITIAL CANTILEVER CONDITION, INSTALLATION, RELOCATION AND REMOVAL OF BRACING, AND SOIL EXCAVATION.
3. TEMPORARY EXCAVATION SUPPORT SYSTEM ELEMENTS CARRYING VERTICAL LOADS AND LATERAL LOADS SHALL BE DESIGNED FOR TENSION AND SHEAR EQUAL TO A MINIMUM OF 10 PERCENT OF THEIR COMPRESSIVE LOAD, UNLESS CALCULATED TENSION AND SHEAR LOADS ARE GREATER.
4. THE TOE OF THE TEMPORARY EXCAVATION SUPPORT SYSTEM SHALL EXTEND A SUFFICIENT DISTANCE BELOW THE BOTTOM OF EXCAVATION IN ORDER TO LIMIT MOVEMENT, PROVIDE ADEQUATE VERTICAL CAPACITY, AND CONTROL GROUND WATER. AT A MINIMUM, THE TEMPORARY EXCAVATION SUPPORT SYSTEM WALL SHALL EXTEND FIVE FEET INTO THE TOP OF BEDROCK.
5. THE FOLLOWING EXCAVATION AND BRACING RESTRICTIONS SHALL BE COMPLIED WITH:

5.A. INITIAL EXCAVATION SHALL NOT EXTEND MORE THAN 8 FEET BELOW THE TOP OF WALL BEFORE THE INSTALLATION OF THE UPPER BRACING LEVEL HAS BEEN COMPLETED.

5.B. THE MAXIMUM VERTICAL SPACING BETWEEN BRACING LEVELS SHALL NOT EXCEED 17 FEET, INCLUDING EXCAVATION TO INSTALL BRACE.

5.C. AT NO TIME SHALL THE VERTICAL DISTANCE FROM THE LOWEST INSTALLED BRACING LEVEL AND THE BOTTOM OF THE EXCAVATION EXCEED 15 FEET.

5.D. DESIGN TEMPORARY EXCAVATION SUPPORT SYSTEM TO ALLOW AT LEAST 2 FEET OF OVEREXCAVATION AT THE BOTTOM OF EXCAVATION WITH NO REDESIGN OR ADDITIONAL SUPPORT.

2 6. CONTRACTOR SHALL USE THE DESIGN PARAMETERS SPECIFIED, OR VALUES INTERPRETED BY CONTRACTOR'S ENGINEER, WHICHEVER IS MORE CONSERVATIVE, TO DEVELOP THE DRIVING AND RESISTING PRESSURES.

7. CONTRACTOR SHALL REFER TO THE GEOTECHNICAL BASELINE REPORT AND THE GEOTECHNICAL DATA REPORT FOR SUBSURFACE STRATA INFORMATION.

LATERAL PRESSURES:

1. DESIGN LATERAL LOADS SHALL INCLUDE EARTH, WATER AND SURCHARGE LOADS
2. WHERE DEWATERING TO LOWER GROUNDWATER LEVELS OUTSIDE OF THE SUPPORT OF EXCAVATION IS PERMITTED AND CONTRACTOR'S DEWATERING APPROACH IS APPROVED, CONTRACTOR MAY REDUCE DESIGN LOADS BY ELIMINATING STATIC GROUNDWATER PRESSURES. IN SUCH CASE, LOWERED GROUNDWATER LEVELS SHALL BE MAINTAINED UNTIL EXCAVATION IS BACKFILLED.
3. ELEVATION SUPPORT SYSTEM IN ROCK IS CONSIDERED TO BE DRAINED (I.e. WITH WEEP HOLES OR OTHER DRAINAGE PROVISIONS)
4. DESIGN OF SUPPORT OF EXCAVATION SHALL BE BASED ON ANALYSIS USING DESIGN EXCAVATION DEPTH PLUS TWO (2) FEET.
5. ELEVATIONS FOR THE TOP OF ROCK ARE PROVIDED IN THE GBR.
6. IF ANY LOADING OCCURS THAT ARE NOT DESCRIBED IN THE CONTRACT DRAWINGS, THEY SHALL BE INCORPORATED INTO THE TEMPORARY EXCAVATION SUPPORT SYSTEM DESIGN

BRACING:

1. DETERMINE LOADS ON BRACING BY USING TRIBUTARY AREA METHOD.
2. SPLICES IN BRACING SHALL BE DESIGNED FOR FULL STRUCTURAL CAPACITY OF THE MEMBER (BOTH IN SHEAR AND MOMENT), USING 100 PERCENT OF AISC ALLOWABLE STRESSES FOR THE CONNECTION.

TOE STABILITY:

1. TO DETERMINE THE EMBEDMENT LENGTH OF THE TOE PENETRATION REQUIRED TO PROVIDE TOE STABILITY, SOLVE FOR THE REQUIRED EMBEDMENT BY MOMENT EQUILIBRIUM ABOUT THE LOWEST BRACING LEVEL. FOR MULTIPLE BRACE LEVEL SYSTEMS, CONSIDER ONLY THE LATERAL PRESSURES ACTING ON THE WALL BELOW THE LOWEST BRACING LEVEL. LATERAL SURCHARGE PRESSURES SHALL BE INCLUDED IF THE SURCHARGE PRESSURE ACTS ON THE WALL BELOW THE LOWEST BRACING LEVEL.
2. TOE PENETRATION REQUIREMENTS FOR MEMBERS OF THE TEMPORARY EXCAVATION SUPPORT SYSTEM WHICH SUPPORT VERTICAL LOADS MAY BE MORE CRITICAL THAN TOE PENETRATION REQUIREMENTS FOR TOE STABILITY AND SHALL BE CONSIDERED IN THE ANALYSIS. IN ADDITION, THE DETERMINATION OF TOE PENETRATION SHOULD CONSIDER THE POTENTIAL FOR SEEPAGE GRADIENTS WHICH COULD CAUSE INSTABILITY AT THE BOTTOM OF THE EXCAVATION. SEEPAGE GRADIENTS SHALL BE TAKEN INTO CONSIDERATION WHEN CALCULATING PASSIVE PRESSURE AS APPLICABLE.

REQUIRED SOIL DESIGN PARAMETERS

STRATUM	TOT. UNIT WEIGHT	EFFECTIVE FRICTION ANGLE	COHESION (C)	EARTH PRESSURE COEFFICIENT	
	PCF	DEGREES	PSF	ACTIVE (Ka)	PASSIVE (Kp)
FILL	120	0	1500	1.00	1.00
GLACIO-LACUSTRINE CLAY	110	0	700	1.00	1.00
GALCIO-LACUSTRINE SAND & GRAVEL	125	34	0	0.28	3.54
WEATHERED SHALE	130	36	0	0.26	3.84

PCF POUNDS PER CUBIC FEET

PSF POUNDS PER SQUARE FEET

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CONSULTANTS

STATE OF NEW YORK MAHMOOD KHWAJA LICENSED PROFESSIONAL ENGINEER 084232

SEALS

BID SUBMISSION
NOT FOR CONSTRUCTION

ALBANY WATER BOARD
ALBANY, NEW YORK

CITY OF ALBANY WATER DEPT.

BEAVER CREEK CLEAN RIVER PROJECT
PHASE III – BEAVER CREEK DIVERSION TUNNEL

NO.	DATE	ISSUED FOR	BY
2	10/12/2020	ADDENDUM #1	AP-JVT
1	10/6/2020	BID SUBMISSION	AP-JVT

DATE: OCTOBER 2020
PROJECT NO.: 3-G
FILE NAME:
DESIGNED BY: JW
DRAWN BY: RB
CHECKED BY: MK

SHEET TITLE

WORKING SHAFT SUPPORT OF EXCAVATION DESIGN REQUIREMENTS

SCALE: AS NOTED

C-101

SHEET 13 OF 18

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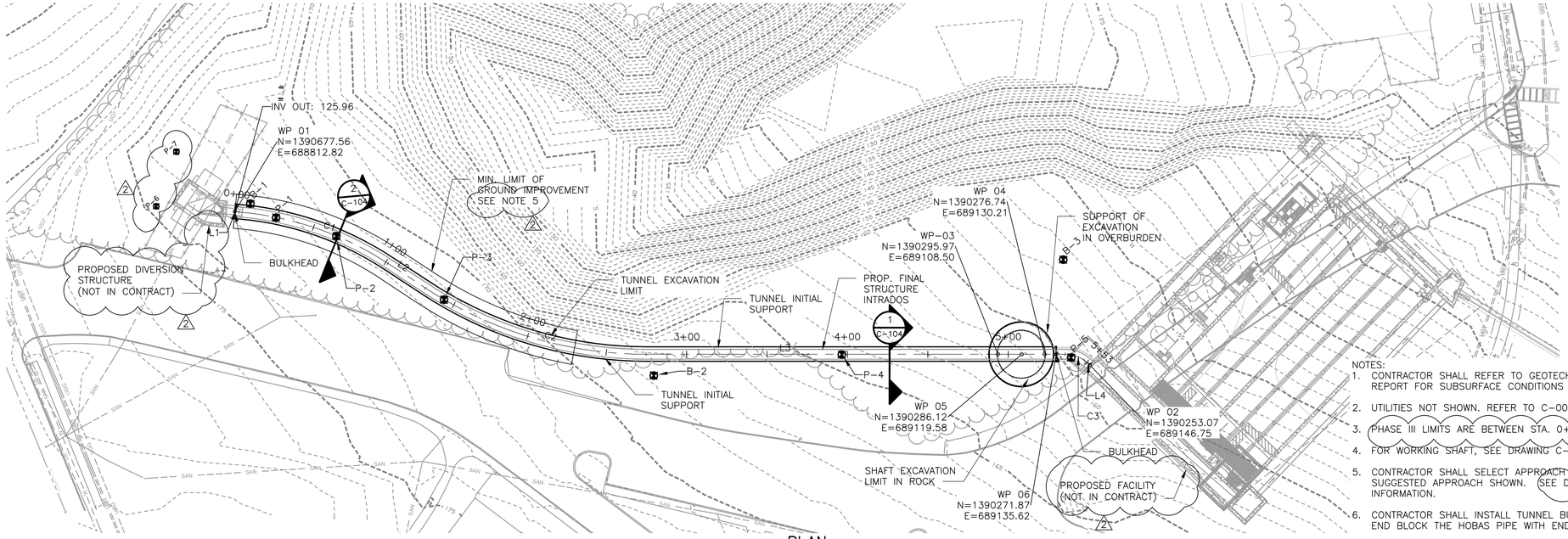

PLAN
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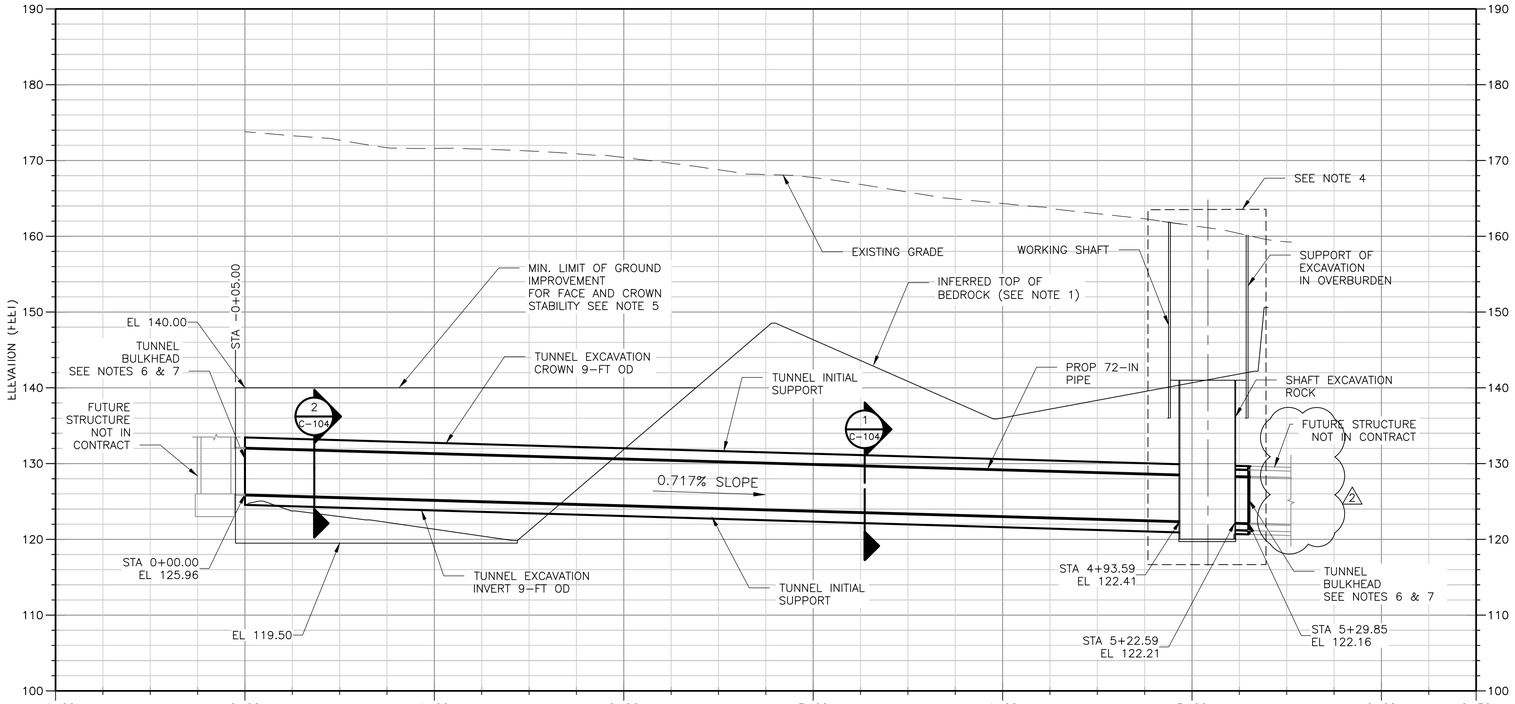

PROFILE
SCALE: H:1"=60' V:1"=20'

NOTES:
1. CONTRACTOR SHALL REFER TO GEOTECHNICAL DATA REPORT AND GEOTECHNICAL BASELINE REPORT FOR SUBSURFACE CONDITIONS AND BASELINE STRATA ELEVATIONS.
2. UTILITIES NOT SHOWN. REFER TO C-001.
3. PHASE III LIMITS ARE BETWEEN STA. 0+00 AND STA. 5+29.85.
4. FOR WORKING SHAFT, SEE DRAWING C-103.
5. CONTRACTOR SHALL SELECT APPROACH TO STABILIZING GROUND FOR TUNNELING. SUGGESTED APPROACH SHOWN. SEE DWG C-105 AND SPECIFICATIONS FOR ADDITIONAL INFORMATION.
6. CONTRACTOR SHALL INSTALL TUNNEL BULKHEAD AT EACH TUNNEL END. CONTRACTOR SHALL END BLOCK THE HOBAS PIPE WITH END CAPS TO PROTECT THE PIPE BEFORE BULKHEADING.
7. AT A MINIMUM, BULKHEAD SHALL BE 6-IN SHOTCRETE WITH WELDED WIRE FABRIC 2X2.

GEOTECHNICAL BORING SCHEDULE

ID	TOP EL.	DEPTH	NORTHING	EASTING	OFFSET
B-01	173.50	60.20	1390674.8006	688823.2118	5.82 L
B-02	168.80	60.50	1390427.4968	688939.7204	13.81 R
B-03	157.50	60.20	1390312.9783	689177.9528	57.98 L

GEOTECHNICAL ROCK PROBE SCHEDULE

ID	TOP EL.	DEPTH	NORTHING	EASTING	OFFSET
P-1	173.30	49.50	1390657.7789	688829.5028	0.00
P-2	172.00	49.50	1390624.1705	688849.7929	0.00
P-3	171.40	51.50	1390550.1908	688873.4876	0.00
P-4	164.40	28.50	1390360.4100	689035.7458	0.00
P-5	159.70	9.00	1390264.2491	689141.1349	0.00
P-6	174.10	48.50	1390712.4764	688778.3921	NA
P-7	173.50	45.00	1390729.5452	688810.2596	NA

BORING/PROBE SCHEDULE NOTES:
A. ELEVATION REFERENCED TO NAVD88.
B. REFER TO THE GEOTECHNICAL DATA REPORT FOR DETAILED GEOTECHNICAL INVESTIGATION PROGRAM.
C. ELEAVATIONS, DEPTHS, NORTHINGS, EASTINGS, AND OFFSETS ARE IN FEET.
D. FOR OFFSETS, 'L' REFERS TO LEFT OF ALIGNMENT CENTERLINE AND 'R' REFERS TO RIGHT OF ALIGNMENT CENTERLINE, WHEN TRAVERSING UP-STATION.

