CHPE LLC
623 Fifth Avenue, 20th Floor
New York, NY 10022

Champlain Hudson Power Express ("CHPE")
Environmental Management & Construction Plan
Notice of Major Change

Project: Champlain Hudson Power Express
Segment: 9
Notice Number: 123
PSC Case: 10-T-0139
USACE Permit Number: NAN-2009-01089-M12
Location (Milepost, Town/County): Selkirk Preferred MP 3.80 to Selkirk Preferred MP 4.40, Town of Bethlehem, Albany County, NY
Drawing References: Segment 9 (Package 5B) EM&CP Appendix C: Sheets C-114, C-115, C-116, C-309, C-310, C-311, C-312, C-313, C-314, C-407, C-408
Other Documents/References: Segment 9 (Package 5B) Appendix O, T
Component(s) Impacted by Change: Segment 9 (Package 5B) EM&CP Appendix C: Sheets C-114, C-115, C-116, C-309, C-310, C-311, C-312, C-313, C-314, C-407, C-408, Appendix E, Appendix J

Description of Change:

This major change is to incorporate an adjustment to Segment 9 (Package 5B) HDD 89 to avoid crossing an existing overhead National Grid sub-transmission line between STA 51200+00 to STA 51220+20. The adjustment to HDD 89 includes extending of the HDD 89 workspace in front of the entry pits along with adjusting the limit of work (LOW) and associated permanent easement (Lands N/F of Linda J. Kasinski TM# 132.00-2-25.2).

This change includes an increase in tree clearing of approximately 0.25 acres in an environmentally sensitive area (ESA 4). This change lies on a historic property (Bullock Tenant Farmhouse), which has been determined by SHPO to be eligible for the National Register of Historic Places. The temporary access road and subsurface impacts (HDD, trench and splice boxes) will have no adverse effects on the property, as confirmed by SHPO on March 25, 2024. Please see the attached reviewer supplement form for full list of changes.

Pursuant to Condition 158(b), this change does not require referral to the Commission based on a substantial increase in environmental impacts, nor does it relate to contested issues decided during the proceeding. This change involves shifting a small portion of the alignment outside of the deviation zone (approximately 1,100 feet in length [all HDD], extending to a maximum distance outside the deviation zone of 22 feet), and is submitted as a change to the approved EM&CP and Facility route under Certificate Condition 158. The anticipated ADZ exceedance constitutes a major change.

This change results in a decrease of 137 SF of Permanent ROW Impacts, a decrease of 7 SF of Temporary Construction ROW Impacts, and an increase of 3,615 SF of Temporary Construction Impacts to Wetland FA. See below for changes to the Segment 9 EM&CP Table 9-2 reflecting the updated wetland impacts. Aside from the rows listed below, there are no additional changes to Segment 9 EM&CP Tables 9-1 and 9-2 included with the change notice.

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CHANGES TO EM&CP TABLE 9-2 (WETLAND IMPACTS):

Wetland ID	Wetland Community Type	Drawing Station (Appendix C)	Jurisdiction	Permanent ROW Impacts (SF)	Temporary ROW Impacts (SF)	Temporary Construction Impacts (SF)
FA	PEM	51191+00	USACE	-	2,366	46,551
FA	PFO	51191+00	USACE	7,740	-	95,176
FA	PSS	51191+00	USACE	-	7,375	80,288

The Deviation Zone Excursion Table 1 of EM&CP "Appendix E Justification for Deviation Zone Excursions in Segment 8" is revised below:

Excursion	Parcel ID	Location (Approximate – see Drawings for Details)				Justification for Revision	Environmental Impact Reviewed
		Sheet	Mile Point	Station Start	Station End		
S9-3	132.00-2-25.2	C-114 to C-116	Selkirk Preferred MP 3.80 to 4.40	51204+00	51215+00	Conflicts with National Grid OH Transmission Line	Cultural Resources; ESA 4; Wetlands; Terrestrial Ecology

Excursion

1. **Description of the Excursion**
   Excursion S9-3 is located within the Town of Bethlehem beginning approximately 0.8 miles north of Bridge Street (Rt. 396) crossing under CSX tracks (approximately STA 51204+00 to 51215+00). See Sheet C-114 and C-115 attached..

2. **Justification**
   National Grid required revisions to the alignment and HDD design along their transmission corridor to increase clearances to their permanent assets. Given the constraints at or near the CSX tracks in conjunction with the National Grid transmission clearance requirements, this ADZ Excursion is the minimum necessary to feasibly achieve installation.

3. **Environmental Impact**
   The anticipated ADZ exceedance constitutes a major change as it is 22 feet perpendicular to the ADZ at its furthest point; environmental impacts will be reduced as noted above, and the overall character of the Facility will not be changed. A detailed impact review and summary of environmental considerations are provided below for the1,100' of HDD.

   Recreation: None present within the vicinity of the excursion based on desktop aerial imagery and field confirmation.

   Agricultural Resources: None present within the vicinity of the excursion based on desktop aerial imagery and field confirmation.

   Cultural Resources: Hartgen Associates performed a review of the Segment 9 alignment and identified areas where the Facility may impact cultural resources (see Table 11-1 of the EM&CP and Appendix O – Cultural Resources

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Management Plan). Hartgen Associates has recommended testing or monitoring in this area during construction to avoid impacts to cultural resources.

Terrestrial Ecology: Excursion S9-3 occurs along the CSX ROW. Tree clearing expected for this work outside the ADZ is anticipated to be similar as what would be required should the placement of the conduit be maintained in the ADZ. Clearing will be selective and only remove what is required for the construction of the Facility and will be performed as described in the EM&CP. The area will be restored as described in Section 14 of the EM&CP.

Threatened and Endangered Species: The change involves a net increase of 0.25 acres of tree clearing in ESA 4. The Contractor will follow the avoidance and minimization efforts outlined in the approved EM&CP and protocol approved by NYSDEC and USFWS.

Wetlands and Streams: This excursion is within wetland FA. This wetland was delineated within the Project Corridor and extends outside of the ADZ. An equal amount of wetland would be impacted by the permanent placement of infrastructure even if the conduit remained within the ADZ. The area will be restored as described in Section 14 of the EM&CP. Therefore, the proposed ADZ Excursion does not significantly increase impacts to wetlands or streams as compared with the approved ADZ.

4. New Landowners Affected

There are no new landowners affected by this change Moreover, CHPE does not need to obtain additional property rights to implement the requested change.

CC Requirements for Modifying an EMCP

#	Certificate Condition	Description of the Proposed change
158	The EM&CP approved by the Commission may incorporate modifications from the EM&CP proposed by the Certificate Holders. No change to the approved EM&CP may thereafter be made except in accordance with the following procedures:	
158(a)	For a proposed change that: (i) would involve a site listed or eligible for listing on the New York State or National Register of Historic Places, the Certificate Holders shall give at least two (2) weeks prior notice to the Field Service Bureau of OPRHP. (ii) would involve any State-regulated wetland or protected stream or water body, the Certificate Holders shall give at least two weeks prior notice to NYSDEC, and, if within the Adirondack Park, to APA. (iii) would affect the occupied habitat of a TE species, the Certificate Holders shall give at least two weeks prior notice to NYSDEC and to the USFWS or NMFS (where applicable) prior to providing notice to DPS staff of the proposed change. (iv) would affect the individual or habitat supporting RTE plants, the Certificate Holders shall give at least two (2) weeks prior notice to NYSDEC and DPS. (v) would involve agricultural land, the Certificate Holders shall give at least two (2) weeks prior notice to Ag & Mkts. (vi) would involve the herbicides planned for use (including mixed proportions, additives or method of application), the Certificate Holders shall give at least thirty (30) days	(i)This change does involve a site listed in the NYS or National Register of Historic Places. However, there will be no adverse effects on the property, as confirmed by SHPO on March 25, 2024. (ii)This change results in an increased impact to federal wetlands. This change does not result in an increased impacts to State-regulated wetland or waterbody and is not located in the Adirondack Park. (iii)This change affects an occupied habitat of a TE species. (iv) This change does not affect individual species or habitat supporting RTE plants. (v)The change does not involve Agricultural Land. (vi)There are no changes in herbicide use as result of the requested revision.

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	prior notice to NYSDEC. (vii) would affect land or water owned or controlled by CNY, the Certificate Holders shall give at least two (2) weeks prior notice to CNY.	(vii) The change is not on land owned or occupied by New York City.
158(b)	The Certificate Holders shall report any proposed changes to the EM&CP to DPS Staff. DPS Staff will refer to the Commission for approval any proposed changes that cause a substantial increase in environmental impact, after consultation with NYSDEC, any proposed changes that relate to contested issues decided during the proceeding, and any proposed changes affecting State highways (but need not do so if the report indicates NYSDOT's agreement to such proposed changes). DPS Staff is authorized to approve all other proposed changes, in accordance with the procedure outlined herein, and will submit reports of such changes to the Secretary or the Secretary's designee, which reports will be posted on the Commission's website under this case number.	See description above.
158(c)	Upon being advised that DPS Staff will refer a proposed change to the Commission, the Certificate Holders shall notify all active parties that have requested to be so notified, as well as property owners or lessees whose property is affected by the proposed change. The notice shall: (i) describe the original conditions and the requested change; (ii) provide documents supporting the request; and (iii) state that persons may comment by writing to the Commission within twenty-one (21) days of the notification date.	N/A
158(d)	The Certificate Holders shall not execute any proposed change until they receive written approval from the Commission (if Commission approval is required pursuant to subparagraph (a) of this paragraph) or oral or written approval from DPS Staff (in the case of a change that Staff has authority to approve) except in emergency situations threatening personal injury, property damage, or severe adverse environmental impact, or as specified in the EM&CP. When the Certificate Holders have obtained oral approval from DPS Staff for a change, DPS Staff will confirm such approval in writing within ten (10) business days.	CHPE anticipates receiving oral or written approval from DPS staff.

Proposed Change Involves New/Additional Impacts to:

☐Site listed or eligible for listing on the New York State or National Register of Historic Places [CC 158(a)(i)]
☐State-regulated wetland or protected stream or water body [CC 158(a)(ii)]
☒Occupied habitat of a TE species [CC 158(a)(iii)]
☐Individual or habitat supporting RTE plants [CC 158(a)(iv)]
☐Agricultural land [CC 158(a)(v)]
☐Herbicides planned for use (including mixed proportions, additives or method of application) [CC 158(a)(vi)]
☐Land or water owned or controlled by CNY [CC 158(a)(vii)]
☒Federally regulated wetland or protected stream or water body [Requires Transmittal to ACOE]

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List of References and Attachments:

NDC-0005 Reviewer Supplement Form
CHPE Segment 9 (Package 5B) EM&CP Appendix C: Revised Sheets
CHPE Segment 9 (Package 5B) EM&CP Appendix E: Added Sheet
CHPE Segment 9 (Package 5B) EM&CP Appendix J: Memorandum – NDC-0005

Signoff by: CHPE Overland Team Date:_____

Approvals

Position	Name	Signature	Date
Segment Engineer:	Beau Nolan	Electronically signed by Beau.Nolan Date: 06/11/2024 7:29:55 AM	2024-06-11
Segment Manager:	Zachary Mayes	Electronically signed by Zackary.Mayes Date: 06/11/2024 1:35:00 PM	2024-06-11
CHPE, LLC Approval:			
Transmitted to DPS by:			
DPS Approval By:			
Transmitted to ACOE by:			

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NDC-0005 Reviewer Supplement Form

NDC-0005 – REVIEWER SUPPLEMENT FORM

Summary of Plan Revisions:

Sheet No.	Rev No.	Revision Description	Summary of Plan Changes
C-114	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Extended HDD 89 workspace in front of pits and adjusted LOW and permanent easement accordingly. Corrected wire pull 191 Direction of cable pull to the preferred reverse direction.
C-115	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Extended HDD 89 workspace in front of pits and adjusted LOW accordingly.
C-116	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Extended HDD 89 workspace in front of pits and adjusted LOW accordingly. Corrected wire pull 193 Direction of cable pull to the preferred reverse direction.
C-309	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Revised HDD Conduit Material Type and Size. Corrected fiber conduit callouts to denote bundling of fiber with Conduit 2.
C-310	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Revised HDD Conduit Material Type and size. Corrected fiber conduit callouts to denote bundling of fiber with Conduit 2.
C-311	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Revised HDD Conduit Material Type and size. Corrected fiber conduit callouts to denote bundling of fiber with Conduit 2.
C-312	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Revised HDD Conduit Material Type and size. Corrected fiber conduit callouts to denote bundling of fiber with Conduit 2.
C-313	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Revised HDD Conduit Material Type and size. Corrected fiber conduit callouts to denote bundling of fiber with Conduit 2.
C-314	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Alignment of HDD adjusted to avoid crossing underneath National Grid overhead electric sub-transmission line from STA 51200+00 to STA 51220+00. Revised HDD Conduit Material Type and size. Corrected fiber conduit callouts to denote bundling of fiber with Conduit 2.
C-407	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Replot of sheet to capture alignment and LOW changes. Updated tree clearing limits and perimeter ESC measures accordingly.
C-408	1	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	Replot of sheet to capture alignment and LOW changes. Updated tree clearing limits and perimeter ESC measures accordingly.