TUNNEL ALIGNMENT GEOMETRICS

NUMBER	LENGTH	RADIUS	LINE/CHORD DIRECTION	TANGENT	DELTA	START POINT	END POINT	PI	CENTER OF CIRCLE
L1	2.58'		S43° 24' 51.70"E			0+00.00 N=1390677.2729 E=688812.9866	0+02.58 N=1390675.4017 E=688814.7570		
C1	98.90'	200.00'	S29° 14' 52.57"E	50.48'	28°19'58.26"	0+02.58 N=1390675.4017 E=688814.7570	1+01.48 N=1390589.9863 E=688862.5879	0+53.06 N=1390638.7306 E=688849.4525	N=1390537.9478 E=688669.4766
L2	28.03'		S15° 04' 53.44"E			1+01.48 N=1390589.9863 E=688862.5879	1+29.50 N=1390562.9239 E=688869.8805		
C2	145.26'	250.00'	S31° 43' 35.52"E	74.74'	33°17'24.16"	1+29.50 N=1390562.9239 E=688869.8805	2+74.76 N=1390441.1050 E=688945.1953	2+04.25 N=1390490.7561 E=688889.3279	N=1390627.9721 E=689111.2697
L3	260.58'		S48° 22' 17.60"E			2+74.76 N=1390441.1050 E=688945.1953	5+35.34 N=1390267.9992 E=689139.9743		
C3	15.33'	20.00'	S26° 24' 32.95"E	8.07'	43°55'29.30"	5+35.34 N=1390267.9992 E=689139.9743	5+50.68 N=1390254.6004 E=689146.6282	5+43.41 N=1390262.6414 E=689146.0029	N=1390253.0498 E=689126.6884
L4	1.53'		S4° 26' 48.30"E			5+50.68 N=1390254.6004 E=689146.6282	5+52.21 N=1390253.0749 E=689146.7468		

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SEALS

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ALBANY WATER BOARD
ALBANY, NEW YORK

BEAVER CREEK CLEAN RIVER PROJECT
PHASE III – BEAVER CREEK DIVERSION TUNNEL

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DRAWN BY: RB
CHECKED BY: MK

SHEET TITLE

TUNNEL / PIPE PLAN AND PROFILE

SCALE: AS NOTED

C-102

SHEET 14 OF 18

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SECTION 312213
TUNNEL EXCAVATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to perform tunnel excavation, install and maintain tunnel support systems, including steel ribs and lagging, rock bolts, welded wire fabric, shotcrete, accessory steel and all other appurtenances required to properly support all underground excavations as necessary for the safety of the work and personnel as shown on the Drawings and as specified herein.

B. Work shall include all labor, material, equipment and incidentals required to excavate and to install and maintain rock support system for the tunnel and shafts. This Section specifies requirements for performing tunnel excavation work. Requirements for shaft excavation, tunnel support systems, groundwater control, and final lining are specified in other Sections

1.02 RELATED WORK

A. Site Preparation is included in Section 311000.

B. Earthwork is included in Section 312200

C. Soil and Aggregate for Earthwork is included Section 310515.

D. Dewatering is included in section 312319.

E. Tunnel Support System is included in Section 312340.

F. Geotechnical Instrumentation is included in Section 310900.

G. Shotcrete is included in Section 033713.

1.03 SUBMITTALS

A. Submit, in accordance with Section 013300, Shop Drawings including detailed drawings with descriptions, data and calculations; methods of operation and control; all proposed equipment, facilities and methods of construction; and methods to control groundwater, tunnel ventilation and lighting.

B. Submit a proposed plan for accomplishing the tunnel excavation. Plans shall show details of proposed methods of excavation and disposing of materials; blasting, including delays; draining; ventilating; temporary support, including shotcrete, rock bolts, steel supports, and other bracing; safety and sanitary measures; survey of alignment and any other pertinent data.

C. Submit, equipment manufacturer's drawings for the proposed machine and ancillary equipment. Include model number, capacity and technical description for each piece of equipment.

1. For each type of equipment include:
    a. Details, including horsepower, torque, and thrust; propulsion system; steering provisions; support erection provisions; drive systems; and power requirements.

2. Used Equipement: In addition to the information required above the following additional information shall be submitted:
    a. The year originally fabricated and released for operation.
    b. The operation record including the project names, rock type and strength excavated, performance records, excavated diameter, total operated hours, and rebuild records of major components.

D. Written documentation of the qualifications of the project manager, project superintendent, roadheader operator, shift foreman, and safety representative.

E. Written site safety plan which includes, but is not limited to, the following: statement of safety and health policy; identification of responsibilities and accountability of personnel implementing the safety plan; safety indoctrination and safety training for site personnel; frequency of safety inspections; recording and distribution of inspection reports; procedures for follow-up to ensure correction of deficiencies; responsibilities for maintaining accident and exposure data, reports and logs; procedures for investigating and reporting accidents; emergency response procedures; air monitoring procedures; job site cleanup and safe access to all work areas; public safety; prevention of alcohol and drug abuse; tunnel communication system: personnel protective equipment; sampling methods; instrument calibration; laboratory testing for safety quality monitoring; disciplinary measures and hazard communication program.

F. Recordkeeping. Heading Shift Report for each shift, regardless of actual progress, submitted no later than the beginning of the following working day. The following shall be integrated with other required reports and data:

1. Face station at start of shift and end of shift.

2. Crew size, employee classification and employee work assignment.

3. Number and type of equipment used.

4. List of idle or inoperative equipment and reason for downtime.

5. Gas testing and air quality and quantity measurements (including the time of day measurements were taken).

6. Cutters or bits replaced or repaired. Include separate report identifying time and date of replacement or repair; cutter position or number, and reason for change.

7. Probe hole drilling records for each hole:
    a. Start and finish times.
    b. Hole length, location and orientation.
    c. Locations of non-operator caused changes in drilling rates.
    d. Locations of changes in water inflow rates.
    e. Locations of drilling water loss.
    f. Water inflow rate in probe hoie.
    g. Gas concentrations at drill collar.

8. For each cycle of tunnel advance indicate:
    a. Stations.

b. Description of ground conditions, including structural features, and type of material being excavated and volume thereof.
c. Description and locations of water inflows, gas inflows, ground loss, and other events.
d. Start and end times plus hour meter readings at the start and end of excavation for each stroke utilizing the mechanized tunnel excavator or for drill-and-blast operations, start and end times for the drilling, charging, smoke time, and mucking cycles.
e. Start and end time for ground support erected. Include type, size, and amount of ground support.
f. Delays to tunnel excavation progress and reasons for delays.

G. Notifications.

1. No less than 5 work days prior to any proposed addition, deletion, or change to the scheduling of shift work.

2. Immediately on discovering misalignment in excess of allowance tolerances.

3. Immediately upon encountering detection of gases exceeding limits established by OSHA and other regulatory agencies.

H. As-Built Data.

1. Reduced tunnel excavation survey data submitted weekly.

2. As-built tunnel profile survey of initial support as a condition prior to installing the final tunnel lining.

I. Modifications.

1. Alternative designs and computations for any proposed modifications to the drawings shall be prepared and certified by a professional Engineer qualified and experienced in tunneling and registered in the state of Iowa.

1.04 DEFINITIONS

A. A-Line: The line designated as "A Line" on the Drawings is the line within which no unexcavated materials and no supports, except structural steel supports, will be permitted to remain

B. Bearing Plate: Forged steel plates with a center hole, allowing articulation in all directions. The bearing plate serves the purpose to support the loose rock around the rockbolt head as well as to distribute the load that comes on the bolt head uniformly into surrounding rock

C. C-Line: The line designated as "C-Line" on the Drawings is the line representing the anticipated excavation line. The space between C-Line and A-Line is meant for initial support for the tunnel.

D. Carrier Pipe: Final pipe used for conveyance. This shall be the same as the final liner.

E. Final Liner: The final liner is the tunnel's permanent lining as specified in the Installation of Carrier Pipe in Tunnels section, Tunnel Backfill Grouting section, Prestressed Concrete Cylinder Pipe section, and Centrifugally Cast Fiberglass Pipe section.

F. GBR. Geotechnical Baseline Report.

G. Grout: The process of fully bonding a rock bolt to the native rock using a cartridge, containing a highly reinforced polyester resin component, together with its catalyst, in accurately measured quantities

H. Initial Support: The first excavation support installed by the contractor.

I. Muck: Materials removed in the process of underground excavation.

J. Roadheader: A mechanical piece of excavating equipment consisting of a boom-mounted cutting head, a loading device usually involving a conveyor, and a crawler travelling track to move the entire machine forward into the rock face.

K. Rock Bolt: An anchor bolt, for stabilizing rock in excavations.

L. Shotcrete: Pneumatically applied mixture of cement, aggregate, and water, conveyed through a hose and projected at velocity onto a surface. The mixture contains admixtures to provide quick set, high early strength, and satisfactory adhesion.

M. Supplemental Rock Supports: Any other rock support systems which will provide the necessary support, as necessary for the safety of the work and personnel.

N. Welded Wire Fabric: Electric fusion welded prefabricated reinforcement consisting of a series of parallel longitudinal wires with accurate spacing welded to cross wires at the required spacing.

1.05 REFERENCE STANDARDS

A. ASTM International

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

3. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

4. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.

5. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

6. ASTM A663 - Standard Specification for Steel Bars, Carbon, Merchant Quality Mechanical Properties.

7. ASTM F 436 – Standard Specification for Hardened Steel Washers.

B. American Welding Society (AWS)

1. AWS D1.1 - Structural Welding Code Steel

2. AWS D1.2 - Structural Welding Code Aluminum

C. American Concrete Institute (ACI)

1. ACI 301 Specification for Structural Concrete for Buildings

D. Code of Federal Regulations (CFR):29 CFR 1926

E. National Fire Protection Association (NFPA): NFPA 241, Safeguarding Construction, Alteration and Demolition Operations

F. NFPA 70 National Electric Code

G. Occupational Safety and Health Administration (OSHA)

H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 MATERIALS

A. Shotcrete shall conform to requirements as outlined in Section 03360.

B. Welded wire fabric for rock reinforcement shall be of the dimensions shown on the Contract Drawings or as approved by the Engineer, and shall conform to ASTM A185. Fabric shall not be galvanized.

2.02 EQUIPMENT

A. Rotary-percussion type drilling equipment shall be used for drilling holes for initial support.

B. Impact wrenches used to tighten rock bolt nuts shall be equipped with a torque-limiting control device.

C. Electrical systems shall conform to the requirements of National Electric Code NFPA70.

D. Muck Handling Equipment.

1. A system shall be provided for handling and transport of moist and water-laden tunnel muck, materials and equipment as applicable, to the shaft.

2. For muck train systems, the Contractor shall maintain track with ties and ballast or direct fixation system for safe operation of trains. The heads of the rails shall not be covered with tunnel muck or other debris at any time during construction and shall be maintained in good operating condition although deterioration of the tunnel invert is expected to occur as described in the GBR. Upon completion of construction of the tunnel, remove all such railroad ties and ballast prior to completion of the work. Rail may be left in place at the

option of the Contractor, provided the minimum clearance dimensions indicated on the Contract Drawings are maintained.

3. For conveyor systems, the Contractor shall design the muck conveyor system(s) to transport water-laden muck to the construction portal with a minimum of spillage and to prevent undue wear of the belts, rollers, and belt supports.

E. Roadheader

1. The roadheader shall have sufficient power delivered to the cutterhead such that the roadheader does not have a limited penetration rate in all expected ground conditions described in the GBR.

PART 3 EXECUTION

3.01 GENERAL

A. Excavate tunnel and vertical shafts to the lines and grades shown on the Drawings, or as directed. Take precautions to minimize overbreak and to prevent immediate or subsequent rock falls or settlement of any material penetrated. Heading may be driven by approved method, provided the work of driving continues to progress at a sufficient rate to meet the schedule requirements.

B. The work shall be properly lighted, ventilated, and drained during construction.

C. The excavated size of the tunnel shall be determined by the Contractor based on construction requirements including installing the final lining, and is subject to the size limitations shown on the Contract Drawings with due consideration of:

1. Fabricated dimensions of the initial support system.

2. Minimum dimensions and clearance requirements related to the means and methods for performing the work.

3. Easements and permit requirements.

4. All tunnel enlargements made for construction purposes shall be fully supported during the excavation of the tunnel and the annular space backfilled at no additional cost to the Owner.

D. Perform tunneling and support the ground in a manner to prevent loss of ground and keep the perimeters and faces of the tunnel, passages and bottoms of shafts stable. Contractor shall monitor ground movements in accordance with the Section 310900. The Contractor shall perform tunnel and shaft excavation in a manner that minimizes the movement of the ground in front of and surrounding the excavation, and minimizes subsidence of the surface, structures, and utilities above and in the vicinity of the excavation. The ground shall be supported to prevent loss of ground and keep the perimeters and faces of the tunnel stable.

E. Clean rock surfaces of the tunnel and vertical shaft; remove all loose blocks and fragments by barring, prying, and other hand methods which will not further fracture the rock.

F. The roof, sides, and portions of the inverts of the tunnel and vertical shaft shall be cleaned prior to backfilling, casting of the final lining or the application of shotcrete by blowing off dust, sludge, and fragments with an air-water jet.

G. Contractor shall install and keep in operation a safe, efficient and adequate ventilation system to extract rapidly all gases, smoke, and dust produced by blasting and for removal of any flammable gas that could be present, and to provide the personnel with adequate fresh air, to enable them to work under safe conditions. Ventilation of the tunnel shall be required 24-hours a day, seven (7) days a week. Continuous ventilation shall be provided in all underground areas until the tunnel is completed. All intermediate or booster fans required for tunnel ventilation shall be installed within the tunnel. No ventilation fans shall be allowed outside of the tunnel except at the shaft sites. All ventilation fans not within the tunnel shall be placed within an enclosure to limit ambient noise in accordance with the Project Requirements section and Temporary Facilities section.

H. Conduct all tunneling operations by methods and with equipment which will positively control dust, fumes, vapors, gases, fibers, fogs, mists, or other atmospheric impurities. Provide approved instrumentation for testing the quality of the tunnel atmosphere and obtain samples under working conditions at intervals requested by the Engineer. Submit the results of the quality tests to the Engineer.

I. Maintain clean working conditions at all times inside the tunnel. Remove all muck, slush, grout spills, and any other material not required for tunneling.

J. Contractor shall assume full and sole responsibility for the safety of the work and the protection of personnel and property in the performance of work. Contractor shall design, furnish, install, test, and maintain support systems as required to meet this responsibility.

K. Construct the tunnel support system to proper line and grade. The tunnel support system may penetrate the tunnel A lines as shown on the Contract Drawings provided there is sufficient room to remove the roadheader, if used, without damage to the tunnel support system. The Contractor shall use the baselines and benchmarks established by the Engineer to establish and maintain construction control points, reference lines and grades for locating tunnel. The Contractor shall establish control points sufficiently far from the face so as not to be affected by the tunneling operations. The Contractor shall ensure that if settlement of the ground surface occurs during construction which affects the accuracy of the temporary benchmarks, the Contractor shall detect and report such movement and reestablish temporary benchmarks.

L. Tolerances for completed tunnel and shaft underground work with final lining in place shall be according to the following:

1. Departure from the established alignment- no more than a total of 6 inches at any point.

2. Departure from established grade- All final lining is not to exceed 1inch per 100 feet or a total of 3 inches, with no back grades.

3. Variation from inside dimension- not less than the dimensions shown on the Contract Drawings.

M. The Contractor shall establish survey station markers over the entire length of the tunnel during excavation to an accuracy of 0.1 foot, at intervals of not more than 500 feet, and at each point of tangency and point of curvature for horizontal curves.

N. The Contractor shall provide simple, legible, painted intermediate tunnel station markers over the entire length of the tunnel during excavation at 50 foot stations, with 8 inch minimum letter height in a contrasting color to the background. The markings shall be on the same side of the tunnel at eye level near the springline, unobstructed from view, throughout the tunnel. The Contractor shall maintain station markers within 50 feet of the face.

O. The Contractor shall provide access and logistical support to assist the Engineer in verifying the Contractor's survey.

P. Waste materials removed from the excavation shall be handled, transported, and disposed of in accordance with the section 312000. In addition, all trucks and other vehicles used for the removal of material shall prevent wind borne losses. Whenever any truck, bucket or other vehicle so used is leaky or unsuitable it shall be immediately withdrawn from the work.

3.02 PREPARATION

A. Contractor shall ensure that an adequate supply of materials are stored on site and available in the amounts needed to install support systems of the type required to support the ground and to provide safe working conditions as soon as practicable during the excavation cycle.

B. All surfaces shall be scaled prior to installation of supports

C. All support elements shall be inspected immediately prior to their use to verify their ability to serve their intended function, including steel shapes, bars, fasteners, and accessories. Ensure that all metal objects are free of scale, rust, mud, oil, grease, concrete and other objectionable materials and of true shape.

3.03 INSTALLATION OF ROCK REINFORCEMENT

A. General

1. Contractor shall install supports as soon as possible after excavation and as close to the heading as work will permit in accordance with Section 312340.

2. Any damaged supports, and any improperly installed initial support shall be removed and replaced or repaired immediately by the Contractor in a manner acceptable to the Engineer.

3. All welding shall conform to the application provisions of ANSI/AWS D1.1.

3.04 TEMPORARY DRAINAGE

A. Install and maintain temporary drainage facilities of adequate size, with standby pumps for emergency use, to collect and dispose of water which enters the underground excavations. Do not permit water to stand at the tunnel face or in working areas.

3.05 GROUTING

A. If determined to be necessary by Engineer, utilize grouting to control flow of water. If used, grouting shall be in accordance with Section 02854

3.06 FINAL LINING

A. Final lining in the tunnel shall be installed in accordance with Section 334420, and as shown on the Drawings

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section covers work necessary for stabilization of soil to prevent erosion and sedimentation during and after construction and land disturbing activities. The work shall include the furnishing of all labor, materials, tools, and equipment to perform the work and services necessary as herein specified and as indicated on the Drawings. This shall include installation, maintenance, and final removal of all temporary soil erosion and sediment control measures. All erosion and sediment control methods and devices used shall conform to the latest requirements imposed by federal, state and local authorities.

B. Comply with the latest version of the New York State Standards and Specifications for Erosion and Sediment Control.

C. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. The right is reserved to modify the use, location, and quantities of soil erosion and sediment control measures based on activities of the Contractor and as the Engineer considers to be the best interest of the Owner.

D. The Contractor shall be responsible for repair of any damage caused and shall be financially responsible for any penalties imposed.

1.2 QUALITY ASSURANCE

A. Soil erosion and sediment control measures shall be implemented in accordance with the requirements and procedures outlined in this specification, contract Drawings and documents, state standards or guidelines for soil erosion and sediment control, and all regulatory authorities having jurisdiction. Where conflicts between requirements exist, the more restrictive rules shall govern.

B. The Contractor shall provide all temporary control measures shown on the Drawings, or as directed by the Owner, Owner's representative, or soil conservation district for the duration of the contract. Erosion and sediment control Drawings are intended to be a guide to address the stages of work shown. Additional measures not specified on the Drawings may be necessary and shall be implemented to address intermediary stages of work and any conditions that may develop during construction at no cost to the Owner.

C. Temporary control provisions shall be coordinated with permanent erosion control features to the extent practical to assure economical, effective and continuous erosion and sediment control throughout the construction and post-construction period.

D. Soil erosion and sediment control measures shall at all times be satisfactory to the Owner's Representative. Owner's Representative will inform the Contractor of unsatisfactory construction procedures and operations if observed. If the unsatisfactory construction procedures and operations are not responded to and corrected within 48 hours, the Owner's Representative may suspend the performance of any or all other construction until the unsatisfactory condition has been corrected. Such suspension shall not be the basis of any claim by the Contractor for additional compensation nor for an extension of time to complete the work. Any complaints, fines, etc. relating to ineffective erosion control, shall be the sole responsibility of the Contractor.

E. The Contractor shall inspect all soil erosion and sediment control measures at least at the beginning and end of each day to ascertain that all devices are functioning properly during construction. Maintenance of all soil erosion and sediment control measures on the project site shall be the responsibility of the Contractor until final stabilization is complete, and until the permanent soil erosion controls are established and in proper working condition.

F. The Contractor shall protect adjacent properties and watercourses from soil erosion and sediment damage throughout construction.

1.3 GENERAL

A. Soil erosion stabilization and sediment control measures consist of the following elements:

1. Maintenance of existing permanent or temporary storm drainage piping and channel systems, as necessary.
2. Installation and maintenance of stabilized construction entrance(s).
3. Construction of new permanent and temporary storm drainage piping and channel systems, as necessary.
4. Construction of temporary erosion control facilities such as silt fences, compost filter socks, check dams, etc.
5. Topsoil and Seeding: Placement and maintenance of Temporary Seeding on all areas disturbed by construction. Placement of permanent topsoil, fertilizer, and seed, etc., in all areas not occupied by structures or pavement, unless shown otherwise.
6. Soil Stabilization Seeding: Placement of fertilizer and seed, etc., in areas as Specified hereinafter.

B. The Contractor shall he responsible for phasing Work in areas allocated for his exclusive use during this Project, including any proposed stockpile areas, to restrict sediment transport. This will include installation of any temporary erosion control devices, ditches, or other facilities.

C. The areas set aside for the Contractor's use during the Project may be temporarily developed to provide satisfactory working, staging, and administrative areas for his exclusive use. Preparation of these areas shall be in accordance with other

requirements contained within these Specifications and shall he done in a manner to both control all sediment transport away from the area.

D. Stockpiles remaining in place longer than 14 calendar days shall be considered permanent stockpiles for purposes of erosion and sediment control.

E. All permanent stockpiles shall be seeded with soil stabilization seed and protected by construction of silt fences completely surrounding stockpiles and located within 10 feet of' the toes of the stockpile slopes.

F. Sediment transport and erosion from working stockpiles shall be controlled and restricted from moving beyond the immediate stockpile area by construction of temporary toe-of-slope ditches and accompanying silt fences as necessary. The Contractor shall keep these temporary facilities in operational condition by regular cleaning, re-grading, and maintenance.

G. The Contractor shall maintain all elements of the Soil Erosion Stabilization and Sedimentation Control systems and facilities to be constructed during this Project for the duration of his activities on this Project.

H. Formal inspections made jointly by the Contractor and the Engineer shall be conducted every 2 weeks to evaluate the Contractor's conformance to the requirements of these Specifications.

I. Replacement or repair of failed or overloaded silt fences, check dams, or other temporary erosion control devices shall be accomplished by the Contractor within 24 hours after receiving written notice from the Engineer.

J. If the Contractor has not complied with any of the above maintenance efforts to the satisfaction of the Engineer within 2 working days after receiving written notification from the Engineer, the Owner shall have the prerogative of engaging others to perform any needed maintenance or cleanup, including removal of accumulated sediment at constructed erosion control facilities, and deduct from the Contractor's monthly partial payment the costs for such efforts in accordance with the General Condition of the Contract.

1.4 SUBMITTALS

A. Submittals shall he made in accordance with Section "Submittal Procedures".

B. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

C. Results of all tests and investigations, including recommendations.

D. Submit product data, samples, specifications and manufacturer's installation procedures for approval as directed by Engineer prior to use.

PART 2 - PRODUCTS

2.1 GENERAL

A. Contractor shall provide all materials necessary to perform the work in accordance with the New York State Standards and Specifications for Erosion and Sediment Control or as shown on the Drawings or specified herein.

2.2 SOIL STABILIZATION AND TEMPORARY SEED

A. Temporary Seed: Rye grass, cereal grasses or other quick growing species suitable to the area as a temporary cover, which will not compete with the grasses specified for permanent cover, or as specified on the Drawings.

2.3 TOPSOIL

A. Topsoil shall be as specified under Section "Soil Preparation."

2.4 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds or clean salt hay.

2.5 COMPOST FILTER SOCK

A. Compost Filter Sock shall conform to the requirements of Section 5 of the New York State Standards and Specifications for Erosion Control.

2.6 SILT FENCE

A. Silt Fence shall conform to the requirements of Section 5 of the New York State Standards and Specifications for Erosion Control.

2.7 EROSION CONTROL BLANKET

A. Erosion Control Blanket (ECB) shall be constructed with a layer of 70 percent straw and 30 percent coconut fiber stitched with degradable thread between a heavyweight UV stabilized polypropylene top net (3 pounds) and a lightweight photodegradable polypropylene bottom net (1.50 pounds). Both the netting and fiber material shall be green in color. Acceptable products shall include SC150 Double Net Straw-Coconut Blanket as manufactured by North American Green; Curlex Double Net (Curlex II) as manufactured by American Excelsior Company or an approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Review the soil erosion and sediment control Drawings as they apply to current conditions. Any deviation from the Drawings must be submitted for approval to the site Engineer in writing at least 72 hours prior to commencing that work.

B. Initial soil sediment and erosion control devices shall be in place prior to any land disturbing activity, in their proper sequence, and maintained until permanent protection is established.

C. The limit of the area of any earthwork operations in progress shall be commensurate with the Contractor's capability and progress in keeping the finished grading, mulching, seeding, and other such permanent control measures current and in accordance with the accepted schedule for construction phasing. Should seasonal limitations make such coordination unrealistic, as determined by the Owner's Representative, temporary erosion control measures shall be provided immediately by the Contractor at no expense of the Owner.

D. Temporary erosion control measures shall be used to correct conditions which develop during construction that are needed prior to installation of permanent control features, or that are temporarily needed to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

E. The Contractor shall incorporate all permanent erosion control features (stabilization) into the project at the earliest practical time to minimize the need for temporary controls.

F. Dust Control: The Contractor shall provide a commercial grade; enclosed broom mechanical street sweeper to control sediment and/or dust that is tracked on to the adjacent streets. The street sweeper shall be equipped with a water storage tank to wet the area prior to sweeping. Where on site controls do not prevent material from being tracked on to adjacent streets, the street sweeper shall be used to clean the adjacent streets immediately. In addition, at a minimum, the adjacent streets shall be swept at the end of each day or as directed by the Engineer.

G. Any disturbed or stockpiled areas that will be left exposed more than 14 days or less according to State NPDES General Stormwater Permits shall immediately receive temporary or permanent seeding. Mulch/straw shall be used if the season prevents the establishment of a temporary cover. Disturbed areas shall be limed and fertilized prior to temporary seeding.

H. Permanent vegetation shall be established as specified on all exposed areas within 7 days or less according to State NPDES General Stormwater Permits after final grading. Mulch as necessary for seed protection and establishment. Lime and fertilize seedbed prior to permanent seeding.

I. Slopes shall be permanently seeded and mulched. Any slopes that erode easily shall be temporarily seeded and mulched. Any slopes deeper than 3:1 or steeper or as indicated on Drawings shall be protected with Erosion Control Blanket per specifications.

J. All storm drainage outlets must be stabilized, as specified, before the discharge points become operational. Equip all inlets with inlet protection immediately upon construction.

K. Soil erosion and sediment control shall include but not be limited to the approved measures. The Contractor shall be responsible for providing all additional measures that may be necessary to accomplish the intent of the Drawings.

L. Comply with all other requirements of authorities having jurisdiction.

M. Soil Stabilization and Temporary Seeding:
   1. Soil stabilization seeding shall consist of the application of the following materials in quantities as further described herein for stockpiles and disturbed areas left inactive for more than 14 days.
      a. Lime.
      b. Fertilizer.
      c. Seed.
      d. Mulch.
      e. Maintenance.
   2. Hydroseeding will be permitted as an alternative method of applying seed and associated soil conditioning agents described above. Should the Contractor elect to apply soil stabilization seeding by hydroseeding methods, he shall submit his operational plan and methods to the Engineer.
   3. Temporary Seeding is to be placed and maintained over all disturbed areas prior to Permanent Seeding. Maintain Temporary Seeding until such time as areas are approved for Permanent Seeding. As a minimum, maintenance shall include the following:
      a. Fix-up and reseeding of bare areas or re-disturbed areas.
      b. Mowing for stands of grass or weeds exceeding 6 inches in height.

N. Topsoil and Permanent Seeding: conform to the requirements of Section "Soil Preparation."

END OF SECTION

GEOTECHNICAL BASELINE REPORT

Beaver Creek Clean River Project

Albany Water Board (AWB),
Albany, New York

October 2020

CDM Smith

Geotechnical Baseline Report

For

BEAVER CREEK CLEAN RIVER PROJECT

Albany Water Board (AWB), Albany, New York

October 2020

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October 13, 2020

CDM Smith

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Acronyms

ACWPD	Albany County Water Purification District
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing Materials
ATL	Atlantic Testing Laboratories
AWB	Albany Water Board
bgs	below ground surface
bl/ft	Blows per foot
CDM Smith	Camp Dresser McKee & Smith
DSC	Differing Site Conditions
El.	Elevation
GBR	Geotechnical Baseline Report
GDR	Geotechnical Data Report
HQ	HQ single core barrel
JBL	Jersey Boring & Drilling Co., Inc.
MTBM	Microtunnel Boring Machine
NAD83	North American Datum 1983
NAVD88	North American Vertical Datum 1988
Project	Beaver Creek Clean River Project
psi	pounds per square inch
RMR	Rock Mass Rating
RQD	Rock Quality Designation
SPT	Standard Penetration Tests
Sta.	Station
UCS	Uniaxial Compressive Strength
USCS	Unified Soil Classification System
WOH	Weigh of Hammer

Section 1
Introduction

1.1 Introduction

This Geotechnical Baseline Report (GBR) has been prepared by Camp Dresser McKee & Smith (CDM Smith) under contract to Albany Water Board (AWB), for the proposed 72-inch sewer line running between the proposed diversion structure and the screening/disinfection facility and the 30-inch sewer discharge line running between the disinfection facility and the precast manhole structure #6; both are part of the Beaver Creek Clean River Project (Project). The project owner is the Albany Water Board. These sections of the Project are designed by CDM Smith. The term "Engineer" and CDM Smith are equivalent in this report.

This GBR is specifically related to the construction of tunnels and open cut segments required to install the 72-inch diameter and 30-inch diameter pipeline segments of the project identified herein, and the associated vertical access shafts, as shown on the Contract Drawings. The 72-inch sewer line and the 30-inch inter-connection line will be procured under separate contracts. Sections specifically related to the 30-inch inter-connection line are not applicable to the 72-inch sewer line; sections specifically related to the 72-inch sewer line are not applicable to the 30-inch inter-connection line. The tunnel for the 72-inch diameter pipeline will be approximately 528 feet in length. The tunnel for 30-inch diameter pipeline segment consist of five (5) individual tunnel runs ranging in length from approximately 250 feet to 700 feet with a combined length of approximately 2,280 feet. The remaining, approximately, 365 feet will be constructed by open cut.

This GBR covers the tunnel alignment defined for the 72-inch sewer pipe from Sta. 0+00 to Sta. 5+29.85. This GBR also covers the micro-tunnel and open cut alignment defined for the 30-inch inter-connection pipe from Sta. 0+00 to Sta. 26+96 (approx.). Although stationing for each tunnel starts at 0+00, the alignment is distinct; at no point do the stationing coincide.

1.2 Project Description

The Project is intended to screen and disinfect combined sewage from the Beaver Creek sewer in the City of Albany that is discharged from Outfall No. 016, or commonly referred to as Big C. The Project consists of constructing a new floatable control and disinfection facility, a new diversion structure, a new 72-inch diameter, 528 feet long sewer line, a new 30-inch diameter, 2,827 feet long wastewater inter-connection line, and other associated structures. The 72-inch diameter sewer line will consist of a 72-inch carrier pipe installed within an estimated 9-foot wide by 9-foot high horseshoe shaped tunnel segment excavated from a working shaft near the disinfection facility to a bulkhead location near Delaware Avenue and approximately 10 feet of tunnel from the working shaft toward the screening facility. This section will be bulkheaded as well. This tunnel segment will be referred to in this GBR as the 72-inch tunnel segment. A second tunnel segment and an open cut segment will be required for the construction of a new wastewater system 30-inch inter-connection line.

This second tunnel segment and the open cut segment will be referred to as the 30-inch tunnel and 30-inch open cut respectively. The purpose of the 30-inch line is to convey wastewater flows and screenings from the new facility to Third Avenue, and ultimately the Albany County Water Purification District (ACWPD) Hudson River Interceptor in the vicinity of South Pearl Street and Gansevoort Street.

1.3 Project Datum

The horizontal project datum is the North American Datum of 1983 (NAD83), in feet. The elevations (El.) noted herein are in feet and referenced to the North American Vertical Datum of 1988 (NAVD88).

1.4 Purpose and Organization of Geotechnical Reports

The geotechnical Contract Documents for this project are comprised of the Geotechnical Data Report (GDR) and the GBR. The description of these reports follows:

Geotechnical Data Report (GDR). The GDR presents a description of the field exploration and testing programs conducted for this project, provides a summary of the methods used for the explorations and testing procedures, provides an overview of the geologic setting and general site conditions, and contains the geotechnical data and information that has been obtained during the design.

Geotechnical Baseline Report (GBR). The primary purpose of the GBR, as defined by the American Society of Civil Engineers (ASCE) suggested guidelines (provide reference here), is to present contractual statements describing the geotechnical conditions anticipated (and to be assumed by Contractors) to be encountered during underground construction. The contractual statements are referred to as baselines or baselines statements. GBR established baselines for the subsurface conditions are to be used by Contractors in preparing their bids and subsequently by the selected Contractor as the basis for any changed conditions claims for the underground work and by the Owner in evaluating differing site condition claims.

1.5 Hierarchy of Contract Documents

This GBR establishes baseline values for bidding and will be used to evaluate any Differing Site Conditions (DSC) claims during the work for tunneling, excavating and supporting the ground for this crossing. The GBR is binding upon the AWB and the Contractor. In the case of conflicts or inconsistencies among the Drawings and Specifications, the GBR and the GDR, precedence shall be given in the following order:

1. General Conditions,
2. Drawings,
3. Specifications,
4. Geotechnical Baseline Report, and
5. Geotechnical Data Report.

1.6 Organization of GBR

An outline of this GBR is presented below:

- Section 1 – Introduction: provides the project background, a project description, describes the purpose and scope, and limitations of this document.
- Section 2 – Geologic Setting and Subsurface Conditions: summarizes an overview of the geologic settings and subsurface conditions. This section also presents the contract interpretation of subsurface soil, and groundwater conditions that underlie the project.
- Section 3 – Baseline Values: provide uniform basis for all bidders in preparation of their bids, this section provides: 1) baseline values for geotechnical parameters, 2) ground conditions/behavior, and 3) groundwater conditions/inflows to be encountered during construction. This section also Identifies important geotechnical considerations and constraints which need to be addressed by the Contractor during construction.
- Section 4 – Construction Considerations: Construction considerations are not baseline statements and will not be accepted as the basis for any changed conditions claims. The intent of this section is to provide bidders with the Engineer's opinion of construction methods. This section discusses construction constraints and flexibilities for the proposed tunnel and open cut segments, the launch shaft and the receiving shaft including construction sequencing, excavation methods, and rationale the engineer assumed in preparing the other contract documents.
- Section 5 – References: includes relevant references.

1.7 Limitations of Use

The Contractor is responsible to read and consider the GBR and all other Contract Documents in their entirety in developing their project approach, construction means and methods, equipment selection, and in planning and bidding all other elements of the work. Bidders should have on staff or retain the services from a qualified engineering geologist/geotechnical tunneling engineer to help evaluate and interpret this document and related geologic/geotechnical documents.