Summary of Affected Easements:

1. Lands N/F of Linda J. Kasinski TM # 132.00-2-25.2

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CHPE Segment 9 (Package 5B) EM&CP Appendix C Revised Sheets

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EXISTING UTILITY POLE AND GUY WIRE TO BE PROTECTED IN PLACE DURING CONSTRUCTION. CERTIFICATE HOLDER (CHPE LLC) TO COORDINATE WITH CO-LOCATED INFRASTRUCTURE (CI) OWNER (NATIONAL GRID).

SELKIRK PREFERRED MP 3.80

CAUTION! HIGH VOLTAGE OVERHEAD ELECTRIC

LANDS N/F OF CSX TRANSPORTATION INC TM# 132.00-2-1.1

PACKAGE 5B CL OF TRENCH

48.4'

102.8'

CERTIFIED ROUTE MP 197.3

LIMITS OF HDD 89 (SEE SHEETS C-309 TO C-314) 2370' CSX MP QG 13.31 – 12.80

HDD WORK AREA

TRACK 2

RAILROAD TRACK (CSX) (TYP.)

WETLAND FA

20.0'

TEMP. OFF-SITE ACCESS RD SB-03-RD (SEE SHEETS C-209 TO C-212)

EXISTING WATERLINE TO BE PROTECTED IN PLACE DURING CONSTRUCTION. CERTIFICATE HOLDER (CHPE LLC) TO COORDINATE WITH CO-LOCATED INFRASTRUCTURE (CI) OWNER.

AGRICULTURAL LAND #2 (STATION 51186+68 TO STATION 51196+17). ALL CERTIFICATE CONDITIONS AND BMPS OUTLINED IN SECTION 7.1 OF THE EM&CP WILL BE FOLLOWED. ALL RESTORATION REQUIREMENTS DETAILED IN SECTION 14.5 OF THE EM&CP WILL BE FOLLOWED

FIBER OPTIC HANDHOLE 191
N: 1353612.69
E: 671572.55

51198+00

51199+00

L=93.60'
R=200.00'
Δ=26°48'53"

51200+00

51201+00

L=44.49'
R=250.00'
Δ=10°11'49"

51202+00

51203+00

51204+00

51205+00

51206+00

51207+00

51208+00

51209+00

51196+00

51197+00

PT = 51196+66.94

L=107.38'
R=250.00'
Δ=24°36'39"

PC = 51195+59.56

PT = 51195+42.54

L=38.55'
R=250.00'
Δ=8°50'05"

PC = 51195+04.00

DESIGNATED CRANE AREA

MATCHLINE – STA 51195+00.00

STATION EQUATION
STA. BACK: 51198+50.00
STA. AHEAD: 51198+50.00

PT = 51198+91.64

PC = 51199+38.03

PT = 51200+40.47

PC = 51200+84.96

PT = 51201+29.80

PC = 51201+73.49

PT = 51202+17.32

PC = 51202+61.81

PT = 51203+06.13

PC = 51203+50.62

L=44.49'
R=250.00'
Δ=10°11'49"

111.0'

WETLAND FA

HDD 89 – CONDUIT 2

HDD 89 – CONDUIT 1

SELKIRK PREFERRED MP 3.90

K-104.0-3.90

K-104.0-2.80

LANDS N/F OF CATHERINE L. BURGESS TM# 132.00-2-26

LANDS N/F OF LINDA J. KASINSKI TM# 132.00-2-25.2

CSX RAILROAD ROW (TYP.)

CENTER OF SPLICE LOCATION 191
STA: 51198+00.00
N: 1353610.76
E: 671633.09

SELKIRK PREFERRED MP 4.00

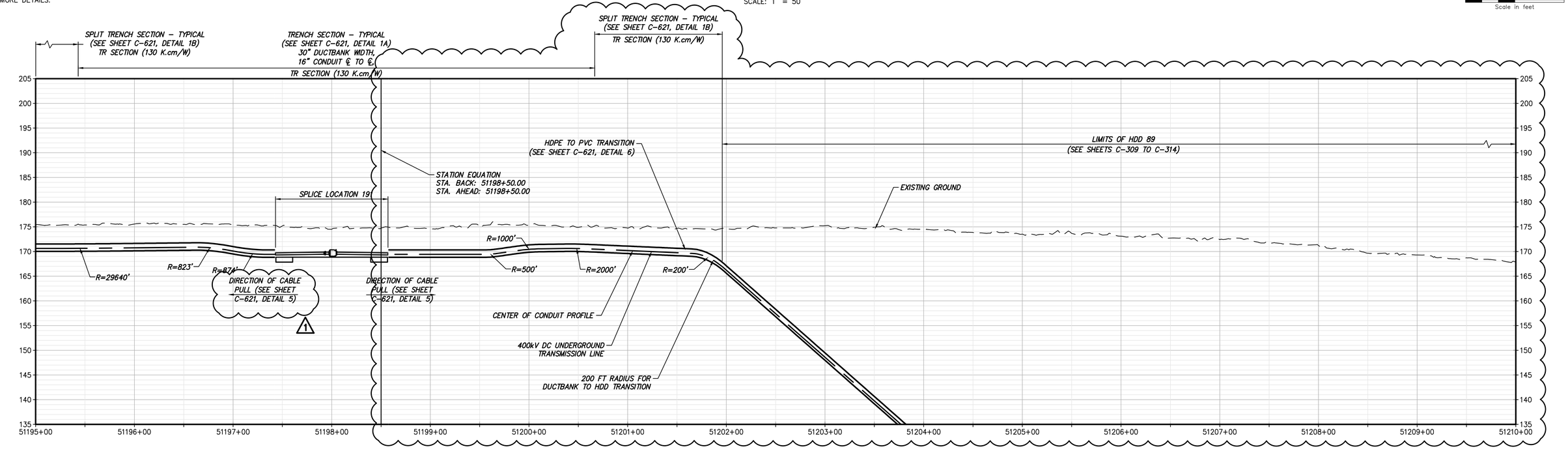
MATCHLINE – STA 51210+00.00

NOTE:
CONSULTING ARCHAEOLOGIST TO BE CONTACTED FOR ARCHAEOLOGICAL MONITORING DURING CONSTRUCTION. REFER TO EM&CP APPENDIX O FOR MORE DETAILS.

STA. 51195+00.00 TO STA. 51210+00.00 PLAN VIEW

SCALE: 1" = 50'

0 50 100
Scale in feet



STA. 51195+00.00 TO STA. 51210+00.00 PROFILE

SCALE: H: 1" = 50' V: 1" = 10'

CHPE Champlain Hudson Power Express

PROJECT NO.: 21162 — Kiewit

PROJECT NO.: 120174 — Engineering and Land Surveying, P.C.

ALTERED ON: 04/19/2024

AFFIXED ON: 06/09/2023

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED, THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE, THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

No.	DATE	SUBMITTAL / REVISION DESCRIPTION	DB	APP
1	04/19/2024	NDC-0005: ALIGNMENT REVISIONS PER NAT. GRID COMMENT	DM	BD
0	06/09/2023	ISSUED FOR CONSTRUCTION SUBMISSION	BV	TK

CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 9 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

STA. 51195+00.00 TO STA. 51210+00.00

HVDC CONDUIT PLAN AND PROFILE

(AND TEMPORARY ACCESS ROAD PLAN)

DRAWN BY: AR | DESIGNED BY: BV | APPROVED BY: TK | SCALE AS SHOWN | DATE: 06/09/2023

PERMIT DRAWING NO.

N/A

DRAWING NO.

C-114

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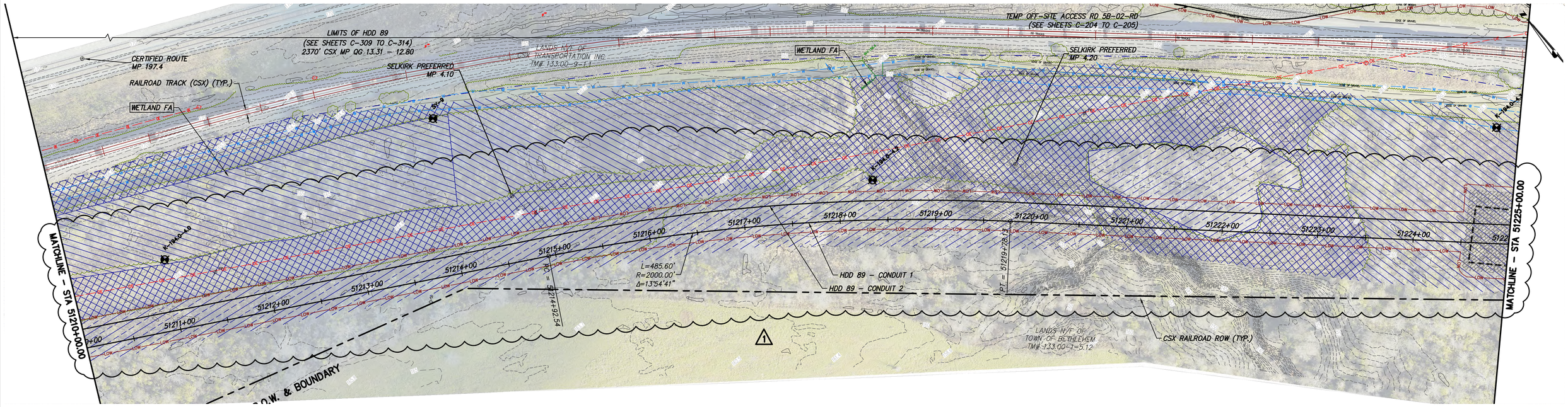

STA. 51210+00.00 TO STA. 51225+00.00 PLAN VIEW
SCALE: 1" = 50'