In establishing these baselines, the Engineer considered available data and past construction experience in similar ground conditions. Although actual conditions encountered in the field are expected to be within the range of conditions discussed herein, there is no warranty that the baseline conditions will be encountered. Ground behavior will be influenced by the construction sequence and methods employed by the Contractor, as well as the Contractor’s equipment and workmanship. It has been assumed that the level of workmanship will be consistent with what can be reasonably expected from an experienced and qualified Contractor.

Section 2
Geologic Setting and Subsurface Conditions

This section presents an overview of the regional geologic conditions and the subsurface conditions along the 72-inch dimeter tunnel segment. The project area geology, subsurface conditions, and groundwater conditions discussed below are based on information obtained from local and regional geologic maps and reports, and the results of the field exploration and laboratory testing programs.

2.1 Regional Geology

The project site lies within the Hudson-Mohawk Lowlands, a physiographic feature that extends nearly the entire north-south length of eastern New York bounded everywhere by uplands except a few ridges in the south, narrowing to the north. The surficial topography is the result of multiple glacial advances and retreats, within which glacial Lake Albany was sited and includes the Mohawk, Black, and Hudson Rivers. The geology is dominated by Ordovician sedimentary rock including soft shales, limestone, sandstone, in addition to mélange (both exotic and non-exotic) from the progressive deformation of flysch (a sedimentary deposit consisting of thinly bedded shale or claystone with repetitive coarser grained sedimentary rock) as an accretionary wedge that occurred along the North American continental margin approximately 440 to 480 million years ago.

2.2 Surficial Geology

The soil cover along the proposed alignment consists of alluvial, and glacial deposits overlying the bedrock. The glacial deposits consist of clays, silts, and sands, commonly varved, that thicken to the east. Within the western portion of the project the soils are deep to shallow fill consisting of predominantly silt and clay which are underlain by silty clay and highly weathered moderately dipping shale. Soils along the eastern portion of the project consisted of a shallow veneer of fill underlain by fine-grained (periodically varved) glacio-lacustrine soils. At some locations dense, dry, coarse grained soils were and hard clay were also encountered just above bedrock. The uppermost bedrock unit in project area consists of moderately dipping shale of the Waterford Flysch Zone.

2.3 Site Exploration

Seventeen (17) test borings (B-1 through B-17) were drilled from March 25 to May 17, 2019 by Jersey Boring & Drilling Co., Inc. (JBD). Boring P-1 through P-7 were drilled between August 31 and September 4, 2020. Boring Locations are shown on **Figure 2-1**.

Atlantic Testing Laboratories (ATL), based out of Canton, New York drilled the borings B-1 through B-17 using a Geoprobe 7822 drill rig. CHA drilled borings P-1 through P-7 using a Geoprobe drill rig. Borings were advanced using rotary wash methods with 3-inch or 4-inch casing to bedrock. The rotary wash method consists of drilling using a tricone roller bit and

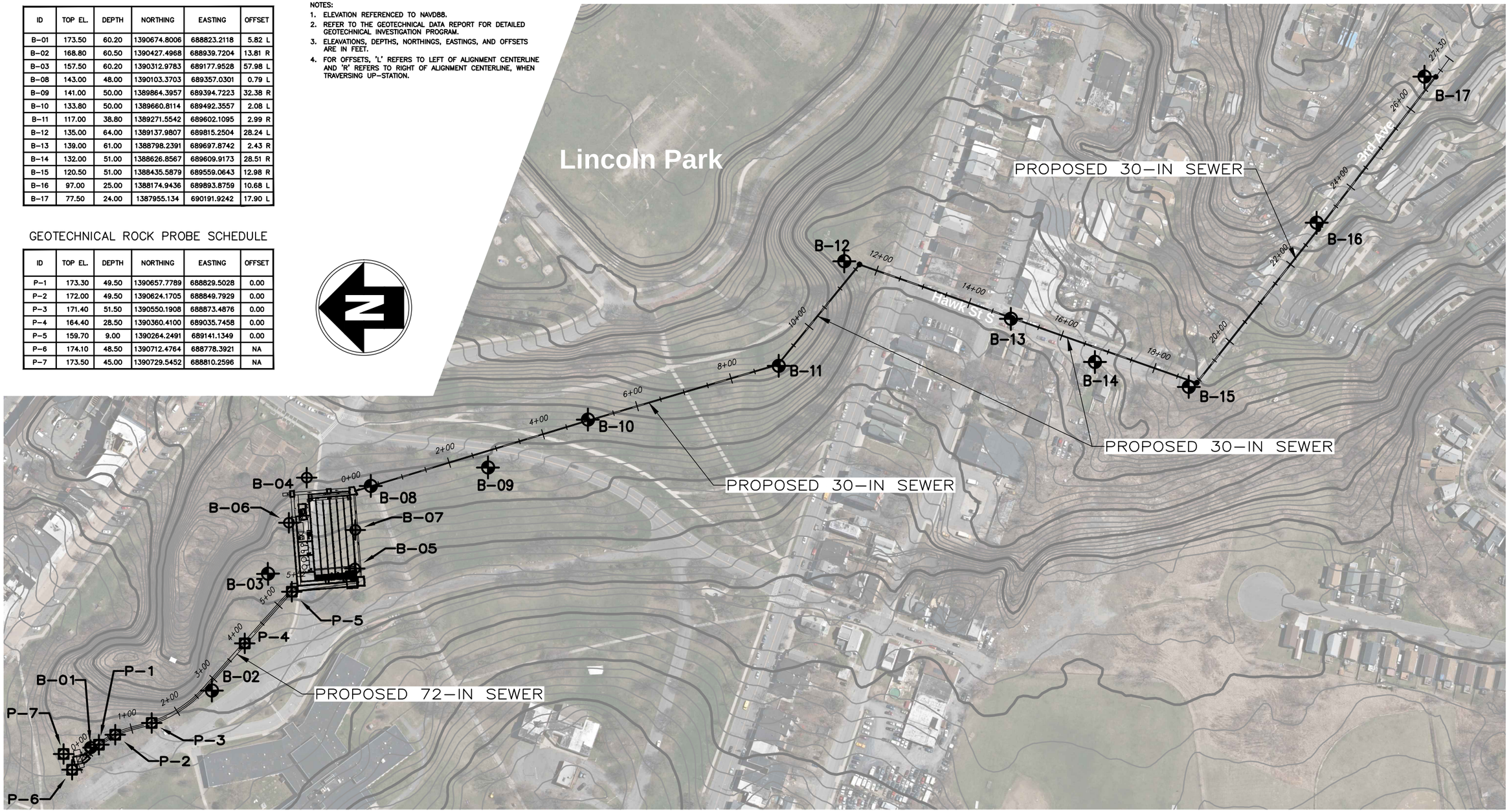
GEOTECHNICAL BORING SCHEDULE

ID	TOP EL.	DEPTH	NORTHING	EASTING	OFFSET
B-01	173.50	60.20	1390674.8006	688823.2118	5.82 L
B-02	168.80	60.50	1390427.4968	688939.7204	13.81 R
B-03	157.50	60.20	1390312.9783	689177.9528	57.98 L
B-08	143.00	48.00	1390103.3703	689357.0301	0.79 L
B-09	141.00	50.00	1389864.3957	689394.7223	32.38 R
B-10	133.80	50.00	1389660.8114	689492.3557	2.08 L
B-11	117.00	38.80	1389271.5542	689602.1095	2.99 R
B-12	135.00	64.00	1389137.9807	689815.2504	28.24 L
B-13	139.00	61.00	1388798.2391	689697.8742	2.43 R
B-14	132.00	51.00	1388626.8567	689609.9173	28.51 R
B-15	120.50	51.00	1388435.5879	689559.0643	12.98 R
B-16	97.00	25.00	1388174.9436	689893.8759	10.68 L
B-17	77.50	24.00	1387955.134	690191.9242	17.90 L

GEOTECHNICAL ROCK PROBE SCHEDULE

ID	TOP EL.	DEPTH	NORTHING	EASTING	OFFSET
P-1	173.30	49.50	1390657.7789	688829.5028	0.00
P-2	172.00	49.50	1390624.1705	688849.7929	0.00
P-3	171.40	51.50	1390550.1908	688873.4876	0.00
P-4	164.40	28.50	1390360.4100	689035.7458	0.00
P-5	159.70	9.00	1390264.2491	689141.1349	0.00
P-6	174.10	48.50	1390712.4764	688778.3921	NA
P-7	173.50	45.00	1390729.5452	688810.2596	NA

NOTES:
1. ELEVATION REFERENCED TO NAVD88.
2. REFER TO THE GEOTECHNICAL DATA REPORT FOR DETAILED GEOTECHNICAL INVESTIGATION PROGRAM.
3. ELEAVATIONS, DEPTHS, NORTHINGS, EASTINGS, AND OFFSETS ARE IN FEET.
4. FOR OFFSETS, 'L' REFERS TO LEFT OF ALIGNMENT CENTERLINE AND 'R' REFERS TO RIGHT OF ALIGNMENT CENTERLINE, WHEN TRAVERSING UP-STATION.



LEGEND

B-01 DESIGNATED AND APPROXIMATE LOCATION OF TEST BORINGS DRILLED AND LOGGED BY CDM SMITH BETWEEN MARCH 25, 2019 AND MAY 17, 2019.

B-4 DESIGNATED AND APPROXIMATE LOCATION OF TEST BORINGS DRILLED AND LOGGED BY CHA IN 2019.

P-1 DESIGNATION AND APPROXIMATE LOCATION OF ROCK PROBES DRILLED AND LOGGED BY CHA IN JULY 2020.

1" = 200'

100 0 200

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ALBANY, NEW YORK

BORING LOCATION PLAN

FIGURE 2-1

drilling fluid (recycled water) to wash the soil cutting from the borehole, cool the bit, and to maintain borehole stability. Soil sampling was performed using a split spoon sampler. Standard 5-foot sampling intervals were typically used from the ground surface to bedrock. At borings B-12, B-15, and B-17, continuous soil sampling intervals were used from the ground surface to bedrock, where tunnel shaft are anticipated for construction.

When competent rock was encountered, rock coring was conducted to advance the boring using a HQ single core barrel (HQ) samples were classified in the field and the Rock Quality Designation (RQD) was determined for each coring run. It should be noted that the use of a single core barrel can result in poor recovery and excess core breakage. A more complete description of the drilling methods and exploration locations is provided in the GDR.

2.4 Laboratory Testing

Representative samples of the overburden soil encountered in the explorations were tested at CDM Smith's Chelmsford, Massachusetts laboratory for moisture content (American Society for Testing Materials (ASTM) D2216), grain size distribution (ASTM D422 and ASTM D1140), and Atterberg limits (ASTM D4318). Laboratory test were conducted on representative samples of the rock core obtained from the test borings. Rock tests included uniaxial compressive strength (ASTM D7012), Point Load Index (ASTM D5731), CERCHAR Abrasivity Index (ASTM D7625), X-Ray Diffraction and thin section petrographic analysis. Geotechnical laboratory testing on rock was conducted by GeoTesting Express of Acton, Massachusetts, except for the petrographic analysis and X-Ray Diffraction, which were conducted by Spectrum Petrographics of Vancouver, Washington and K-T GeoServices Inc of Gunnison, Colorado, respectively. A complete description of the testing and results is provided in the GDR.

Geotechnical laboratory testing was performed on selected soil and rock samples. The laboratory testing program included index test, strength tests, and minerology tests to classify soil/rock into similar geologic units and project strata and to measure the engineering properties to support engineering analyses.

The following tests were performed:

Soil Testing:

- Twenty-seven (27) Atterberg Limits,
- Twenty-four (24) Hydrometer and Sieve Analysis,
- Twenty-five (25) moisture content tests, and
- Nineteen (19) triaxial tests on seven (7) undisturbed Shelby Tube samples.

Rock Testing:

- Nine (9) X-ray diffraction analyses. The predominant mineral detected in the test consisted of mixed layer clay minerals which ranged from 42 to 49 percent followed by Quartz which ranged from 32 to 26 percent. Mixed-layer clay minerals are materials in which different kinds of clay mineral layers alternate with each other. Commonly described mixed-layer clays include: illite-vermiculite, illite-smectite, chlorite-vermiculite (corrensite), chlorite-smectite, and kaolinite-smectite.
- Nine (9) petrographic analyses. The results identified that clay minerals were predominant in the sample.
- Three (3) Uniaxial Compressive strength tests, Because of the intensely fracture nature of the rock relatively few samples large enough for Unconfined Compressive Strength (UCS) test were obtained. The UCS of the claystone shale ranges from 121 to 1,713 pounds per square inch (psi) with an average value of 1,013 psi for the all three test samples that were tested.
- Eight (8) Brazilian splitting tensile strength tests.
- Nineteen (19) axial point load tests. The point load index (IS50) ranged from 15 to 175 psi in axial testing orientation.
- Eleven (11) Cerchar Abrasivity index tests. The results of these tests ranged from 0.61 to 1.01 with an average of 0.77.
- Four (4) Drillability Index Suite tests. The test results ranges are as show in **Table 2-1**.
- Nine (9) Slake Durability tests. Slake durability index of the tested samples ranged from 96.6 to 98.8.

Table 2-1 Drillibility Test Results

Test Result	Result Range
Drilling Rate Index	70 – 81
Bit Wear Index	8 – 15
Cutter Life Index	63.3 – 116.6

2.5 Subsurface Conditions

The subsurface conditions encountered at the proposed tunnel segments consisted of fill, clay, Sand – Silt, and hard clay with sand and gravel overlying weathered shale and shale.

2.5.1 Fill

Fill was encountered at all three exploration locations. The fill layer thickness ranged from approximately 7 to 25 feet at the exploration locations and consisted of brown, SILT and CLAY with trace sand and gravel and various amounts of debris and organic matter.

2.5.2 Clay

The clay layer was encountered at boring locations B-1, B-2, B-10 through B-17, and its thickness generally ranged between 5 and 14 feet. This layer typically consisted of tan to reddish brown, silty clay with various amount of sand and gravel, and occasionally interbedded layers of fine sand. Consistency of the material ranged from very soft to stiff. Very soft to soft soils were typically encountered near the top of groundwater table with higher strength soil layers both above and below the very soft layers. Standard Penetration Tests (SPT) N-values in this layer ranged from weight of hammer (WOH) to 14+ blows per foot (bl/ft) with an average of about 7 bl/ft at the exploration locations. The Unified Soil Classification System (USCS) symbol of the soils within this layer include CL (Low Plastic Clay), SM (Silty Sand) and CH (High Plastic Clay).

2.5.3 Very Stiff to Hard Clay with Sand and Gravel

The Very Stiff to Hard Clay with Sand and Gravel was encountered at boring locations B-8 and B-9, and the thickness generally ranged between 1 and 7 feet. This layer typically consisted of very stiff to hard gray, silty clay with various amount of sand and gravel, and occasionally interbedded layers of fine sand. SPT N-values in this layer ranged from 41 bl/ft to 69+ bl/ft with an average of about 52 bl/ft at the exploration locations. The USCS classification symbol of the soils within this layer include CL (Low Plastic Clay), SC (Clayey Sand) and CH (High Plastic Clay).

2.5.4 Sand - Silt

The sand layer was encountered at boring locations B-10, B-11, B-13, B-14, and B-15, and the thickness generally ranged between 5 and 8 feet. This layer typically consisted of very dense, olive brown to gray, sand with occasionally interbedded thin layers of silt and clay. SPT N-values in this layer ranged from 29 bl/ft to 67+ bl/ft with an average of about 48 bl/ft at the exploration locations. The USCS classification symbol of the soils within this layer include SP (Poorly Graded Sand), GC (Clayey Gravel), and SM (Silty Sand).

2.5.5 Weathered Shale

The boundary between soil and rock is not sharply defined. This transitional zone for this project has been characterized as “Weathered Shale”. Weathered shale is found overlying all the parent shale bedrock units encountered at boring locations B-1 through B-11. Weathered shale is defined, for engineering purposes, as residual material exhibiting Standard Penetration Resistances in excess of 50 bl/ft and rock exhibiting an RQD of less than 50. Because of the transitional nature of the weathering, the profile of the Weathered shale is irregular and erratic, even over short horizontal distances. The Weathered shale layer will have a variable thickness and grades to unweathered rock with depth. RQD values in this layer ranged from 0 to 43 percent with an average of about 20 percent at the exploration locations.

Based on the rock core data RQD, the Q-value for rock mass classification, and the Rock Mass Rating (RMR) were calculated. Q-values ranged from 0.2 (very poor) to 4.1(fair) with an average of 1.7 (poor). RMR values ranged from 14 (very poor) to 31(poor) with an average of 22.3(poor). These values are typical for highly fractured rock.

2.5.6 Shale

Bedrock consisting of dark gray moderately to slightly weathered shale was encountered below approximate El. 114 at the B-1 exploration location, El. 133 at the B-2, and El. 129 at the B-3. The RQD of the shale are anticipated to range from 0 to 100 percent.

Based on the rock core data RQD, the Q-value for rock mass classification, and the RMR were calculated. Q-values ranged from 0.3 (very poor) to 30 (good) with an average of 4.9 (fair). RMR values ranged from 20 (very poor) to 44 (fair) with an average of 29.3 (poor). These values are typical for intensely fractured rock.

2.5.7 Groundwater

Along the open cut segment and along both tunnel segments, the Contractor can anticipate encountering groundwater near the top of the clay stratum or within the fill. The groundwater levels are expected to vary with the season and rainfall intensity within the range indicated. The levels will vary with time, season, temperature, the amount of rainfall, and construction activities in the area, as well as other factors. Therefore, groundwater conditions at the time of construction may be different from those found during the exploration program.

As part of the field geologic investigation effort, the groundwater levels were recorded and documented at all exploration locations. Water levels measured in the explorations do not necessarily represent stabilized groundwater levels. Available information regarding the groundwater levels is presented on the boring logs in the GDR. Permeability of the shale was measured by packer testing in the borings B-2 and B-3 above and within10 feet of the tunnel vertical alignment. The calculated Lugeon values ranged from 0 to 3.78 Lugeons and averaged 0.76 Lugeons.

Section 3

Baseline Statements

3.1 Shafts

The shaft locations are expected to be dominated by medium to high plastic clay (CL-CH) with sand lenses at or near the top of the weathered rock contact. Soil conditions will be firm to squeezing in accordance with the Tunnelman's Ground Classification system as shown in **Table 3-1**. Below the overlying soils the shaft excavation will encounter weathered rock that grades into intensely fractured shale with depth. Anticipated rock mass behavior during shaft excavation and when tunneling operation are ongoing are based on the RMR and the Rock Quality Rating or Q-system that is expected to be poor to very poor. The anticipated top elevations for each of the rock stratum are shown in **Table 3-2**.

3.1.1 72-inch Tunnel Working Shaft

The profile shown on **Figure 3-1** is specific for the 72-inch sewer pipe installed in a 9-feet (approximately) diameter tunnel. A working shaft centered at Sta. 5+08 will be constructed and used for the tunnel excavation.

This shaft will encounter fill and clay with some sand lenses overlying moderately hard to hard weathered and frequently fractured, shale. SPT values in the soil ranged from 7 to 36 blows per foot. RQD values of the upper twelve feet of weathered shale ranges from 0 to 50 percent with an average of 24 percent. Values in the shale below the weathered zone RQD range from 0 percent to 85 percent with an average of 34 percent. Rock conditions are expected to be Poor to Very Poor-Quality Shale. Fracture spacings of less than 0.3 feet are anticipated. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block should be expected.

Drilling for the installation of rock bolts is anticipated to be difficult. Fractured rock is anticipated to bind with the rock drill slowing drilling rates and fractured rock may prevent the insertion of the bolt slowing rock bolt installation or requiring additional drilling.

3.1.2 30-inch Tunnel Shafts

The profile shown on **Figures 3-2 and 3-3** is specific for the 30-inch sewer.

Shaft at Station 0+00

The shaft centered at Sta. 0+00 will be constructed and used for the tunnel and manhole construction. This shaft will encounter fill and Hard Clay with sand and gravel layers overlying moderately hard to hard, weathered shale and frequently fractured, shale. SPT values in the soil ranged from 6 to 69 blows per foot. RQD values of the upper weathered shale ranges from 0 to 29 percent with an average of 15 percent and below this weathered shale zone RQD values range from 12 percent to 100 percent with an average of 42 percent. Fracture spacings of less than 0.3 feet are anticipated. Soils may be slow or fast raveling depending upon degree of overstress. Rock conditions are expected to be Poor to Very Poor-Quality Shale. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded

Table 3-1 Tunnelman's Ground Classification

CLASSIFICATION	BEHAVIOR	TYPICAL SOIL TYPES
Firm	Heading can be advanced without initial support, and final lining can be constructed before ground starts to move.	Loess above water table, hard clay, marl, cemented sand and gravel when not highly overstressed.
Slow Raveling to Fast Raveling	Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed; due to loosening or to overstress and "brittle" fracture (ground separates or breaks along distinct surfaces, as opposed to squeezing ground). In fast raveling ground, the process starts within a few minutes; otherwise, the ground is slow raveling.	Residual soils or sand with small amounts of binder may be fast raveling below the water table, slow raveling above. Stiff fissured clays may be slow or fast raveling depending upon degree of overstress.
Squeezing	Ground squeezes or extrudes plastically into tunnel, without visible fracturing or loss of continuity, and without perceptible increase in water content. Ductile, plastic yield and flow due to overstress.	Ground with low frictional strength. Rate of squeeze depends on degree of overstress. Occurs at shallow to medium depth in clay of very soft to medium consistency. Stiff to hard clay under high cover may move in a combination of raveling at excavation surface and squeezing at depth behind face.
Cohesive Running to Running	Granular materials without cohesion are unstable at a slope greater than their angle of repose (+ 30°-35°). When exposed at steeper slopes, they run like granulated sugar or dune sand until the slope flattens to the angle of repose.	Clean, dry granular materials. Apparent cohesion in moist sand, or weak cementation in any granular soil, may allow the material to stand for a brief period of raveling before it breaks down and runs. Such behavior is cohesive running.
Flowing	A mixture of soil and water flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown, and wall, and can flow for great distances, completely filling the tunnel in some cases.	Below the water table in silt, sand, or gravel without enough clay content to give significant cohesion and plasticity. May also occur in highly sensitive clay when such material is disturbed.
Swelling	Ground absorbs water, increases in volume, and expands slowly into the tunnel.	Highly pre-consolidated clay with plasticity index in excess of about 30, generally containing significant percentages of montmorillonite.

Modified from Terzaghi (1946) by Heuer (1974)

Table 3-2 Top of Rock

	Shaft			
	72-inch Tunnel	30-inch Tunnel		
	Sta. 5+08	Sta. 0+00	Sta. 5+00	Sta. 9+00
Top of Weathered Shale Elevation (ft)	144-152	133-129	108-104	96-92
Top of Shale Elevation (ft)	138-144	123-119	100-96	87-83

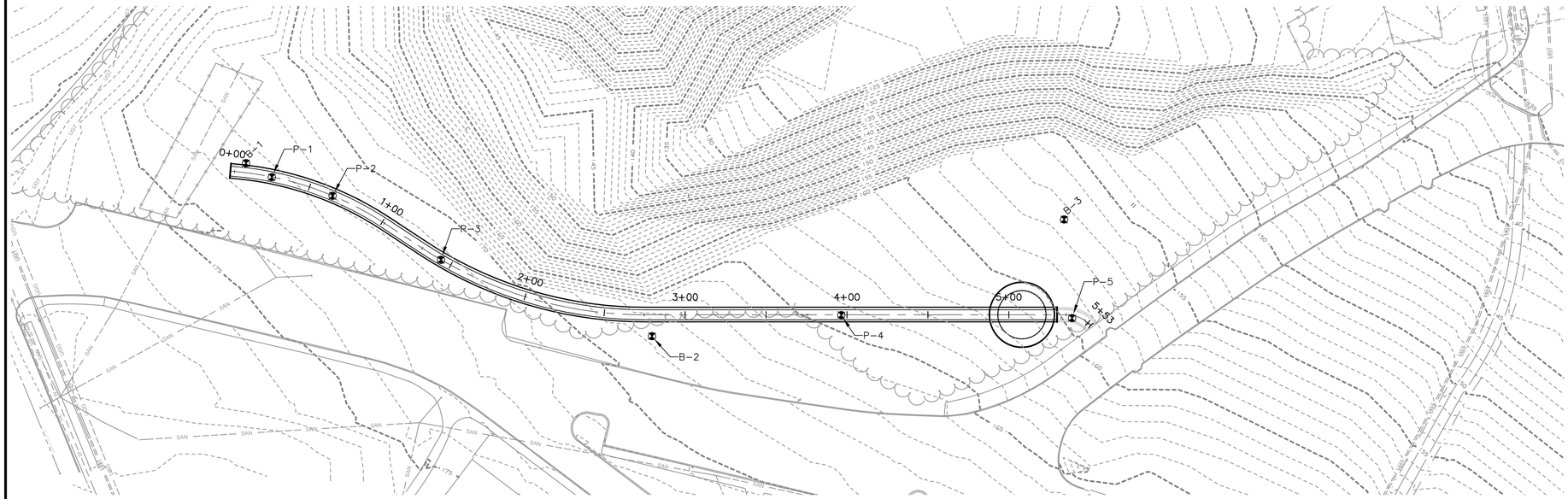
block should be expected. For base line purposes the Contractor should expect to encounter boulders and hard drilling within the hard clay that will require special tooling. Driving of sheet piles is not expected to be feasible. With proper drilling tooling the boulders shall be considered incidental to the shaft construction. However, production rates for the installation of shafts support shall expected to be reduced by half within the Hard Clay. Drilling for the installation of rock bolts is anticipated to be difficult. Fractured rock is anticipated to bind with the rock drill slowing drilling rates and fractured rock may prevent the insertion of the bolt slowing rock bolt installation or requiring additional drilling.

Shaft - Manhole Structure #2

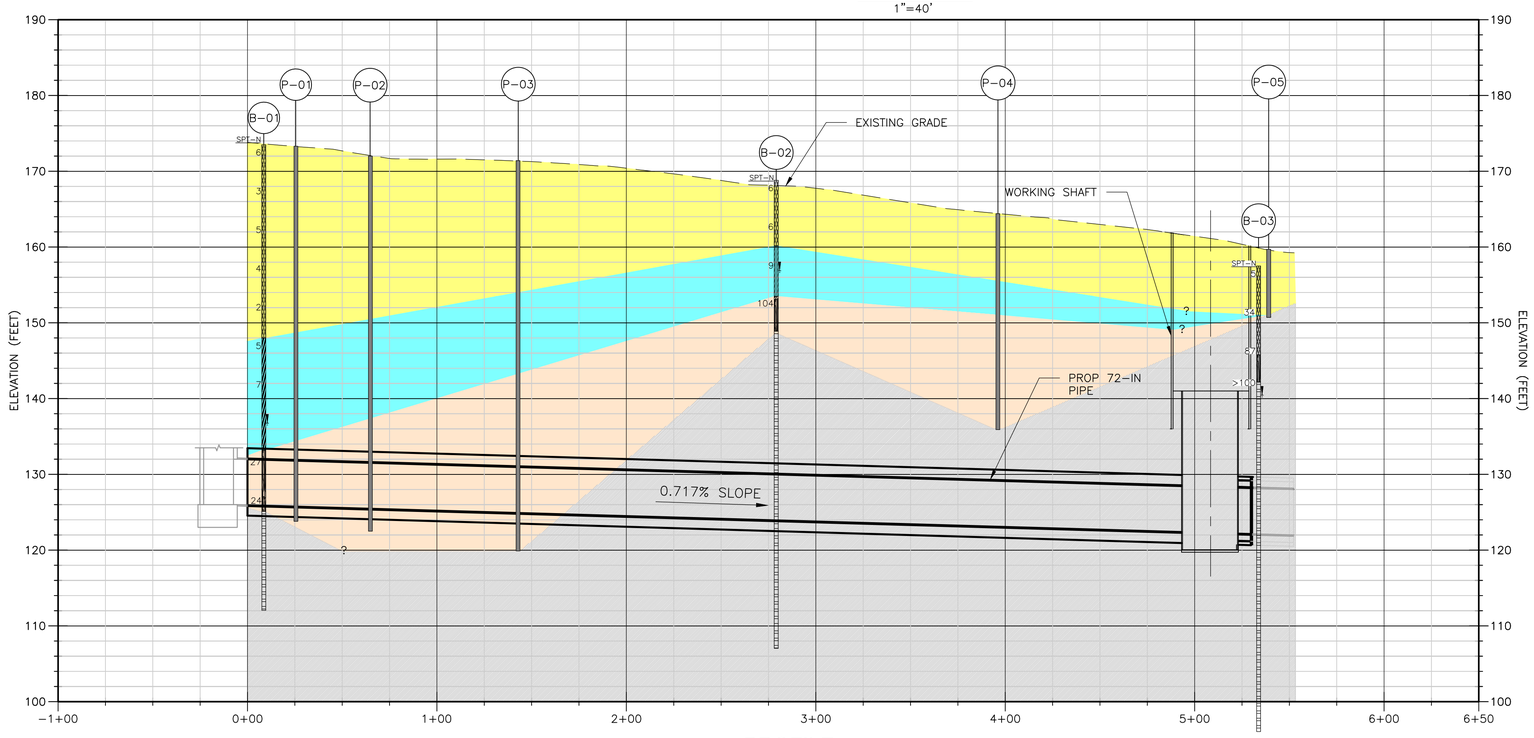
The shaft centered at Sta. 5+00 will be constructed and used for the tunnel and manhole construction. This shaft will encounter fill, medium stiff clay and weathered shale overlying moderately hard to hard, frequently fractured, shale. SPT values in the soil ranged from 7 to 37 blows per foot. RQD values of the weathered shale ranges from 0 to 46 percent with an average of 15 percent and below weathered shale zone RQD values range from 48 percent to 84 percent with an average of 36 percent. Fracture spacings of less than 0.3 feet are anticipated. Squeezing to raveling soil conditions should be anticipated. Soil will squeeze or ravel into the excavation. Depending on the moisture content ductile, plastic yield and flow may occur due to overstress. Rock conditions are expected to be Poor to Very Poor-Quality Shale. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block should be expected. Drilling for the installation of rock bolts is anticipated to be difficult. Fractured rock is anticipated to bind with the rock drill slowing drilling rates and fractured rock may prevent the insertion of the bolt slowing rock bolt installation or requiring additional drilling.

Shaft - Manhole Structure #3

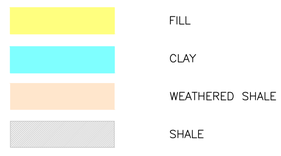
The working shaft centered at Sta. 9+00 will be constructed and used for the tunnel and manhole construction. This shaft will encounter fill, medium stiff clay and dense sand and weathered rock overlying moderately hard to hard, frequently fractured, shale. SPT values in the soil ranged from 7 to 37 bl/ft. RQD values of the shale ranges from 0 to 79 percent with an average of 52 percent. Fracture spacings of less than 0.3 feet are anticipated. Squeezing to raveling soil conditions should be anticipated Above the water table soil will squeeze or ravel into the excavation. below the water table ductile, plastic yield and flowing conditions may occur due to overstress. Rock conditions are expected to be Poor to Very Poor-Quality Shale. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block should be expected.



PLAN
1"=40'



PROFILE
HORIZ: 1"=40'
VERT: 1"=10'

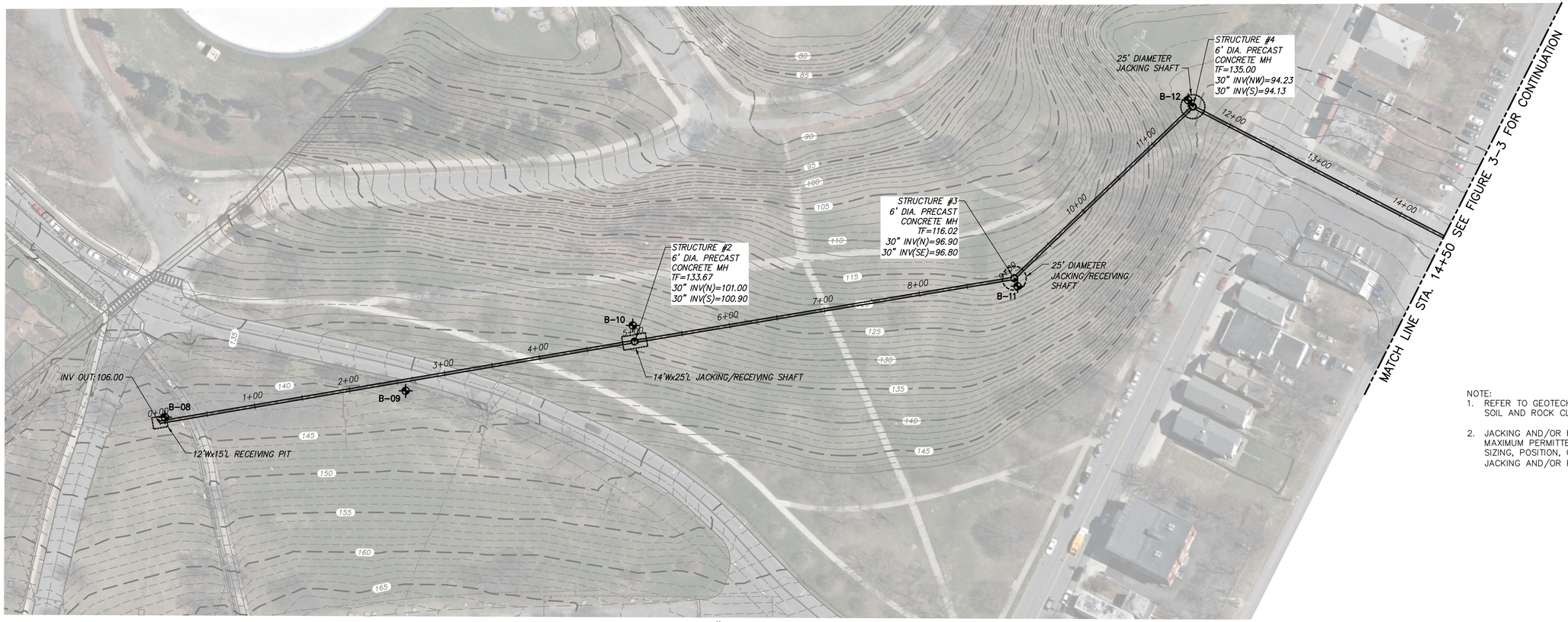


0 20 40
Scale in feet

CDM Smith

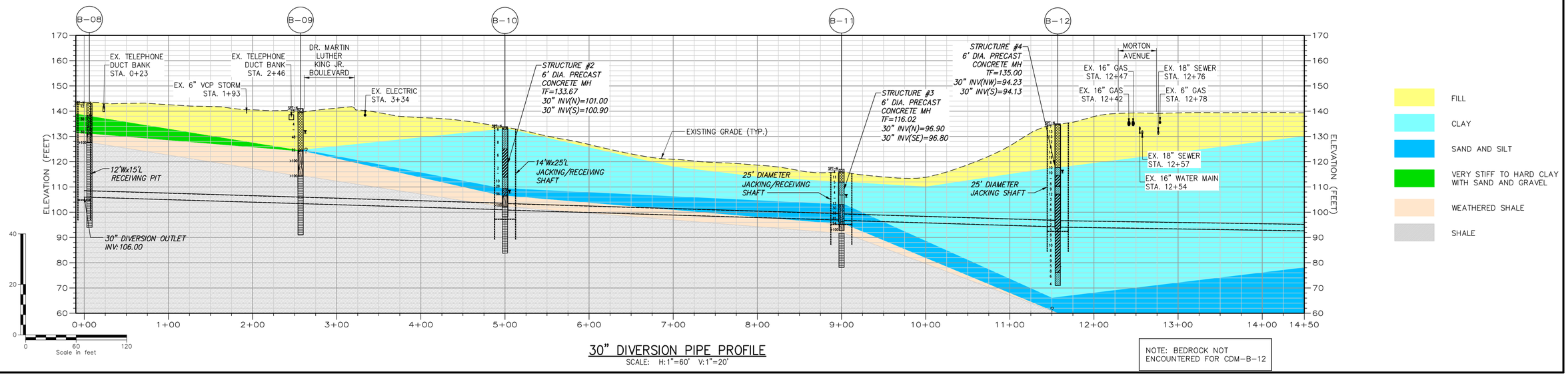
ALBANY WATER BOARD
BEAVER CREEK CLEAN RIVER PROJECT
ALBANY, NEW YORK

PROPOSED 72-IN PIPELINE PLAN AND PROFILE
FIGURE 3-1



NOTE:
1. REFER TO GEOTECHNICAL DATA REPORT FOR THE DETAILS ON SOIL AND ROCK CLASSIFICATION.
2. JACKING AND/OR RECEIVING SHAFT/PIT SIZES SHOWN AS MAXIMUM PERMITTED. CONTRACTOR SHALL BE RESPONSIBLE FOR SIZING, POSITION, ORIENTING, DESIGNING, AND ETC., THE JACKING AND/OR RECEIVING SHAFTS AND/OR PITS.