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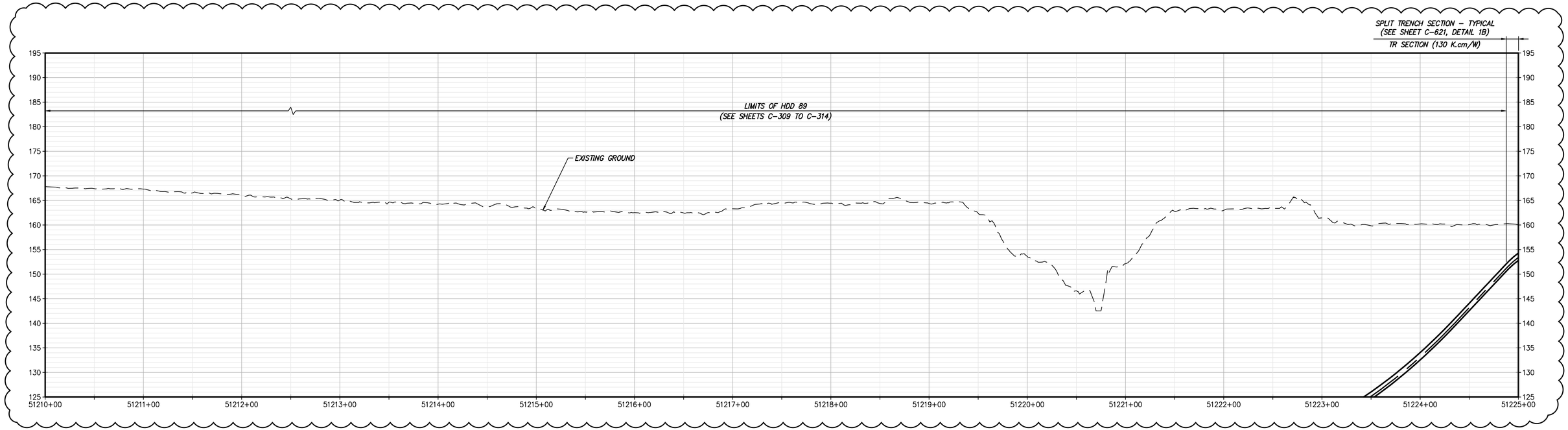
Scale in feet



STA. 51210+00.00 TO STA. 51225+00.00 PROFILE
SCALE: H: 1" = 50' V: 1" = 10'

CHPE Champlain Hudson Power Express

PROJECT NO.: 21162 — Kiewit

PROJECT NO.: 120174 — Engineering and Land Surveying, P.C.

ALTERED ON: 04/19/2024

AFFIXED ON: 06/09/2023

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0	06/09/2023	ISSUED FOR CONSTRUCTION SUBMISSION	BV	TK

CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 9 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

STA. 51210+00.00 TO STA. 51225+00.00

HVDC CONDUIT PLAN AND PROFILE

(AND TEMPORARY ACCESS ROAD PLAN)

DRAWN BY: AR | DESIGNED BY: BV | APPROVED BY: TK | SCALE: AS SHOWN | DATE: 06/09/2023

PERMIT DRAWING NO.

N/A

DRAWING NO.

C-115

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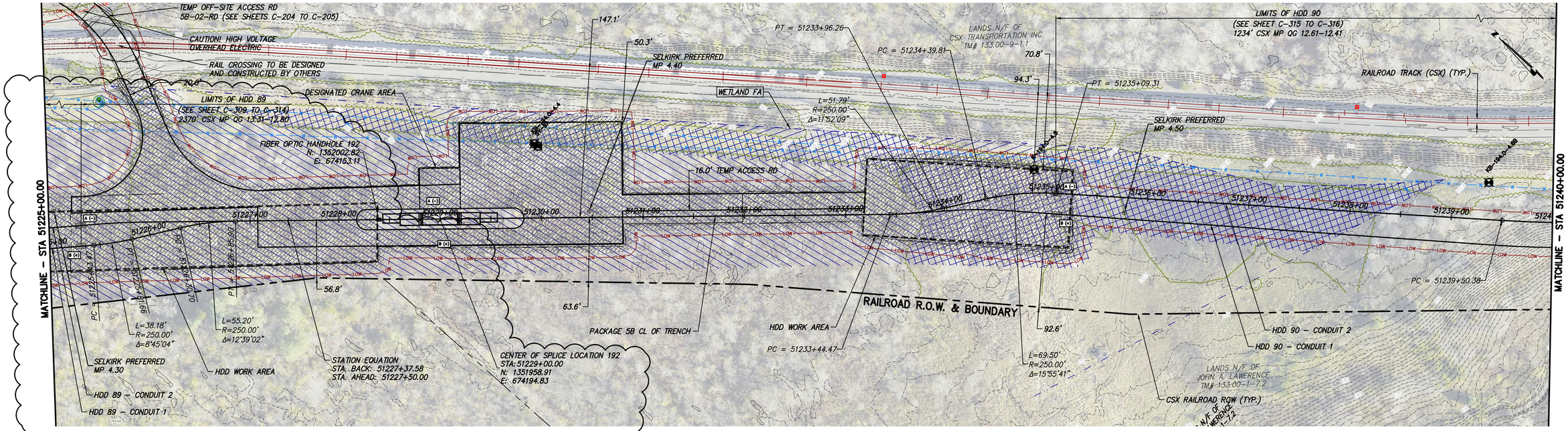
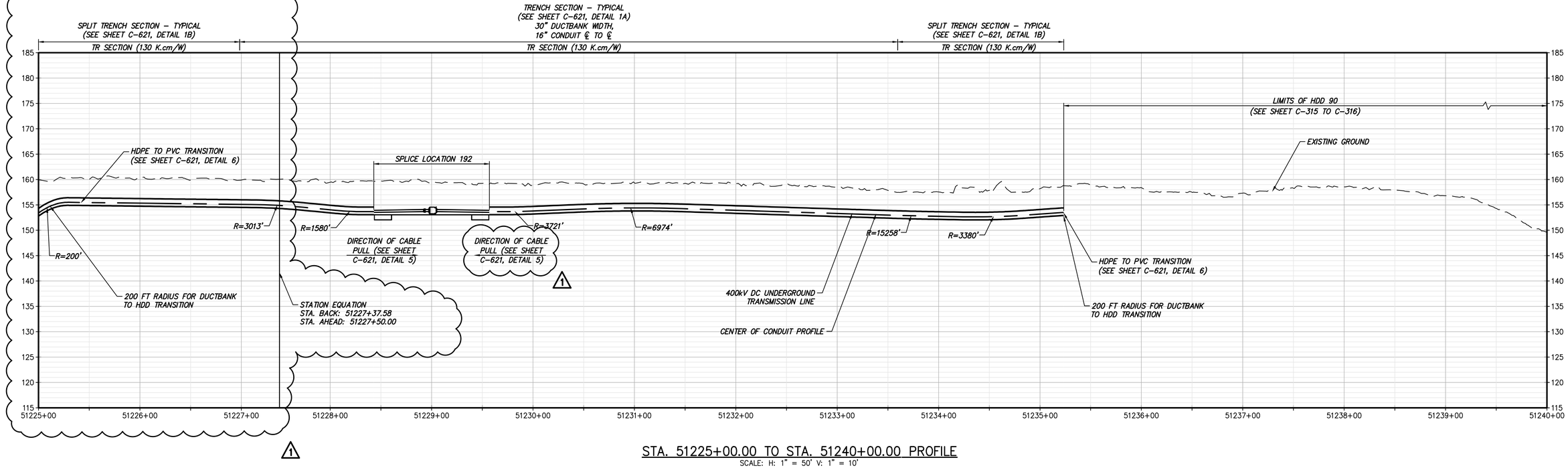


STA. 51225+00.00 TO STA. 51240+00.00 PLAN VIEW
SCALE: 1" = 50'

0 50 100
Scale in feet



STA. 51225+00.00 TO STA. 51240+00.00 PROFILE
SCALE: H: 1" = 50' V: 1" = 10'

CHPE Champlain Hudson Power Express

PROJECT NO.: 21162 | PROJECT NO.: 120174

Kiewit | Engineering and Land Surveying, P.C.

ALTERED ON: 04/19/2024 | AFFIXED ON: 06/09/2023

STATE OF NEW YORK · DANY BIRBAL SINGH · 085756 · LICENSED PROFESSIONAL ENGINEER

STATE OF NEW YORK · THOMAS A. KELLY · 109559 · LICENSED PROFESSIONAL ENGINEER

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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 9 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

STA. 51225+00.00 TO STA. 51240+00.00

HVDC CONDUIT PLAN AND PROFILE

(AND TEMPORARY ACCESS ROAD PLAN)

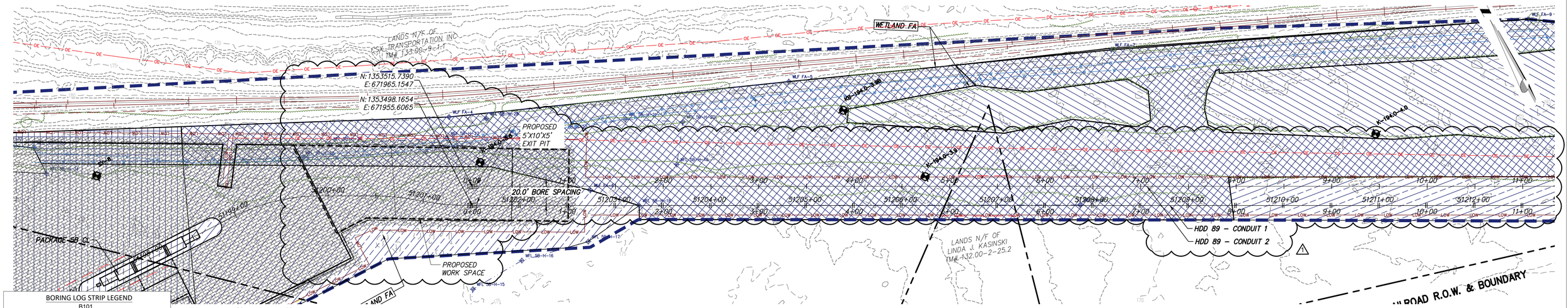
DRAWN BY: AR | DESIGNED BY: BV | APPROVED BY: TK | SCALE AS SHOWN | DATE: 06/09/2023

PERMIT DRAWING NO.