30" DIVERSION PIPE LAYOUT PLAN
SCALE: 1"=60'



30" DIVERSION PIPE PROFILE
SCALE: H:1"=60' V:1"=20'

NOTE: BEDROCK NOT ENCOUNTERED FOR CDM-B-12

CDM Smith

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BEAVER CREEK CLEAN RIVER PROJECT
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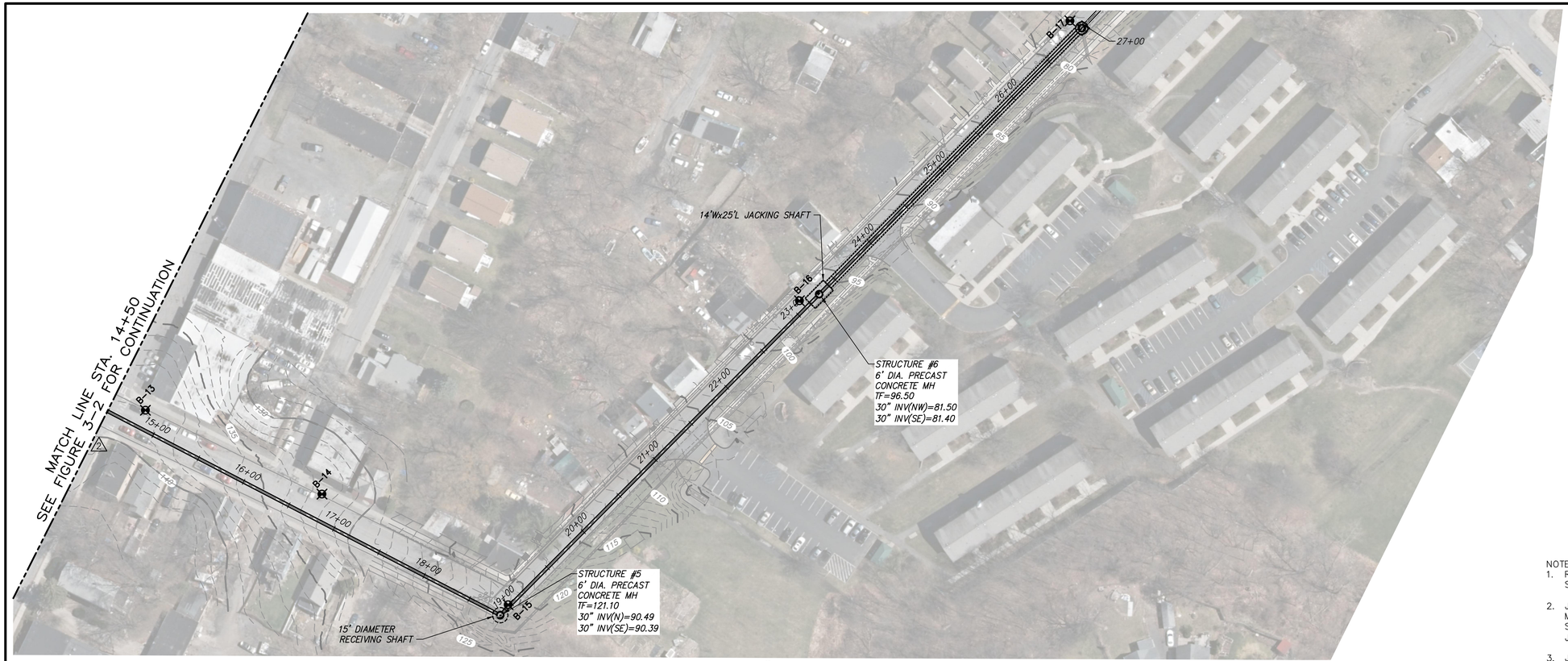
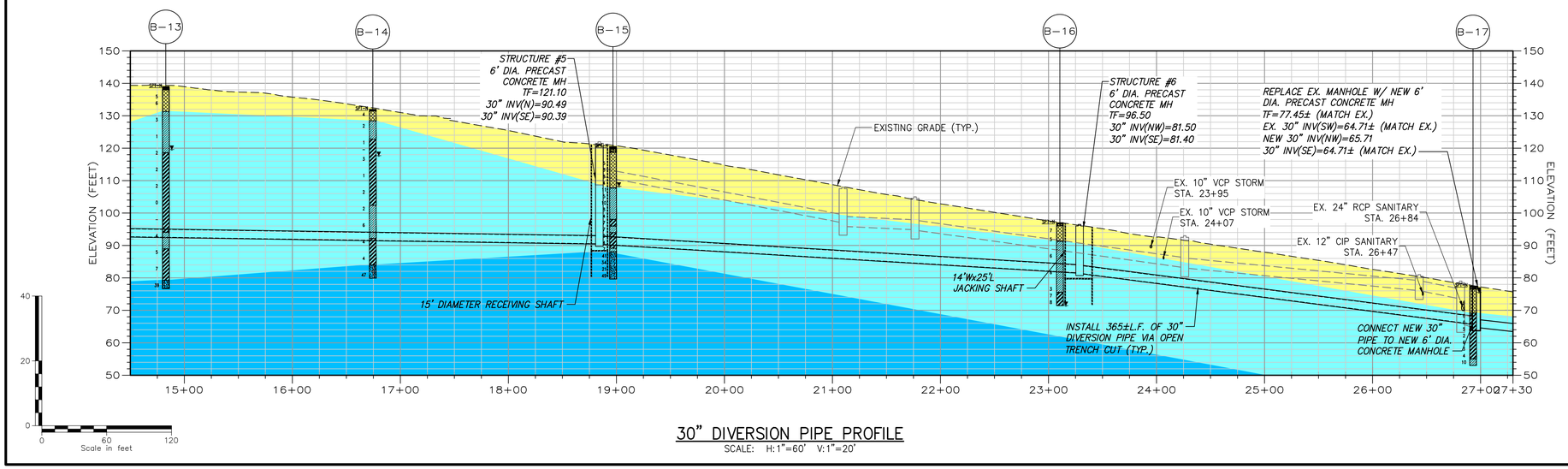
PROPOSED 30-IN PIPELINE PLAN AND PROFILE
FIGURE 3-2



30" DIVERSION PIPE LAYOUT PLAN

SCALE: 1"=60'



30" DIVERSION PIPE PROFILE

SCALE: H:1"=60' V:1"=20'

NOTE:

1. REFER TO GEOTECHNICAL DATA REPORT FOR THE DETAILS ON SOIL AND ROCK CLASSIFICATION.
2. JACKING AND/OR RECEIVING SHAFT/PIT SIZES SHOWN AS MAXIMUM PERMITTED. CONTRACTOR SHALL BE RESPONSIBLE FOR SIZING, POSITION, ORIENTING, DESIGNING, AND ETC., THE JACKING AND/OR RECEIVING SHAFTS AND/OR PITS.
3. JACKING SHAFT SHOWN AT STRUCTURE 6 MAY BE INTEGRATED AS PART OF THE OPEN-CUT PIPE INSTALLATION BETWEEN STRUCTURE #6 AND LIMIT OF CONTRACT AT APPROXIMATELY STATION 27+00

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PROPOSED 30-IN PIPELINE PLAN AND PROFILE

FIGURE 3-3

Shaft - Manhole Structure #4

A working shaft centered at Sta. 11+57 will be constructed and used for the tunnel and manhole construction. This shaft will encounter fill, and clay and sand. SPT values in the soil ranged from 5 to 20 bl/ft. Squeezing to raveling soil conditions should be anticipated. Above the water table soil will squeeze or ravel into the excavation. below the water table ductile, plastic yield and flowing conditions may occur due to overstress.

Shaft - Manhole Structure #5

A working shaft centered at Sta. 18+80 will be constructed and used for the tunnel and manhole construction. This shaft will encounter fill, medium stiff clay and dense sand. SPT values in the soil ranged from 4 to 57 bl/ft. Squeezing to raveling soil conditions should be anticipated. Above the water table soil will squeeze or ravel into the excavation. below the water table ductile, plastic yield and flowing conditions may occur due to overstress.

Shaft - Manhole Structure #6

A working shaft centered at Sta. 23+27 will be constructed and used for the tunnel and manhole construction. This shaft will encounter fill, and medium stiff clay. SPT values in the soil ranged from 5 to 8 bl/ft. Squeezing to raveling soil conditions should be anticipated. Above the water table soil will squeeze or ravel into the excavation. below the water table ductile, plastic yield and flowing conditions may occur due to overstress.

3.2 Initial Shaft Support

Shoring is required for the overburden soil and partially weathered rock shaft support. Vertical or near vertical cuts in the exposed shale of the shaft will also be unstable. Contractor is expected to use shotcrete, rock anchors or liner plate for temporary ground support. The minimum support requirements and excavation support design values are shown in the contract drawings. If left unsupported, possible loose fragmented rocks falling as a result of the intensely fractured shale should be anticipated during excavation or other activities in the shaft. When excavating shafts in rock, the joint orientation of the rock should be taken into consideration and additional rock support will be needed to account for joint dipping toward the shaft wall.

It is highly unlikely that a single shaft support system type will be suitable for the anticipated variations in ground conditions. The contractor's selection of each shaft support type should consider the ground characterization at each individual shaft location discussed in Section 3.1 and the potential groundwater inflows discussed in Section 4.6.5. The shaft support selected shall be coordinated with the proposed dewatering system to provided additional pumping capacity when shoring systems that are not watertight are used.

Manhole structure location 6 is located within public streets and limited access and work area are available. Additional care needs to be taken to prevent damage to roadways, adjacent structures and/or Contractor is required to restore the work area to its original state prior to demobilizing.

3.3 Tunnel Reaches

For the purposes of establishing baselines, the 72-inch and 30-inch tunnel alignments have both been divided into 3 reaches. Reach 3 of the 72-inch tunnel and Reach 2 of the 30-inch tunnel excavation will encounter mixed face tunneling conditions consisting of intensely fractured shale that grades into weathered rock and then clay. Based on the RMR and the Rock Quality Rating or the Q-system, the anticipated rock mass behavior during tunnel excavation is expected to be poor to very poor for shale and the weathered shale. Soil conditions will be firm to slow raveling in accordance with the Tunnelman's Ground Classification system. The anticipated soil strata are shown on Figure 3-1 for the 72-inch tunnel and Figures 3-2 and 3-3 for the 30-inch tunnel. The anticipated stationing for each of the tunnel reaches are shown in **Tables 3-3** and **3-4**.

3.4 Open Cut Segment – Sta. 24+57 to Sta. 27+00

An open cut excavation will begin at Sta. 24+57 and end at Sta. 27+00. This excavation will encounter fill, and very soft to medium stiff clay. SPT values in the soil ranged from weight of hammer to 8 bl/ft. Unstable excavation walls and unsuitable subgrade conditions should be anticipated. Above the water table soil will squeeze or ravel into the excavation, below the water table ductile, plastic yield and flowing conditions may occur due to overstress. The use of additional bedding stone and geotextile should be anticipated to provide a suitable subgrade. For baseline purposes the Contractor should assume 75 percent of the opencut open cut alignment will require 2 feet of subgrade stabilization.

3.5 Tunnel Support Systems

The Contractor is responsible for the installation of all initial support systems as specified and shown on the Drawings to provide for the safety of the excavation and to achieve and maintain stable ground conditions until the carrier pipe is installed. For the purpose of design, the engineer assumed the 30-inch tunnel will be excavated by MTBM and supported by either a casing pipe (two-pass system) or the carrier pipe (one-pass system). The Contractor is required to submit a work plan detailing means and methods that demonstrate adherence to the design intent described here.

It is assumed that the 72-inch tunnel will be excavated by roadheader. The anticipated type of initial support to be installed for the 72-inch tunnel is based on the RMR rating of the rock. This rating has taken into account the orientation of the tunnel heading relative to the rock structure and adjusted accordingly. The RMR system accounts for the span opening of the excavation. The cross-sectional area of the excavated tunnel used for this evaluation and baseline is based on the dimensions shown on the contract drawings and the anticipated excavation method. If the contractor selects a larger cross-sectional excavation to accommodate means and methods an adjustment to the RMR value will be made accordingly so that additional support requirements do not result in additional cost to the Owner. The support type specified is based on the range of RMR values presented in **Table 3-5**.

Table 3-3 72-inch Tunnel Reaches

Tunnel Reach	Reach Station Range (ft)	Face Conditions
1	2+30 to 5+00	Poor to Very Poor-Quality Shale. Fracture spacings of less than 0.3 feet are anticipated. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block.
2	0+75 to 2+30	Poor to Very Poor-Quality Weathered Rock. Fracture spacings of less than 0.3 feet are anticipated. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block.
3	0+00 to 0+75	Mixed Face of Weather Rock and medium stiff Clay. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block.

Table 3-4 30-inch Tunnel Reaches

Tunnel Reach	Reach Station Range (ft)	Face Conditions
1	0+00 to 6+50	Full face of Poor to Very Poor-Quality Weathered Shale and Shale. Fracture spacings of less than 0.3 feet are anticipated. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block.
2	6+50 to 11+50	Mixed Face of Slow to Fast Raveling Sand and Poor to Very Poor-Quality Weathered Rock. Fracture spacings of less than 0.3 feet are anticipated. Poorly interlocked, heavily broken rock mass with mixture of angular and rounded block. Within clayey soil squeezing to raveling soil conditions should be anticipated. Soil will squeeze or ravel into the excavation. Below the groundwater table ductile, plastic yield and flowing conditions may also occur due to overstress. Boulders are anticipated.
4	11+50 to 24+57	Full Face of Squeezing Clay. Squeezing to raveling soil conditions should be anticipated. Soil will squeeze or ravel into the excavation. Below the groundwater table ductile, plastic yield and flowing conditions may also occur due to overstress. Sticky soils are anticipated.

Table 3-5 72-inch Tunnel Support Type

Support Type	Support Description	RMR Range	Baseline Length of Initial Support by Type
1	4-in shotcrete with 2x2 welded wire fabric; Spot bolting as needed	85 to 100	50 ft
2	Pattern of 4 rock bolts, 6.5 ft length at 5 linear feet on center with 4-inch shotcrete and 2x2 welded wire fabric	65 to 85	179 ft
3	Ground improved zone as specified on Contract Drawings or as needed, with 4-in shotcrete with 2x2 welded wire fabric	less than 65	300 ft

3.6 Rock Baselines

The range of rock property parameter values and the baseline properties of the rock are presented in **Table 3-6**. Baseline Rock Properties represent the anticipated condition of the rock prior to construction and does not account for any alteration of the rock conditions caused during construction. **Figures 3-4 through 3-7** are histograms showing frequency of tests within the overall range of the data for this project and of all the data used for UCS tests values, tensile strength, abrasivity and Point Load test.

Table 3-6 – Baseline Rock Values

Baseline Parameter		Strata Unit	
		Weathered Shale	Shale
Unit Weight (pcf)		140	160
Engineering Properties	Uniaxial Compressive Strength (ksi)	0.5-2	0.5 – 2
	Tensile Strength (psi)	100-300	100-300
	Poisson's Ratio	0.25	0.09
	Abrasiveness (Cherchar Abrasion Index)	1.0	1.0
	Slake Durability	80	97

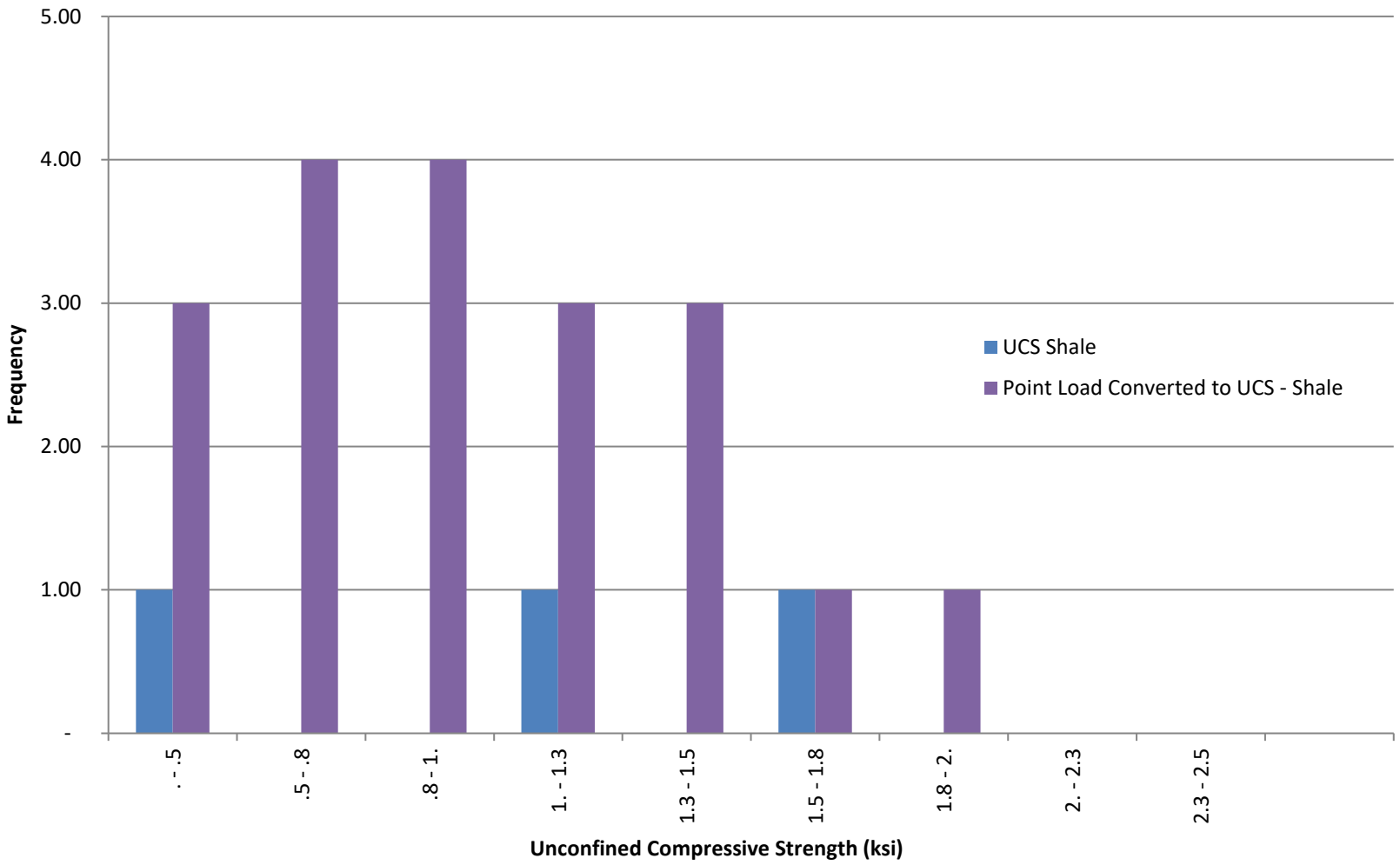
3.7 Additional Baselines

3.7.1 Stickiness/Clogging

The stickiness potential of the soil is presented based on the natural state of the soil without any conditioners. Plots illustrating the stickiness limits of the soils within the tunnel alignment are presented in **Figure 3-8**. For baseline purposes the excavation of the soils within the tunnel alignments is expected to encounter medium to high stickiness soils. Contractor shall be prepared to remove this material from the working chamber of the MTBM and muck handling system or cutter head of the roadheader. For baseline purposes the contractor shall assume that cleaning the cutters on a roadheader or the buckets on the excavators will be required daily during excavation of Reach 3 of the 72-inch tunnel and the open cut segment respectively. Removal of material from the cutting chamber of a MTBM and muck handling systems will be expected up to seven times during completion of the 30-inch tunnel segment.

3.7.2 Boulders and Obstructions

At the tunnel crossings boulders less than 36 inches measured along the longest axis and cobbles (>3 inches and <12 inches in size) will be encountered. The contractor shall use tunneling equipment capable of crushing, cutting, or removing boulders and rock in a mixed face condition. For bidding purposes boulders are considered incidental and a reduced excavation rate shall be included in the contractor's bid for the 30-inch tunnel in tunnel Reach 2 and for removal of the boulders along the open cut alignment. Contractor should anticipate boulders to occur in either



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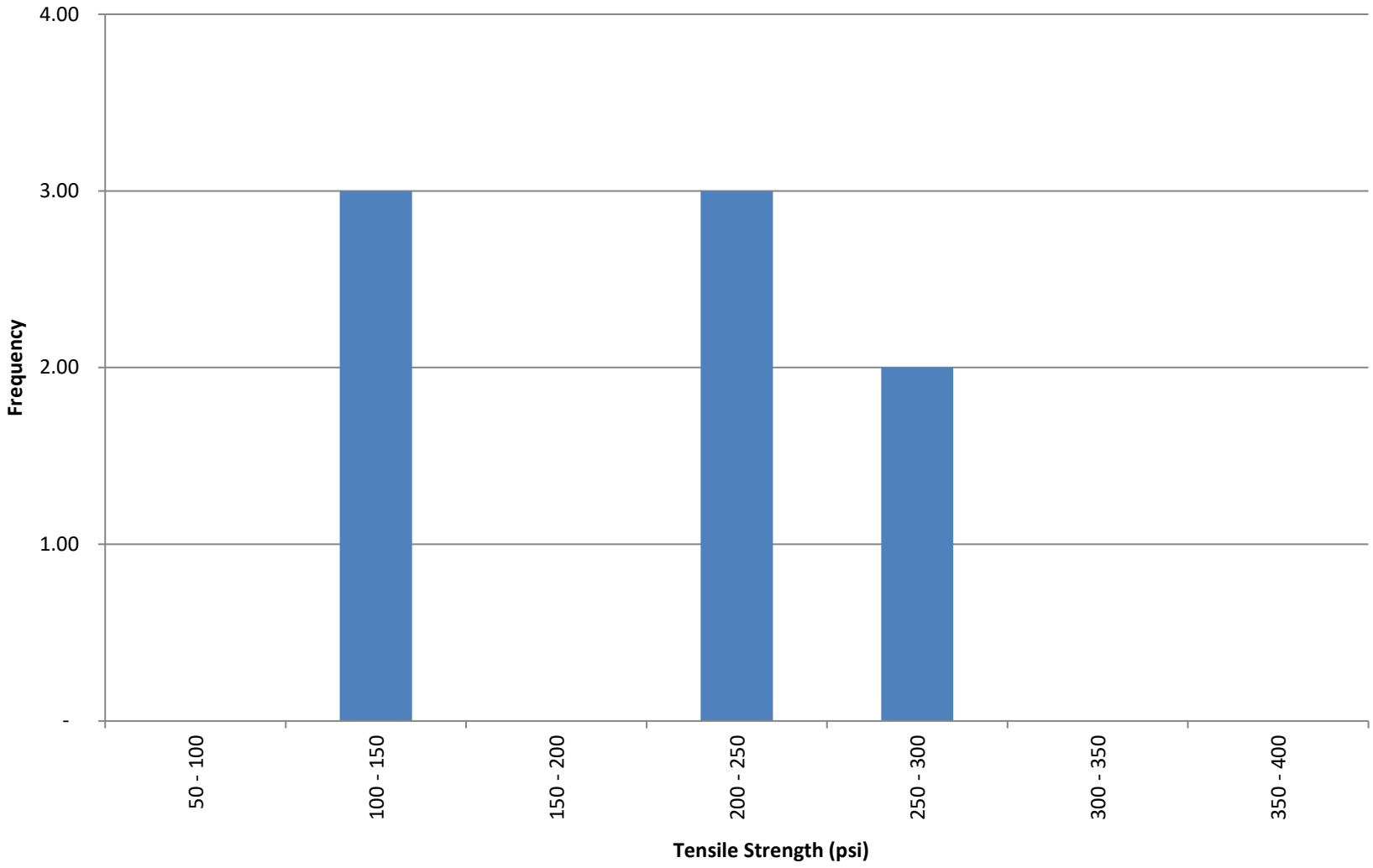
Histogram of Unconfined Compressive Strength Test
Figure 3-4



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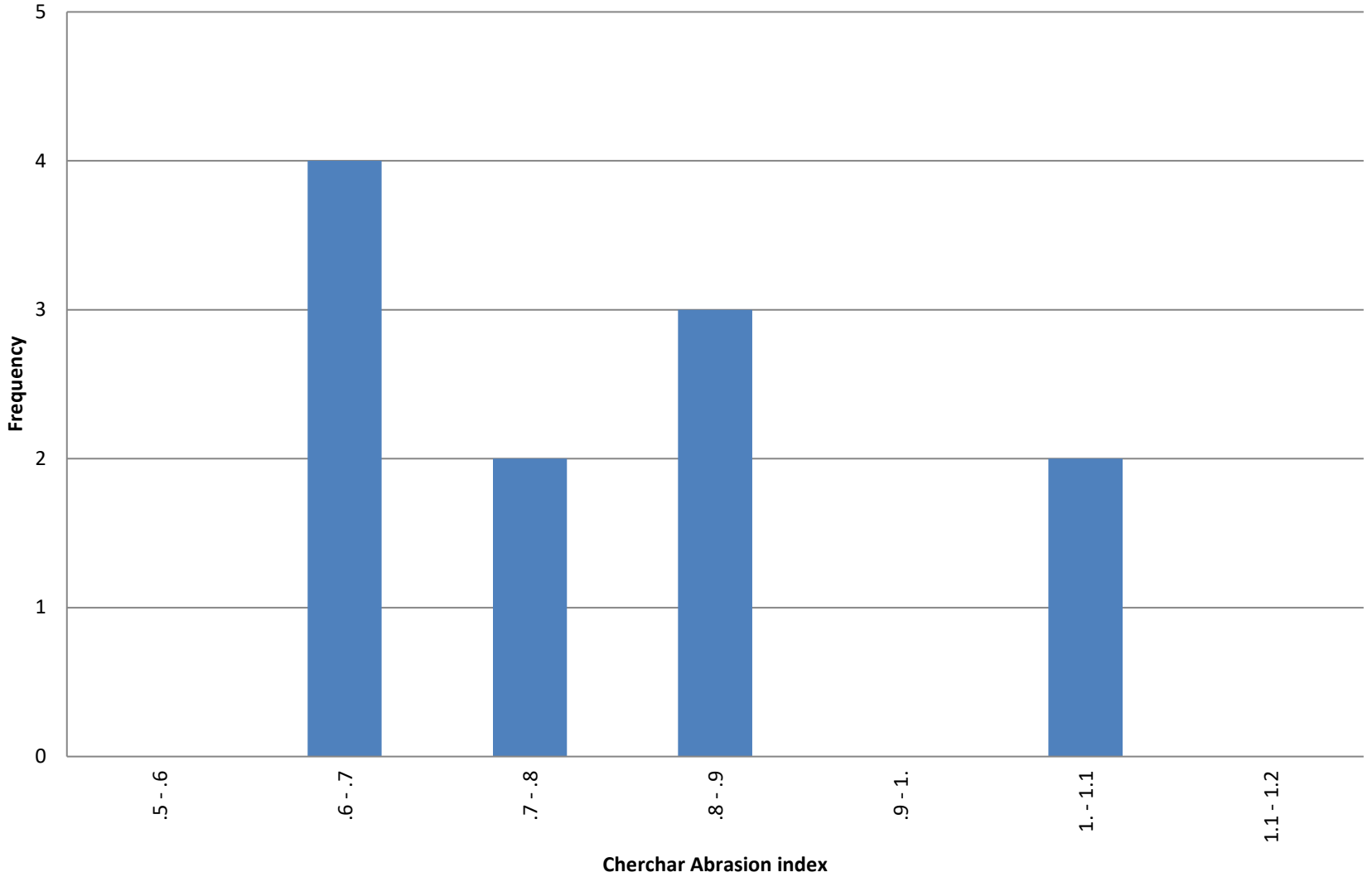
Histogram of Indirect Tensile Strength Test
Figure 3-5



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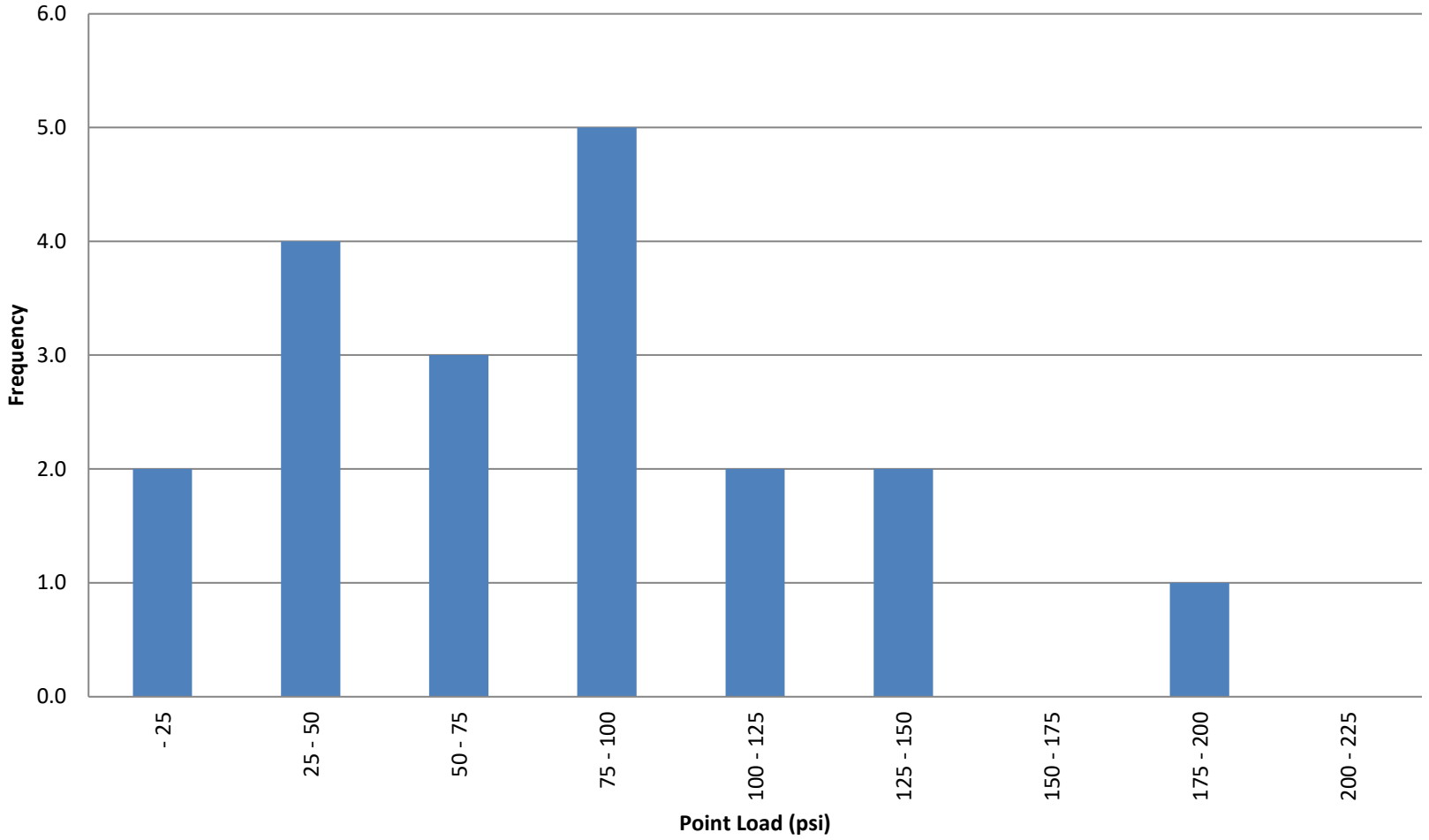
Histogram of Cherchar Abrasion Test
Figure 3-6