N/A

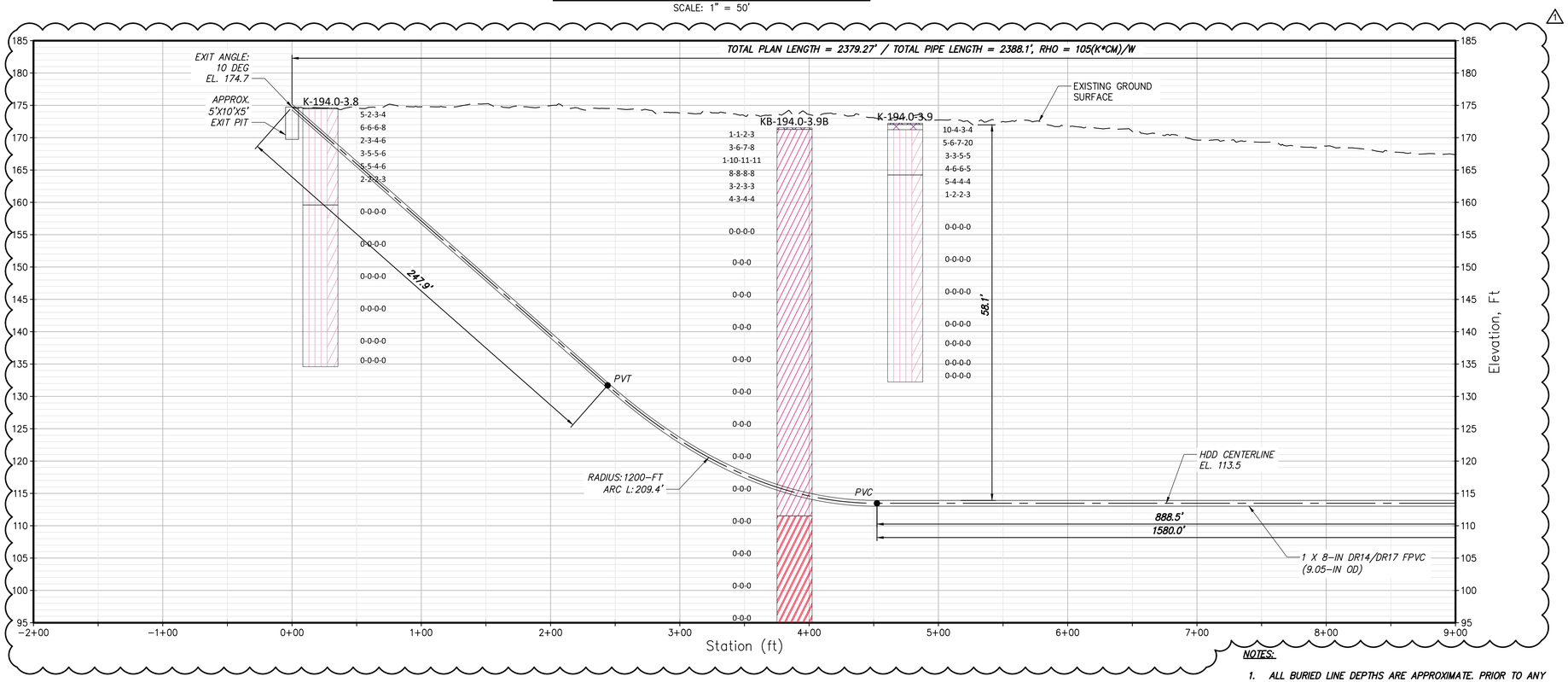
DRAWING NO.

C-116



PROPOSED HDD 89, CONDUIT 1 – PLAN

SCALE: 1" = 50'



NOTES:

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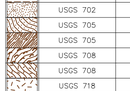
PROPOSED HDD 89, CONDUIT 1 – PROFILE

SCALE: 1" = 50'

BORING LOG STRIP LEGEND



2D strip logs shown at 10x exaggeration
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Legend	
ASPHALT	Asphalt
Bedrock	Bedrock
Boulder	Boulder
CH	Fat CLAY
CH–MH	SILTY Fat CLAY
CL	Lean CLAY
CL–ML	SILTY CLAY
CONCRETE	Concrete
Fill	Fill
GC	CLAYEY GRAVEL
GC–GM	SILTY CLAYEY GRAVEL
GM	SILTY GRAVEL
GP	Poorly Graded GRAVEL
GP–GC	Poorly Graded Gravel with CLAY
GP–GM	Poorly Graded GRAVEL with SILT
GW	Well Graded GRAVEL
GW–GC	Well Graded GRAVEL with CLAY
GW–GM	Well Graded GRAVEL with SILT
Limestone	Limestone
MH	Elastic SILT
ML	SILT
OH	ORGANIC Fat CLAY
OL	ORGANIC Lean CLAY
OL/OH	ORGANIC SOIL
PT	PEAT
Rock	Rock
Sandstone	Sandstone
SC	CLAYEY SAND
SC–SM	SILT, CLAYEY SAND
SHALE	Shale
SILTSTONE	Siltstone
SM	SILTY SAND
SP	Poorly Graded SAND
SP–SC	Poorly Graded SAND with CLAY
SP–SM	Poorly Graded SAND with SILT
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SW–SM	Well Graded SAND with SILT
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USGS 702	Quartzite
USGS 705	Schist
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USGS 708	Gneiss
USGS 708	Gneiss
USGS 718	Granite 1
Void	Void
Water	Water
Weathered Rock	Undefined
Water Table	Water Table during drilling
Delayed Water Table	Water Table after drilling

CHPE Champlain Hudson Power Express

PROJECT NO.: 21162

PROJECT NO.: 322004-000

Kiewit

BRIERLEY ASSOCIATES
Creating Space Underground
26 Smith Pl, Ste 2, Cambridge, MA 02138
PHONE: 617.714.5784

ALTERED ON:

AFFIXED ON:

STATE OF NEW YORK * BRIAN C DORWART * 102722 * LICENSED PROFESSIONAL ENGINEER
Brian C Dorwart 06/09/2023

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED, THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE, THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 8 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

PROPOSED PLAN AND PROFILE - HDD 89
STREAM CROSSING, CONDUIT 1
SCHENECTADY COUNTY, NY

DRAWN BY: BC | DESIGNED BY: NS | APPROVED BY: BD | SCALE AS SHOWN | DATE: 06/09/2023 0

PERMIT DRAWING NO.

DRAWING NO.

C-309

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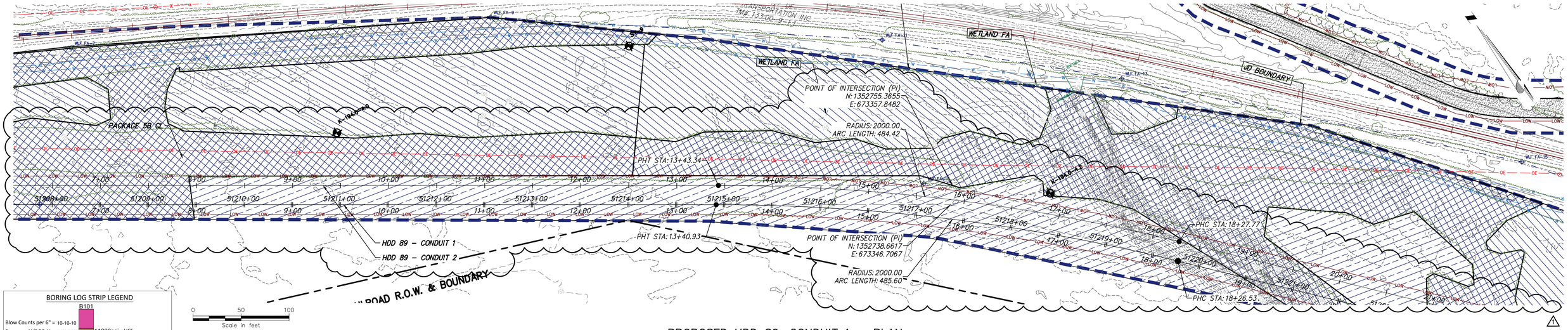

PROPOSED HDD 89, CONDUIT 1 – PLAN

SCALE: 1" = 50'

BORING LOG STRIP LEGEND

B101

Blow Counts per 6" = 10-10-10

Recovery %/RQD % = 95%/90%

11000psi =UCS

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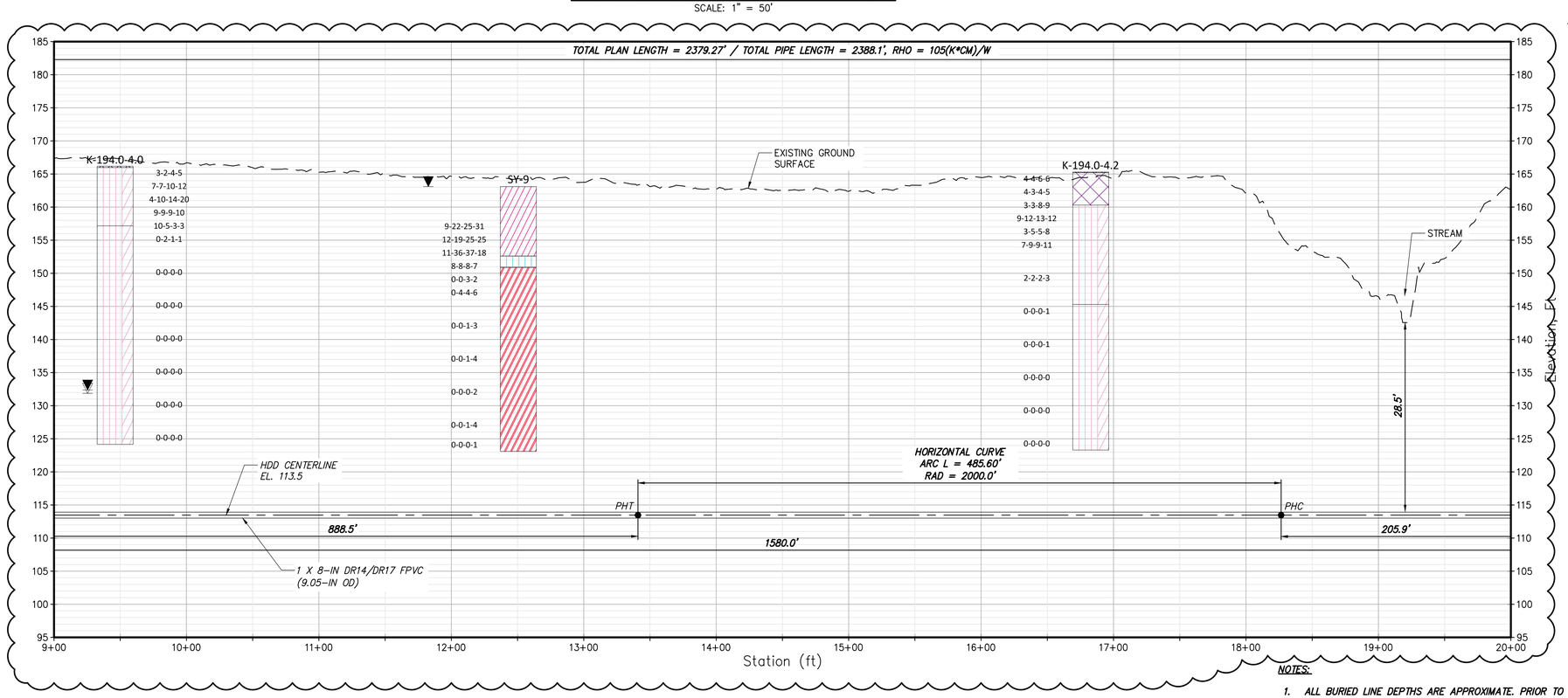

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0 50 100 Scale in feet

Champlain Hudson Power Express

PROJECT NO.: 21162

PROJECT NO.: 322004-000

Kiewit

BRIERLEY ASSOCIATES
Creating Space Underground
26 Smith Pl, Ste 2, Cambridge, MA 02138
PHONE: 617.714.5784

ALTERED ON:

AFFIXED ON:

STATE OF NEW YORK * BRIAN C DORWART * LICENSED PROFESSIONAL ENGINEER

Brian C Dorwart

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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 8 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

PROPOSED PLAN AND PROFILE - HDD 89
STREAM CROSSING, CONDUIT 1
SCHENECTADY COUNTY, NY

DRAWN BY: BC | DESIGNED BY: NS | APPROVED BY: BD | SCALE AS SHOWN | DATE: 06/09/2023 | 0

PERMIT DRAWING NO.

DRAWING NO.