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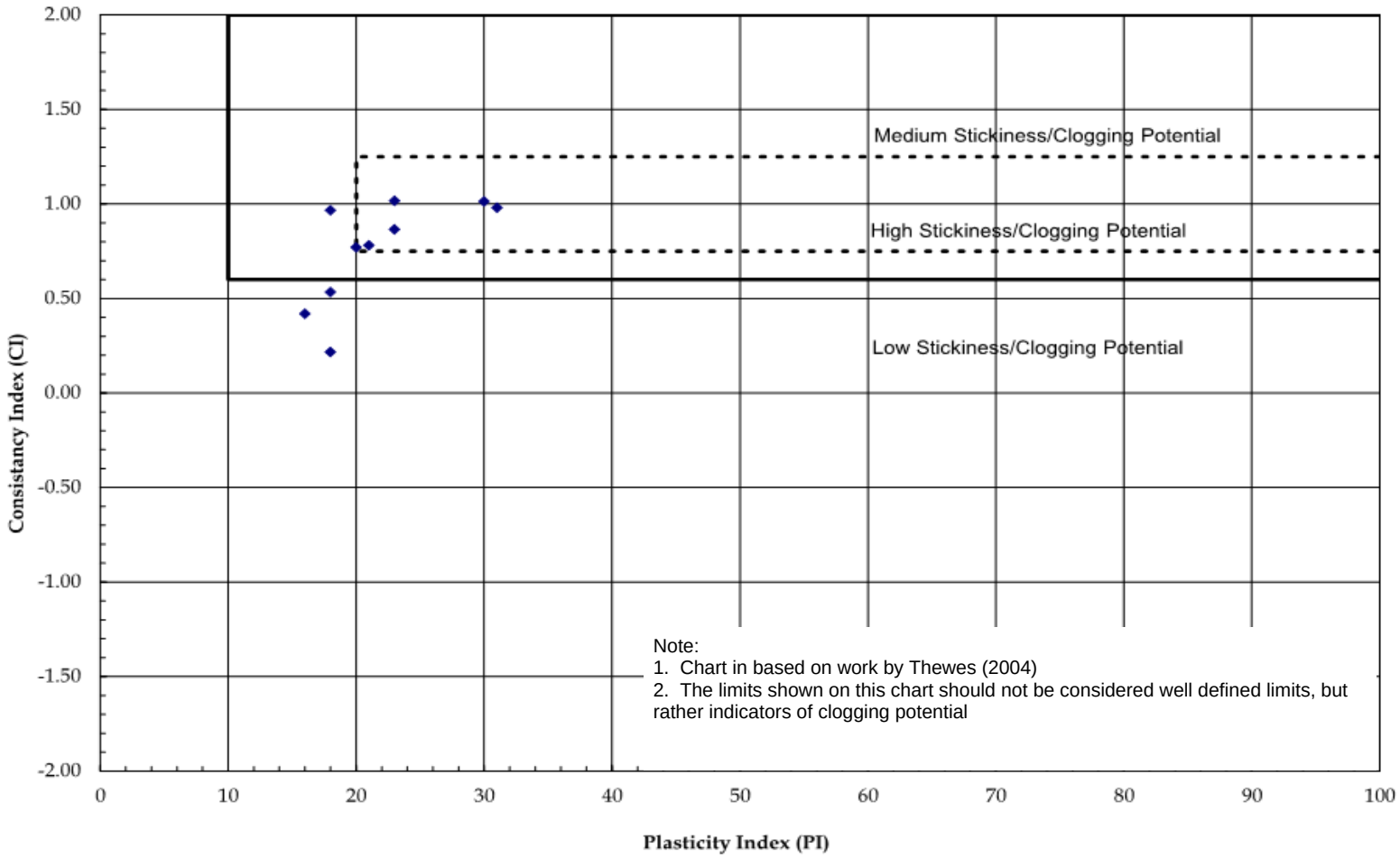
Histogram of Point Load Test
Figure 3-7



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Stickiness/Clogging Potential
Figure 3-8

isolated locations or in nested zones within the project alignment. Cobbles are considered incidental to the work, and equipment should be capable or excavating them regardless of quantity. The origin of the cobbles and boulders are expected to be consistent with local bedrock. The 30-inch tunnel baseline shall also include, four boulders not consistent with the local bedrock and consistent with granite or other high strength rocks shall also be anticipated.

3.7.3 Excavation of Mixed-Face Conditions

Changes in the face conditions from clay to a granular condition and/or rock are expected to occur along portions of the 30-inch tunnel within a tunnel length of less than 10 feet. In addition, lenses of granular material are expected within clay strata and the tunnel face. Alignment and grade will need to be closely controlled when the tunnel face transitions between the clay strata and more granular strata such as sand and/or harder rock zones. Continuous monitoring and adjustments of alignment, grade and thrust are necessary when tunneling through mixed-face conditions to achieve the alignment and grade tolerances required in the specifications. Changes in the behavior of the excavated materials will also occur as the proportion and orientation of the different strata units exposed in the face change. The selected tunneling equipment and personnel shall monitor and adjust to these anticipated changes in the face conditions in a timely manner to maintain line and grade.

3.7.4 Soil Abrasion

The contractor will encounter highly abrasive dense gravel and sands within the face of the 30-inch tunnel Reach 2. Low abrasive soils are anticipated in Reach 3 of both the 30-inch and 72-inch tunnels. Tunnel Reach 1 and 2 for both, the 30-inch and the 72-inch pipeline, tunnel will be excavated in rock and contractors should refer to the Section 3.5 for rock abrasiveness baselines.

3.7.5 Groundwater Inflow

The control of groundwater entering the shaft and the tunnels both along the excavated tunnel alignment and at the tunnel face is the responsibility of the Contractor. The Contractor's design and implementation of a dewatering system for construction of the tunnel and shafts needs to be capable of adequately controlling both the steady-state and peak inflow values presented in the following section.

Baseline inflow quantities for each tunnel and the shaft and the open cut segment are presented in **Tables 3-7, 3-8 and 3-9**. These values are based on evaluation of the rock quality in borings B-1, B-2, and B-3. Inflow within the shale is expected to be to be at relatively low rates with the exception of significantly higher inflow rates in locations were joints and fractures are encountered below the water table. In the partially weathered rock there are anticipated to be several zones of intense joint fractures where high ground water inflow should be expected. This anticipated rock condition has been taken into account in establishing inflow baseline values in the tables below.

Table 3-7 72-inch Tunnel Groundwater Inflow Quantities

Location	Steady State Inflow	Peak Inflows
Shaft	< 10 gpm	15 gpm for 8 hours
Reach 1	< 10 gpm	15 gpm for 8 hours
Reach 2	< 20 gpm	30 gpm for 8 hours
Reach 3	< 20 gpm	30 gpm for 8 hours

Table 3-8 30-inch Tunnel Groundwater Inflow Quantities

Location	Steady State Inflow	Peak Inflows
Structures 1,4,5,6,7	< 30 gpm	45 gpm for 8 hours
Structures 2,3	< 250 gpm	375 gpm for 8 hours
Reach 1	< 10 gpm	15 gpm for 8 hours
Reach 2	< 120 gpm	180 gpm for 8 hours
Reach 3	< 120 gpm	180 gpm for 8 hours
Reach 4	< 10 gpm	15 gpm for 8 hours

Table 3-9 Open Cut Reach Groundwater Inflow Quantities

Location	Steady State Inflow	Peak Inflows
Station 24+57 to 26+90	< 30 gpm per 100 feet of excavation	45 gpm for 8 hours

3.7.6 Spoil Handling and Disposal

Proper disposal of excavated materials from tunnel and shaft excavations (muck or spoil) is the Contractor's responsibility, in accordance with all applicable State and Federal regulations and permits. For estimating purposes, the Contractor should anticipate that the excavated material is not contaminated.

3.7.7 Noxious or Explosive Gases

Evidence of gas was not identified during the subsurface investigation and no evidence of hazardous gases was found within the borings. For baseline purposes, the operation in the tunnel is classified as non-gassy. However, personnel entering the tunnel should be equipped with appropriate gas detection and monitoring equipment to assure safe working conditions and efficient ventilation through the tunnel and into the reachable areas of the tunneling machine at the heading. The tunnel boring equipment requirements are provided in the Contract Specifications.

3.7.8 Bulkhead

The 72-inch tunnel will require two bulkheads: One at station 0+00 (approx.); another at Sta. 5+29.85 (approx.). Bulkhead represents stabilizing the tunnel excavation, as well as excavation face for follow-on contract to construct final connections. The equipment selected for the tunnel excavation shall be capable of backing out of the tunnel to allow for the bulkhead installation. Contractor will be responsible for final design of the bulkhead. The Contractor is

advised that at approximately Sta. 0+00, there is an existing functional brick sewer. The Contractor will protect the brick sewer adjacent to the planned bulkhead location against damage related to any and all construction activities performed for constructing the tunnel and installing the carrier pipe/final liner.

Section 4

Construction Considerations

4.1 General

This section provides a discussion of construction considerations for this project that could be useful to the selected contractor in planning and executing the work. Design considerations for items that will be selected and/or designed by the Contractor or the Contractor's Engineer are also discussed. This section does not change or modify the baseline statement and conditions contained in Section 3 and will not be the basis for any claims for differing site conditions. The selection of the Contractor's construction methods and equipment for each tunnel segment shaft location and the open cut segment should:

- Be suitable for the geologic and hydrogeologic conditions,
- Be capable of achieving reasonable advancement rates,
- Account for the impact available space at the shaft and tunnel segment and provide for necessary safe clearance and other safety precautions,
- Protect adjacent roadways, structures, and utilities,
- Control surface settlement to within specified criteria,
- Control groundwater inflows, and
- Install an initial support system that provides adequate support for the ground.
- Be capable of removal through the excavated 72-inch tunnel prior to installing the bulkhead and carrier pipe.

4.2 Shaft Sites

For all shafts the Contractor's excavation support design must meet required minimum excavation diameter and design requirements as shown on the contract drawings. Where needed, additional excavation can be performed to accommodate the contractors means and methods at no additional cost. However, the limits of all excavations must be maintained within public right-of-way and any indicated easements shown on the contract drawings.

In preparing the design the Engineer has assumed the Contractor will design and install shaft excavation support systems at the shaft locations shown on the Drawings to provide for the safety of the excavation, to achieve and maintain stable ground conditions, and to help limit and manage groundwater inflows until the shaft is backfilled. Additionally, it has been assumed that the Contractor's design of the initial support systems for the excavations shall be compatible with the final lining installations and that internal bracing, ring beams, tie-back anchors, rock bolts, etc., and will not interfere with installation of the carrier pipe, nor construction of the final shaft structure.

The Contractor is advised that some or all of the shafts may require utility relocation and/or in-place utility support.

4.3 Excavation Sequence

4.3.1 72-inch Tunnel Segment

In preparing the design the Engineer has assumed that the contractor's excavation will start at the shaft shown on the contract drawings at Sta. 5+08 and proceed toward Sta. 0+00. The working shaft location will be used by the Contractor for primary tunneling activity and staging area. This working shaft shall be used for construction of the tunnel, for all tunnel access, or for installation of any required ground improvements. Construction of additional shafts to facilitate the contracts means and methods will not be allowed.

4.3.2 30-inch Tunnel Segment

We have assumed that the Contractor's excavation will start at the shaft at Sta. 22+80 and proceed toward Sta. 0+00. However, the sequence of excavation for the 30-inch tunnel segment should be based on the contractors proposed means and methods. The contractor will have the flexibility to select the direction of tunneling and the primary working site location for each tunnel run of the 30-inch tunnel.

4.3.3 Open Cut Segment

Third avenue will be closed to traffic during excavation of the open cut segment. During design it was assumed that the Contractor's excavation will start excavation at Sta. 27+00 and proceed upgrade to allow for groundwater to flow away from the active excavation. However, the sequence of excavation for the open segment should be based on the contractors proposed means and methods. The contractor will have the flexibility to select the direction of excavation and the schedule for laying of the pipe.

It is also anticipated that the contractor will support the trench excavation using trench boxes. Due to the presence of soft soils at or near the pipe invert, additional measures such as driven steel sheets or over excavation and replacement of any soft or heaving subgrade soils with additional bedding material and filter fabrics may also be required to stabilize the excavation bottom. Careful backfilling and compaction of the trench after pipe installation is required to reduce surface settlement of the roadway after construction is completed.

An existing sanitary sewer alignment parallels the open cut alignment. Monitoring requirements of the existing sewer and allowable deformations for the excavation support system are included in contract specifications. Several utilities also cross above the open cut excavation and will require either temporary relocation or to be supported during installation of the new 30-inch pipe. Overhead utility lines are also present along the street and the Contractor should consider overhead clearances when developing the open cut work plan and when selecting equipment.

4.4 Tunnel Excavation

The presence of intensely fractured shale, weathered rock and mixed face conditions are baselined in this GBR. The soil and rock conditions will require careful selection of the tunnel excavation support by the Contractor. The method selection by the contractor will impact excavation rates. Contractors shall review and consider the anticipated ground behavior and all geotechnical data provided prior to tunneling equipment selection.

4.4.1 Selection of Excavation Method for 30-inch Tunnel

The contractor is required to select, design, and utilize a MTBM system capable of excavating the ground conditions stated in Section 3. The Contractors selection of a tunneling equipment and methods also should consider the effects of excavating a mixed face condition and consider soil stickiness as discussed below. The installed pipeline must meet the required 30-inch inside diameter, but the Contractor has the flexibility to mitigate the risk by changing cutters at shaft locations and/or increase the outside excavation as needed to accommodate their means and methods including the installation of a larger diameter casing pipe.

4.4.1.1 Excavation of Mixed-Face Conditions

Alignment and grade control are of particular concern when the tunnels face transitions between the shale and clay strata. Therefore, equipment selection should allow for continuous monitoring and adjustments of alignment, grade and thrust are considered necessary when tunneling through mixed-face conditions. Changes in the behavior of the excavated materials will also occur rapidly as the proportion and orientation of the different strata units exposed in the face change. The speed at which the contractor's equipment can adjust to changes in strata should be considered.

4.4.1.2 Stickiness

Sticky soils have been identified and baselined within both tunnel segments in Section 3. The potential of the soils to clog the forward chamber of a MTBM should be anticipated. Therefore, clumping, balling and sticking will likely occur, and the material will be difficult to remove from within the working chamber and muck handling system. MTBM's equipped with water jets or use of ground conditioning additives should be considered to mitigate problems related to clay "stickiness".

4.4.2 Selection of Excavation Method for 72-inch Tunnel

The Contractor is responsible for the selection, design, and use of an excavation system capable of excavating the ground conditions stated in Section 3. The Contractors selection of a tunneling equipment and methods should anticipate unstable ground if left unsupported and subject groundwater inflows for more than 8 hours. Ground behavior expected to be encountered during open face excavation has been defined in Section 3.

4.4.3 Tunnel Support

As required the tunnel segments will be excavated and meet the minimum support requirements, as shown on the Drawings. The Contactor shall be responsible for selecting the final type/length/thickness of the initial support lining considering the available space in the working shafts, the anticipated ground conditions to be encountered along the tunnel alignment, and in accordance with the requirements of the Specifications. The Contractor is required to ensure the

compatibility of the initial lining used with the selected tunnel excavation methods. For the purposes of design, permitting, and environmental assessment, the excavated diameter meets the required minimum neat line (A-line) shown on the contract drawings so that the final liner can be constructed. Selection of the excavated diameter greater than the minimum required is at Contractor's option. After the tunnel excavation has been completed, the primary liner will be installed, per project specifications and drawings. During construction it is assumed that the final tunnel lining will be installed so as to control groundwater inflow into the finished tunnel during grouting of the lining. Any changes to the tunnel support system proposed by the Contractor must limit groundwater inflow into the finished tunnel as per the contract specifications.

For the 30-inch tunnel segment, the contractor may select either direct jacking the carrier pipe or using a casing pipe for ground support.

The 72-inch tunnel will require Type 3 support or ground stabilization ahead of the excavation for safe excavation of the tunnels as shown on the Contract Drawings. This ground support type may include the installation of spiles, steel pipe arches, or grouting ahead of the face. It should be noted that the interruption of the excavation process for holiday breaks and/or weekends, allows time dependent stress re-distribution. For this reason, strengthening of the initial support near the face should be considered. To guard against this due to planned and unforeseen events, it is recommended that the contractor provide contingencies of sufficient material and equipment on hand to deal with such conditions by reinforcing initial supports if deformation exceeds project specified limiting values.

4.5 Adjacent Structures Protection

A geotechnical instrumentation and monitoring program are included in the Specification Section 31 09 00 of the Contract Documents to monitor deformations during shaft construction and tunneling activities. The allowable ground movements (settlement/heave/deflection) during tunneling, shaft and open cut excavations are provided in the Contract Documents. The Contractor is responsible for selecting and implementing means and methods to perform the tunnel, shaft and open cutwork as specified in these Contract Documents that protects utilities, roadways, railways, and structures from damage, as well as repairing any damage resulting from the work.

The Geotechnical readings from the instrumentation program will be compared with expected deformations for the excavation support systems submitted by the contractor. This process, together with visual observations, is essential for the decision-making process of the determination of adequate performance of each of the ground support categories.

4.6 Groundwater Inflow

4.6.1 30-inch Tunnel

The excavation support system designed by the Contractor will be designed to use either a watertight casing or carrier pipe. It is anticipated that the contractor will utilize a tunnel seal on both the launching and receiving shafts for the 30-inch tunnel segment to control groundwater inflow into the shaft.

4.6.2 72-inch Tunnel

The tunnel dewatering system is anticipated to work in conjunction with a contractor designed sump and pumping system to control groundwater entering the shafts and the tunnel and there by limit adverse effects of lowering the groundwater along the tunnel alignments and any resulting settlement. It is the Contractor's responsibility to select, design and implement additional methods to control groundwater inflows up to the baseline values, such as probe drilling and permeation grouting, at no additional cost to the owner such that the settlements resulting from changes in the groundwater level are within the limiting values listed within the contract specifications.

4.7 Spoil Handling and Disposal

The systems that remove spoil from the tunnel face and transport it to the surface must be capable of transporting all ground and groundwater described in the GDR and Section 3 of this GBR. Contractor is responsible for carefully and deliberately selecting the required equipment, based on available surface space for processing of tunnel spoils, hauling schedules and limited space available at the shaft and portal sites. Proper transportation and disposal of excavated materials from tunnel and shaft excavations (muck or spoil) is the Contractor's responsibility as defined by the Contract Documents.

Section 5
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