C-310

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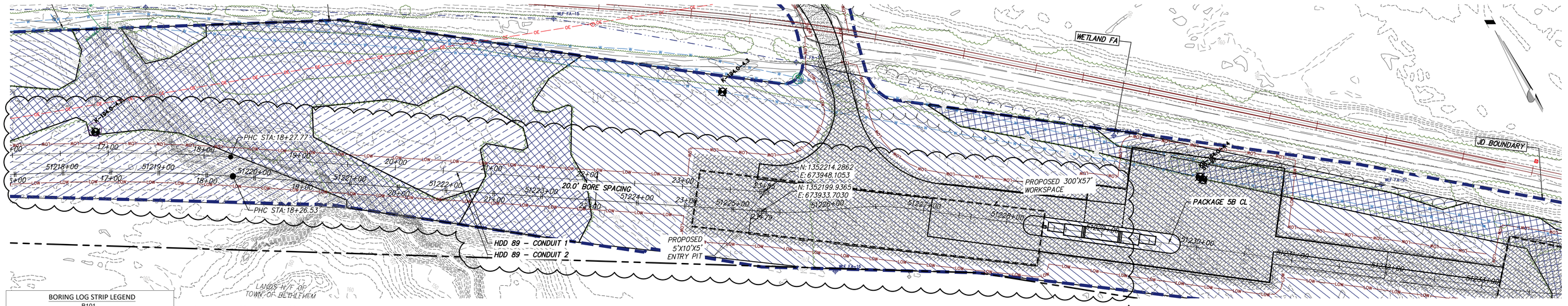

BORING LOG STRIP LEGEND

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USGS 705	Schist
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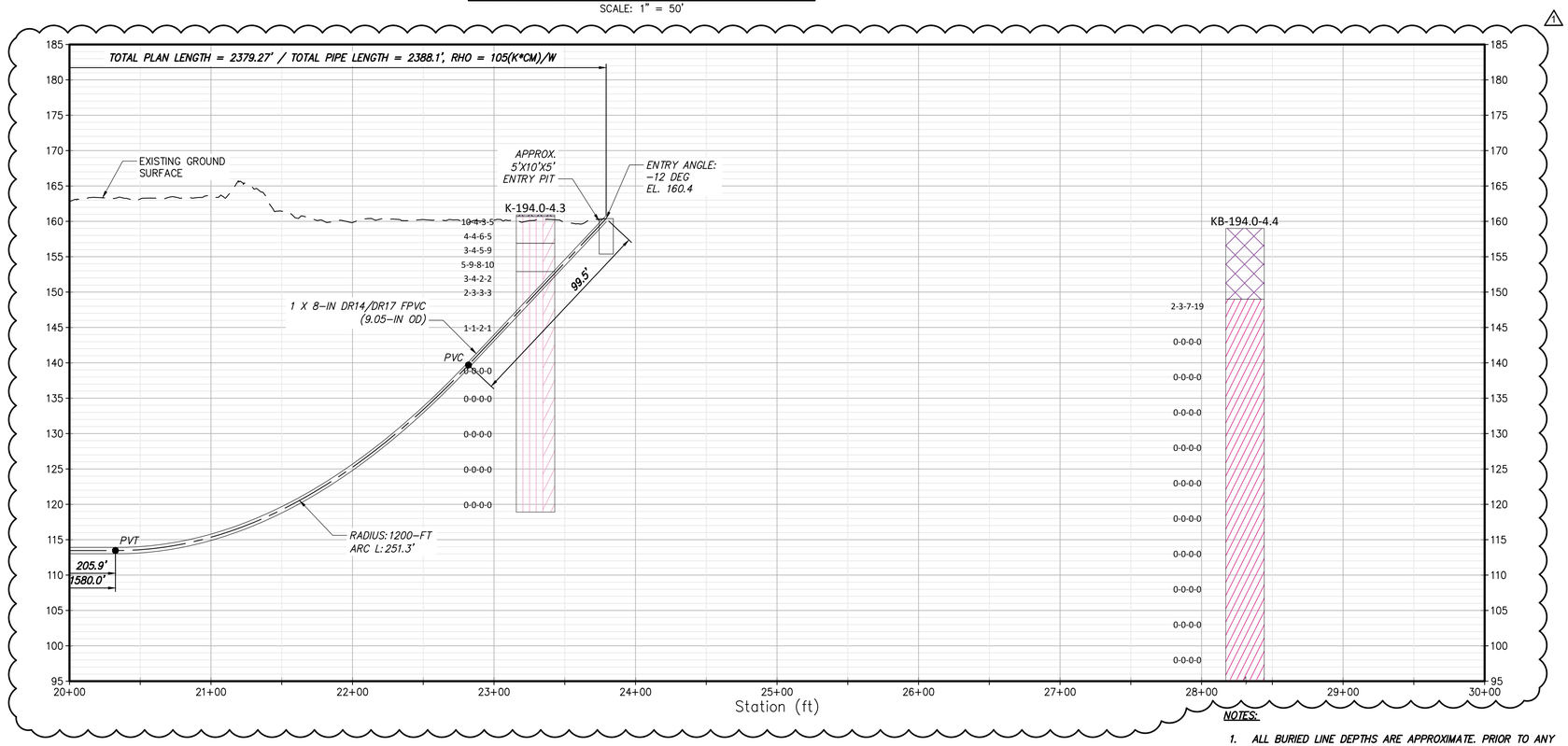
USGS 708	Gneiss
USGS 708	Gneiss
USGS 718	Granite 1
Void	Void
Water	Water
Weathered Rock	Undefined
Water Table	Water Table during drilling
Delayed Water Table	Water Table after drilling

PROPOSED HDD 89, CONDUIT 1 – PLAN

SCALE: 1" = 50'



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0 50 100
Scale in feet

PROPOSED HDD 89, CONDUIT 1 – PROFILE

SCALE: 1" = 50'

0 10 20

Scale in feet

Champlain Hudson Power Express

Kiewit

BRIERLEY ASSOCIATES
Creating Space Underground
26 Smith Pl, Ste 2, Cambridge, MA 02138
PHONE: 617.714.5784

PROJECT NO.: 21162

PROJECT NO.: 322004-000

ALTERED ON:

AFFIXED ON:

STATE OF NEW YORK – BRIAN C DORWART – 080378 – LICENSED PROFESSIONAL ENGINEER

Brian C Dorwart

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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 8 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

PROPOSED PLAN AND PROFILE - HDD 89

STREAM CROSSING, CONDUIT 1

SCHENECTADY COUNTY, NY

DRAWN BY: BC | DESIGNED BY: NS | APPROVED BY: BD | SCALE: AS SHOWN | DATE: 06/09/2023 | 0

PERMIT DRAWING NO.

DRAWING NO.

C-311

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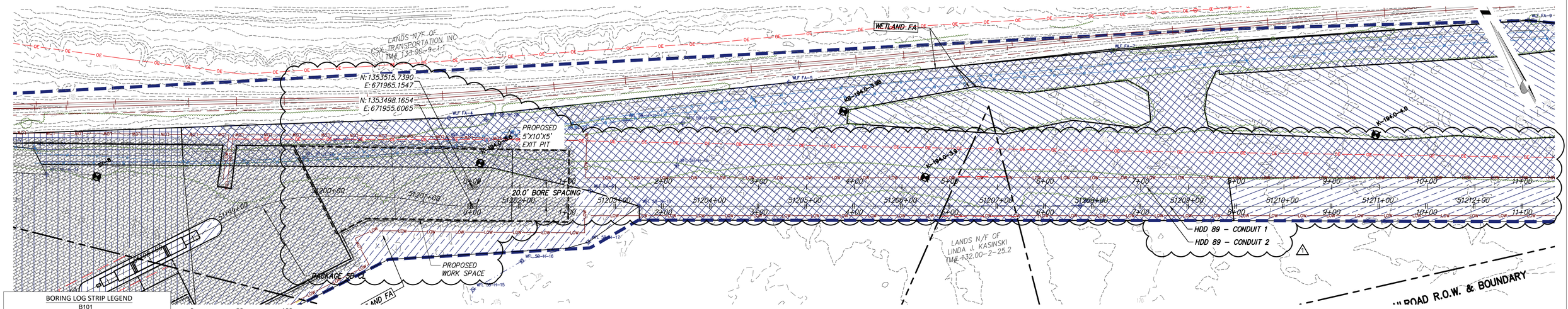
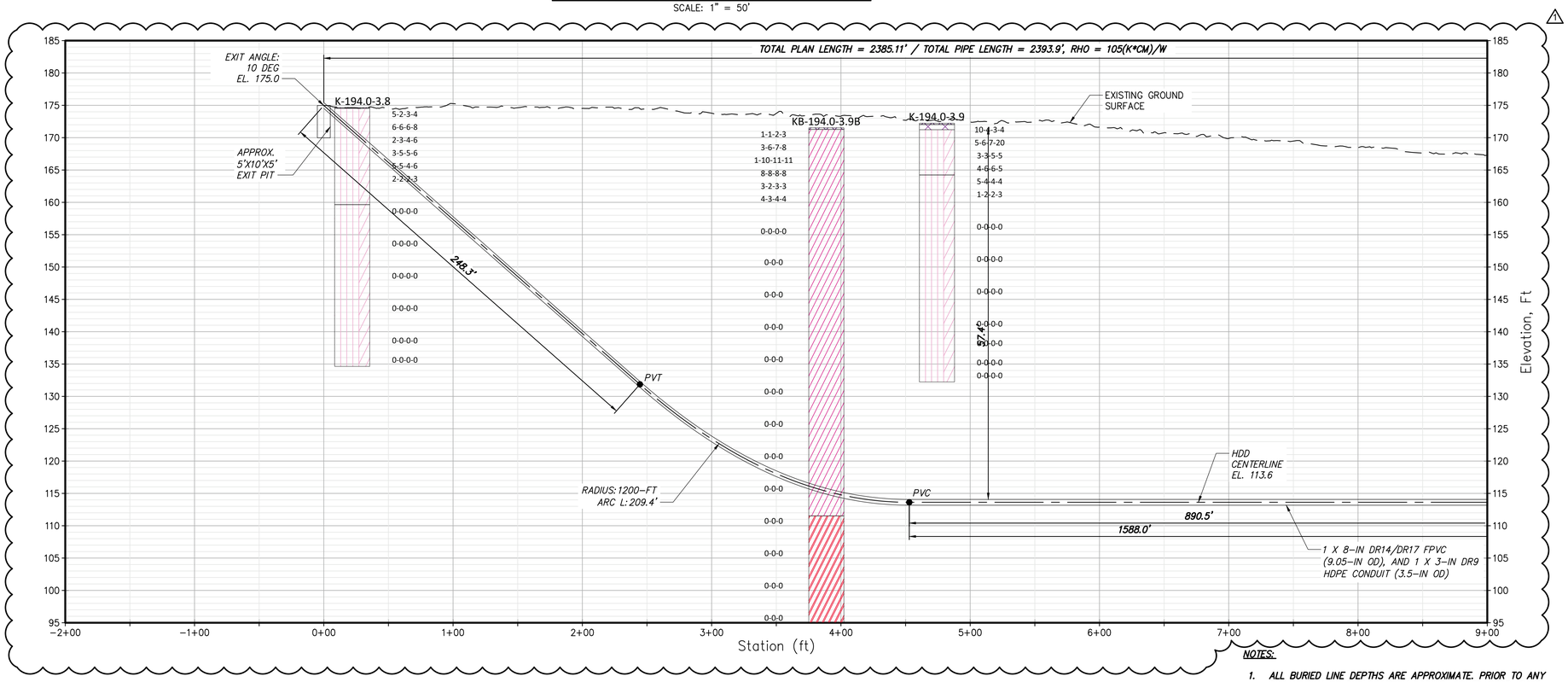


PROPOSED HDD 89, CONDUIT 2 – PLAN

SCALE: 1" = 50'



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PROPOSED HDD 89, CONDUIT 2 – PROFILE

SCALE: 1" = 50'

BORING LOG STRIP LEGEND

B101

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DRAWN BY: BC | DESIGNED BY: NS | APPROVED BY: BD | SCALE AS SHOWN | DATE: 06/09/2023 0

CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 8 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS
PROPOSED PLAN AND PROFILE - HDD 89
STREAM CROSSING, CONDUIT 2
SCHENECTADY COUNTY, NY

PERMIT DRAWING NO.

DRAWING NO. **C-312**

CHPE Champlain Hudson Power Express

Kiewit

BRIERLEY ASSOCIATES
Creating Space Underground
26 Smith Pl, Ste 2, Cambridge, MA 02138
PHONE: 617.714.5784

PROJECT NO.: 21162

PROJECT NO.: 322004-000

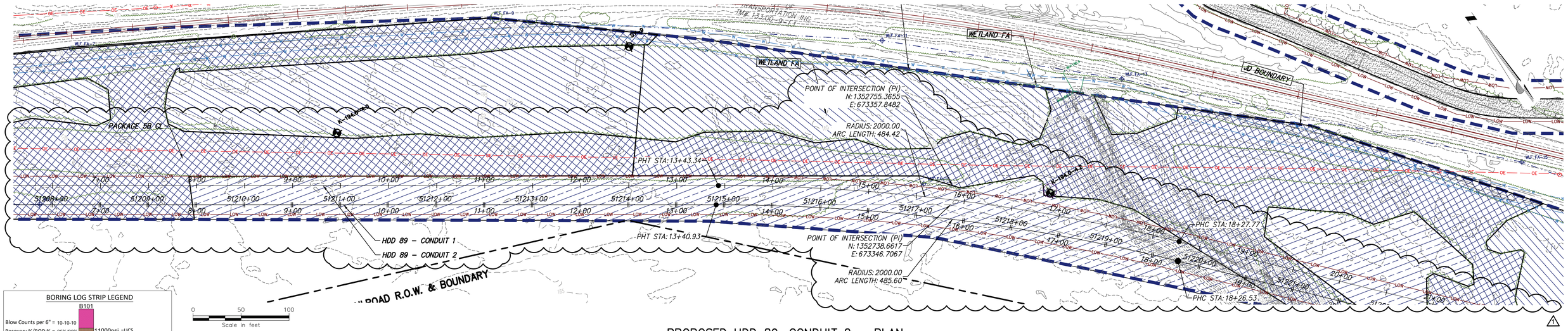
ALTERED ON:

AFFIXED ON:

STATE OF NEW YORK · BRIAN C DORWART · 069242 · LICENSED PROFESSIONAL ENGINEER

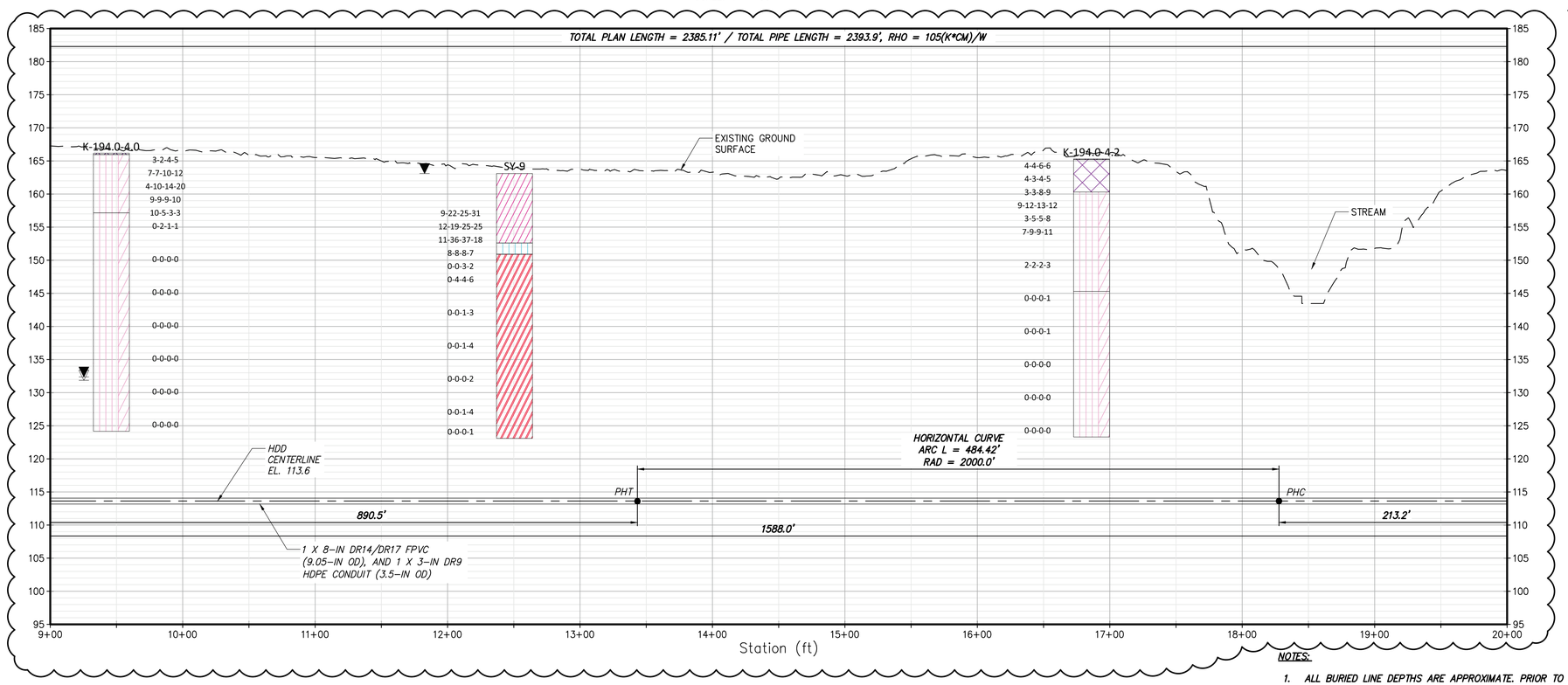
Brian C Dorwart

File: C:\USERS\BCONNELLY\DC\ACCDOCS\KIEWIT\01480--CHPE_TRANS\PROJECT FILES\40 DESIGN ENG\01 CAD\PSB\HDD\SB_BA_HDD-SHEETS.DWG Saved: 4/19/2024 6:39:52 PM Plotted: 4/23/2024 12:27:14 PM Current User: Brian Connelly LastSavedBy: bconnelly



PROPOSED HDD 89, CONDUIT 2 – PLAN

SCALE: 1" = 50'



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0 10 20

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26 Smith Pl, Ste 2, Cambridge, MA 02138
PHONE: 617.714.5784

ALTERED ON:

AFFIXED ON:

STATE OF NEW YORK · BRIAN C DORWART · 090127 · LICENSED PROFESSIONAL ENGINEER

Brian C Dorwart

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No.	DATE	SUBMITTAL / REVISION DESCRIPTION	DB	APP
1	04/19/2024	NDC-0005_ALIGNMENT REVISIONS PER NAT. GRID COMMENT	NS	BD
0	06/09/2023	ISSUED FOR CONSTRUCTION SUBMISSION	NS	BD

CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 8 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

PROPOSED PLAN AND PROFILE - HDD 89
STREAM CROSSING, CONDUIT 2
SCHENECTADY COUNTY, NY

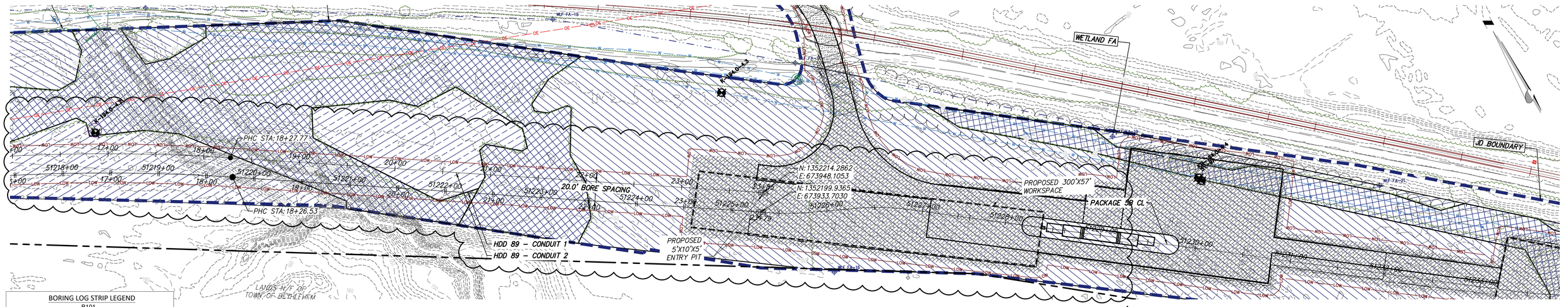
DRAWN BY: BC | DESIGNED BY: NS | APPROVED BY: BD | SCALE AS SHOWN | DATE: 06/09/2023 | 0

PERMIT DRAWING NO.

DRAWING NO.

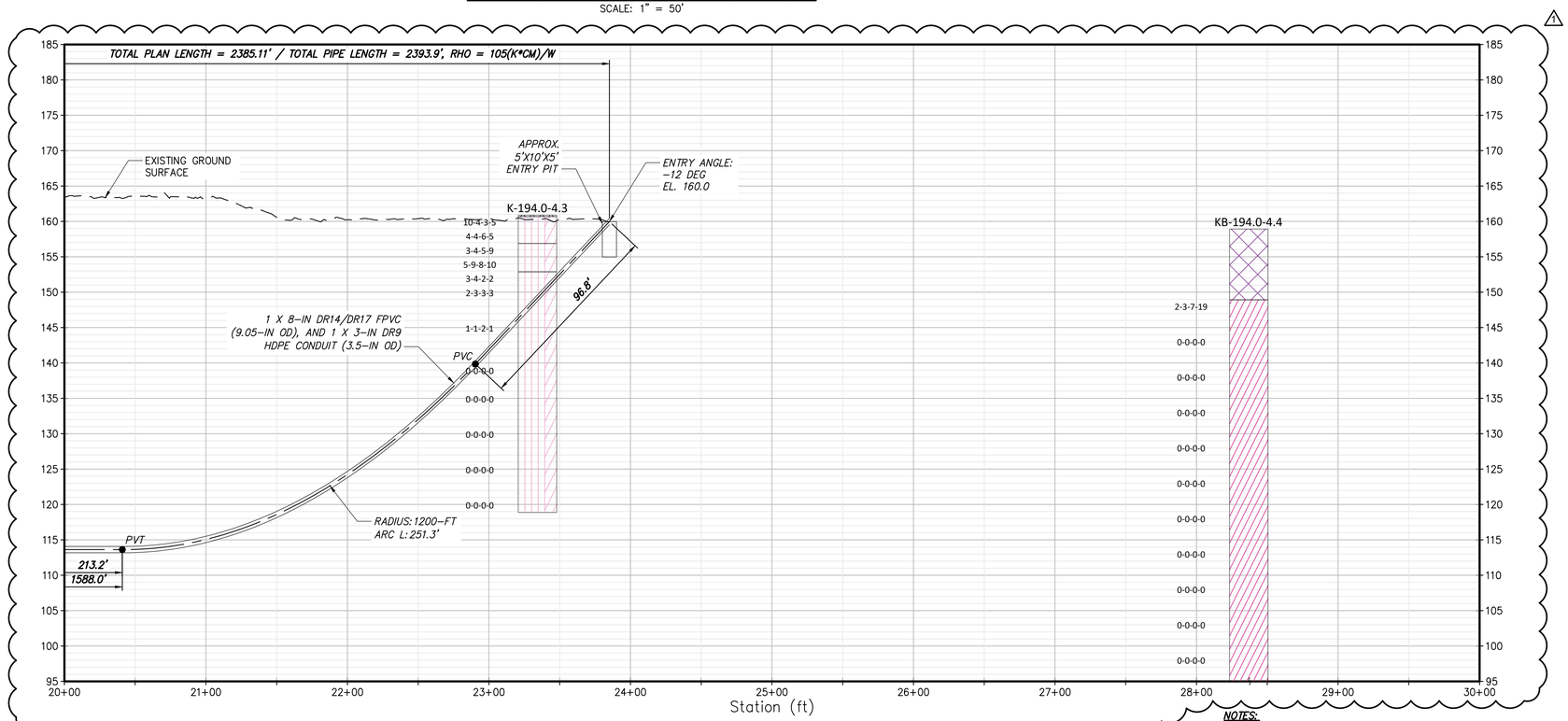
C-313

File: C:\USERS\BCONNELLY\DC\ACCDOCS\KIEWIT\01480-CHPE_TRANS\PROJECT FILES\40 DESIGN ENG\01 CAD\P5B\HDD\5B_BA_HDD-SHEETS.DWG Saved: 4/19/2024 6:39:52 PM Plotted: 4/23/2024 12:28:56 PM Current User: Brian Connelly LastSavedBy: bconnelly



PROPOSED HDD 89, CONDUIT 2 – PLAN

SCALE: 1" = 50'



PROPOSED HDD 89, CONDUIT 2 – PROFILE

SCALE: 1" = 50'

NOTES:

1. ALL BURIED LINE DEPTHS ARE APPROXIMATE. PRIOR TO ANY EXCAVATION OR EXPLORATORY BORING, CONTRACTOR MUST CONTACT 811 AND ABIDE BY ALL STATE EXCAVATION REQUIREMENTS.
2. CSX SHALL BE CONTACTED WHENEVER WORK IS BEING PERFORMED WITHIN THE RAILROAD RIGHT OF WAY.

0 50 100
Scale in feet

BORING LOG STRIP LEGEND

B101

Blow Counts per 6" = 10-10-10

Recovery %/RQD % = 95%/90%

11000psi =UCS

2D strip logs shown at 10x exaggeration
3D strip logs have no exaggeration
Boring ground elevations are from survey data and topo maps (or approximated from Google Earth when topo or survey aren't available)

Legend	
ASPHALT	Asphalt
Bedrock	Bedrock
Boulder	Boulder
CH	Fat CLAY
CH–MH	SILTY Fat CLAY
CL	Lean CLAY
CL–ML	SILTY CLAY
CONCRETE	Concrete
Fill	Fill
GC	CLAYEY GRAVEL
GC–GM	SILTY CLAYEY GRAVEL
GM	SILTY GRAVEL
GP	Poorly Graded GRAVEL
GP–GC	Poorly Graded Gravel with CLAY
GP–GM	Poorly Graded GRAVEL with SILT
GW	Well Graded GRAVEL
GW–GC	Well Graded GRAVEL with CLAY
GW–GM	Well Graded GRAVEL with SILT
Limestone	Limestone
MH	Elastic SILT
ML	SILT
OH	ORGANIC Fat CLAY
OL	ORGANIC Lean CLAY
OL/OH	ORGANIC SOIL
PT	PEAT
Rock	Rock
Sandstone	Sandstone
SC	CLAYEY SAND
SC–SM	SILT, CLAYEY SAND
SHALE	Shale
SILTSTONE	Siltstone
SM	SILTY SAND
SP	Poorly Graded SAND
SP–SC	Poorly Graded SAND with CLAY
SP–SM	Poorly Graded SAND with SILT
SW	Well graded SAND
SW–SC	Well Graded SAND with CLAY
SW–SM	Well Graded SAND with SILT
Topsoil	Topsoil
USGS 601	Gravel or Conglomerate 1
USGS 654	Subgraywacke
USGS 670	Interbedded Sandstone and Shale
USGS 702	Quartzite
USGS 705	Schist
USGS 705	Schist
USGS 708	Gneiss
USGS 708	Gneiss
USGS 718	Granite 1
Void	Void
Water	Water
Weathered Rock	Undefined
Water Table	Water Table during drilling
Delayed Water Table	Water Table after drilling

CHPE Champlain Hudson Power Express

PROJECT NO.: 21162

Kiewit

PROJECT NO.: 322004-000

BRIERLEY ASSOCIATES
Creating Space Underground
26 Smith Pl, Ste 2, Cambridge, MA 02138
PHONE: 617.714.5784

ALTERED ON:

AFFIXED ON:

STATE OF NEW YORK · BRIAN C DORWART · 095709 · LICENSED PROFESSIONAL ENGINEER
Brian C Dorwart

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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 8 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

PROPOSED PLAN AND PROFILE - HDD 89

STREAM CROSSING, CONDUIT 2

SCHENECTADY COUNTY, NY

DRAWN BY: BC | DESIGNED BY: NS | APPROVED BY: BD | SCALE AS SHOWN | DATE: 06/09/2023 | 0

PERMIT DRAWING NO.

DRAWING NO.

C-314

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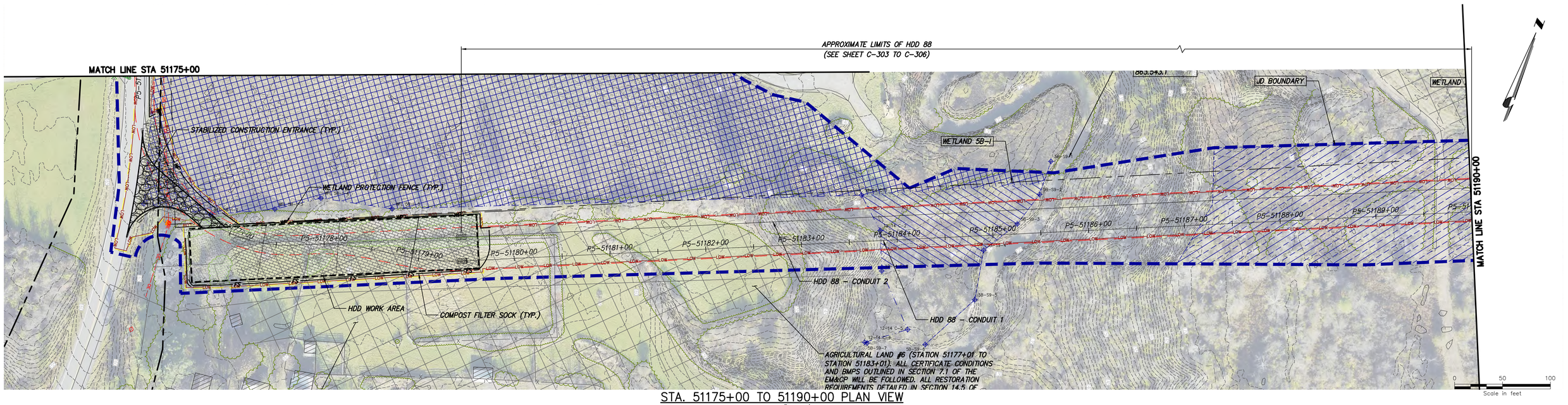
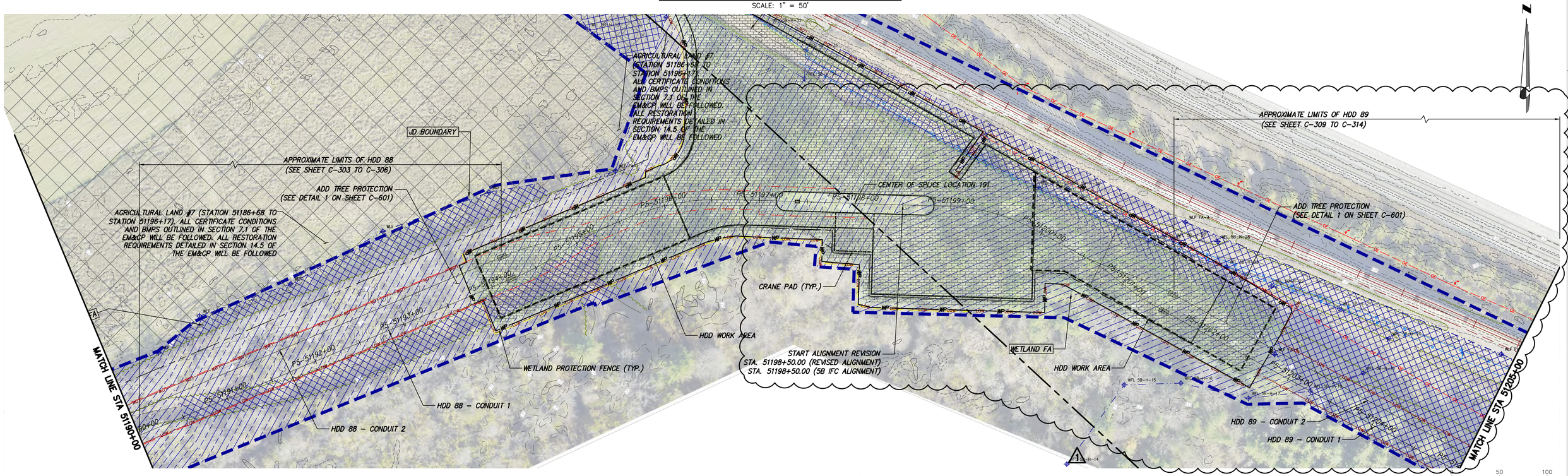


STA. 51175+00 TO 51190+00 PLAN VIEW

SCALE: 1" = 50'



STA. 51190+00 TO STA. 51205+00 PLAN VIEW

SCALE: 1" = 50'

CHPE Champlain Hudson Power Express

PROJECT NO.: 21162	PROJECT NO.: 120174	ALTERED ON: 03/26/2024	AFFIXED ON: 06/09/2023
Kiewit	Engineering and Land Surveying, P.C.	STATE OF NEW YORK DANT BIRBAL SINGH 85756 LICENSED PROFESSIONAL ENGINEER	STATE OF NEW YORK NATHANIEL DALE HAVENER 103692 LICENSED PROFESSIONAL ENGINEER

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0	06/09/2023	ISSUED FOR CONSTRUCTION SUBMISSION	MK/TH	NH

CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 9 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

EROSION AND SEDIMENT CONTROL PLAN

STA. 51175+00 TO STA. 51205+00

DRAWN BY: SC/TH | DESIGNED BY: MK | APPROVED BY: NH | SCALE: AS SHOWN | DATE:

PERMIT DRAWING NO.: **N/A**

DRAWING NO.: **C-407**

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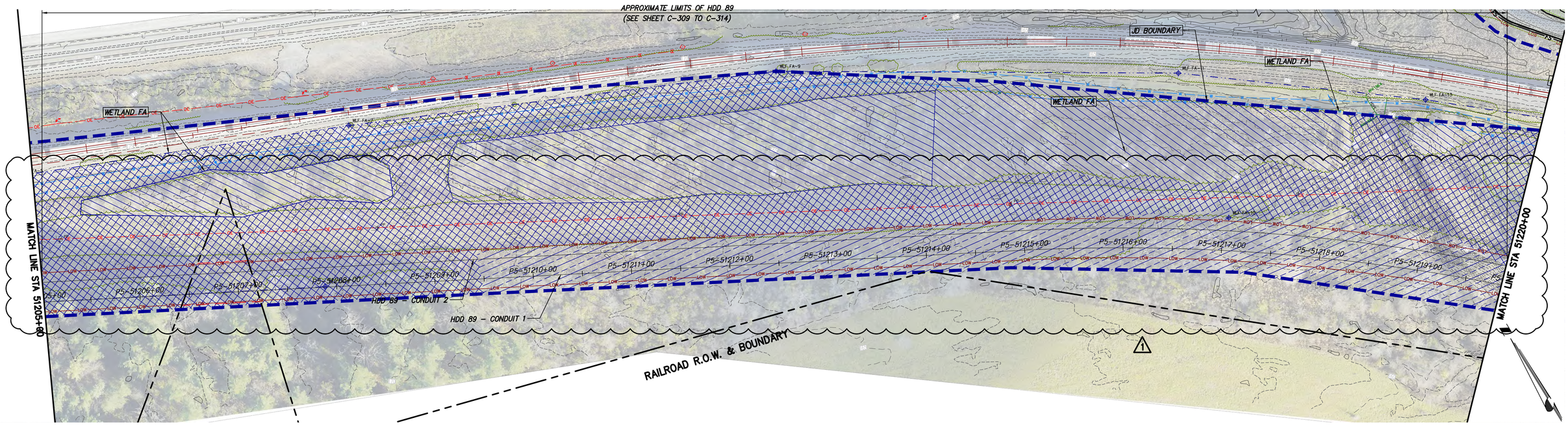
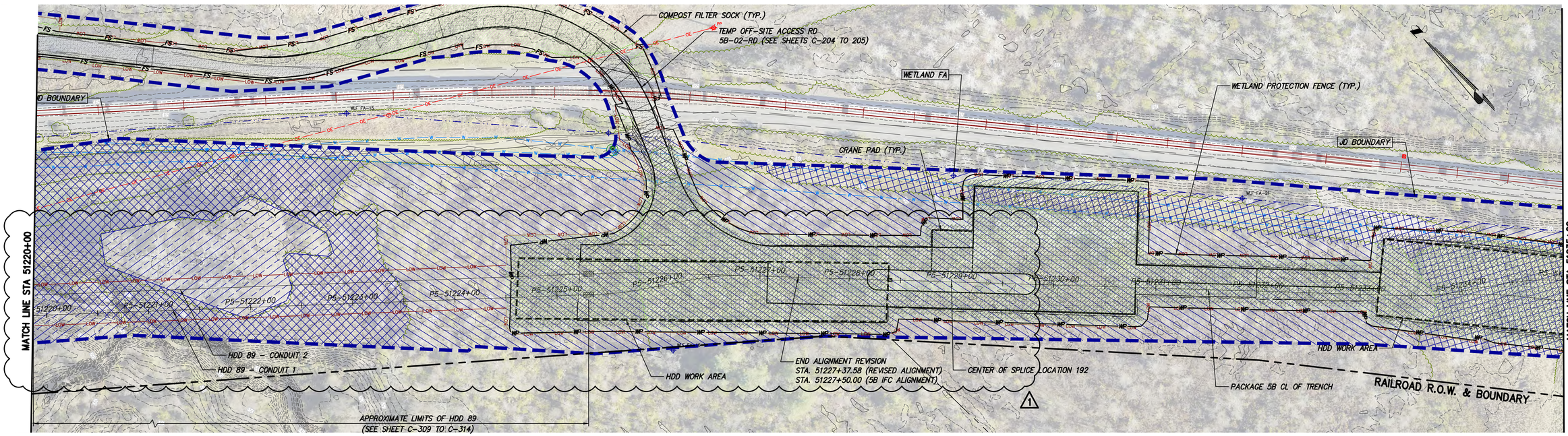


STA. 51205+00 TO STA. 51220+00 PLAN VIEW
SCALE: 1" = 50'

0 50 100
Scale in feet



STA. 51220+00 TO STA. 51235+00 PLAN VIEW
SCALE: 1" = 50'

0 50 100
Scale in feet

CHPE Champlain Hudson Power Express

PROJECT NO.: 21162	PROJECT NO.: 120174	ALTERED ON: 03/26/2024	AFFIXED ON: 06/09/2023
Kiewit	Engineering and Land Surveying, P.C.	STATE OF NEW YORK · DANY BIRBAL SINGH · 85756 · LICENSED PROFESSIONAL ENGINEER	STATE OF NEW YORK · NATHANIEL DALE HAYENGA · 103692 · LICENSED PROFESSIONAL ENGINEER

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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 9 (PACKAGE 5B) - CSX: SELKIRK RAIL YARD BYPASS

EROSION AND SEDIMENT CONTROL PLAN
STA. 51205+00 TO STA. 51235+00

DRAWN BY: SC/TH | DESIGNED BY: MK | APPROVED BY: NH | SCALE: AS SHOWN | DATE:

PERMIT DRAWING NO.
N/A

DRAWING NO.
C-408

CHPE LLC
623 Fifth Avenue, 20th Floor
New York, NY 10022

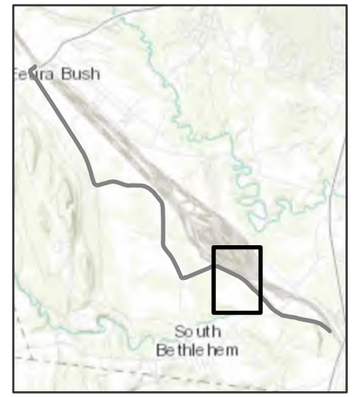
CHPE Segment 9 (Package 5B) EM&CP Appendix E Added Sheet

CHPE EM&CP

Schenectady and Albany County, New York

Deviation Zone Analysis

- Mile Post
- Segment 9 Trench Excursion
- Segment 9 HDD Excursion
- Segment 9 Trench
- Segment 9 HDD
- Segment 9 (Previous Alignment)
- Delineated Wetland
- Deviation Zone



0 87.5 175 350

Feet

Prepared March 19, 2024

Basemap: Esri "World Imagery" map service

EDR

CHPE LLC
623 Fifth Avenue, 20th Floor
New York, NY 10022

CHPE Segment 9 (Package 5B) EM&CP Appendix J Memorandum – NDC-0005

BRIERLEY ASSOCIATES
Creating Space Underground

April 18, 2024
File No. 322004-000

Kiewit Engineering (NY) Corporation
470 Chestnut Ridge Rd, 2nd Floor
Woodcliff Lake, NJ 07677

Attention: Jason Neff, PE, PMP - Design Engineering Manager

Subject: HDD 89 Design Revisions
Champlain Hudson Power Express – Segment 5b
Rotterdam to Fuera Bush, NY

Dear Mr. Neff:

At your request, we have modified HDD 89 to accommodate minor alignment modification and duct material changes. Specifically, these modifications include reversal of the drilling direction, and shifting of the pits. In addition, the duct will be fusible PVC rather than HDPE. Amended design calculations are attached.

The discussions and recommendations contained in our HDD Basis of Design Report and IRR plan otherwise remain unchanged.

We thank you for this opportunity to be of service to you and your team on this project. Should you have any questions or require additional information, please do not hesitate to contact the undersigned at your convenience.

Sincerely,

Brierley Associates Underground Engineers, PLLC

Nick Strater, P.G.
Trenchless Design Manager

Brian C. Dorwart, P.E., P.G.
Sr. Consultant

Brian C Dorwart

Digitally signed by Brian C Dorwart
DN: C=US, O=BRIERLEY ASSOCIATES CORPORATION, dnQualifier=A01410C000001881F68602400021945, cn=Brian C Dorwart
Date: 2024.04.19 15:52:50 -04'00'

BRIERLEY ASSOCIATES
Creating Space Underground

HORIZONTAL DIRECTIONAL DRILL DESIGN

PROJECT: Champlain Hudson Power Express
Segment 9 (Pkg. 5B) - CSX: Selkirk Railyard Bypass
Schenectady County, NY

CROSSING: **HDD 89 Circuit #1**
Wetlands Crossing

ISSUE: **Issued For Construction**

Contents:

Table 1	DESIGN SUMMARY, ASSUMPTIONS, CONDITIONS
Table 2	DESIGN DRILL PATH CALCULATION
Table 3	ANTICIPATED PULLING FORCE - CONSTANT FORCE
Figure 1	APC AND FPC CURVES AND ASSUMED GEOLOGIC SECTION

Prepared For: Kiewit

Prepared By: Brierley Associates
167 S. River Road, Suite 8
Bedford, NH 03110
603.206.5775 (O)

Project No: 322004-000
Print Date: 18-Apr-2024

Date	ID	DESCRIPTION	BY
10/23/2022	0	Design Submittal	ABL
3/23/2023	1	Issued for Construction	NHS
4/18/2024	2	Pipe Material Revisions	NHS

DRILL PATH DESIGN CALCULATIONS

			PROJECT STA
Entry Plan Length	0+00.00	Entry Station	0+00.00
Exit Plan Length	23+79.27	Exit Station	23+79.27
Station entry to exit: (+1) increase, (-1) Decrease			1

	East	North	Elevation
HDD Entry	673933.7030	1352199.9365	160.40 ft
HDD Exit	671955.6065	1353498.1654	174.70 ft
Azimuth Entry to Exit	N 303.276975 E	Straight Length =	2,366.07 ft
Horizontal Curves	East	North	Radius (ft)
PI-1	673346.7067	1352738.6617	2,000.00 ft
PI-2			
PI-3			

Water Elev.	0.00 ft
Mudline Elev.	-35.00 ft
Lowest centerline Elev.	113.50 ft
Acceptible Depth	ACCEPT
Depth to Mudline =	195.40 ft
Clearance Depth =	-148.50 ft
Measured Station Length =	2,379.27 ft
Calculated Plan Length =	2,379.27 ft
QC - Station = Plan	ACCEPT
Number of Horizontal Curves, N =	1
Assumed Exit Overbend Radius =	1200
Total Bend =	35.911

Path Geometry

Segment	Plan Forward	Path Forward	Start Elevation	Start Vert. Ang.	Radius	Start Az.
ENTRY	97.28 ft	99.451 ft	160.40 ft	-12.00 deg	0 ft	312.5446529
PVC1	249.49 ft	251.327 ft	139.72 ft	-12.00 deg	1,200 ft	312.5446529
PVT1	205.97 ft	205.967 ft	113.50 ft	0.00 deg	0 ft	312.5446529
PHC1	485.60 ft	485.596 ft	113.50 ft	0.00 deg	-2,000 ft	312.5446529
PHT1	888.86 ft	888.864 ft	113.50 ft	0.00 deg	0 ft	298.633366
PVC2	208.38 ft	209.440 ft	113.50 ft	0.00 deg	1,200 ft	298.633366
PVT2	243.69 ft	247.450 ft	131.73 ft	10.00 deg	0 ft	298.633366
EXIT	0.00 ft	0.000 ft	174.70 ft	10.00 deg	0 ft	298.633366

PIPE ENTRY Drill Exit INPUT: 'Drill Entry' or 'Drill Exit'

**North entry is defined as center of drill bit intersecting an elevation plane at given location. South entry is the center of casing at given location/elevation.*

HORIZONTAL PLAN CALCULATIONS (FT)

Horizontal Curve 1	*(+) = clockwise*	*Horizontal Curve 2*		*Horizontal Curve 3*	
Entry Azimuth,deg =	N312.5447E	Entry Azimuth,deg =		Entry Azimuth,deg =	
Exit Azimuth,deg =	N298.6334E	Exit Azimuth,deg =		Exit Azimuth,deg =	
Arc Angle, A, deg =	-13.911 deg.	Arc Angle, A, deg =	0.000 deg.	Angle, A, deg =	0.000 deg.
Arc Length, L_A =	485.5955	Arc Length, L_A, ft =		Arc Length, L_A, ft =	
PHC1 Easting	673526.4721	PHC2 Easting		PHC3 Easting	
PHC1 Northing	1352573.679	PHC2 Northing		PHC3 Northing	
PHT1 Easting	673132.549	PHT2 Easting		PHT3 Easting	
PHT1 Northing	1352855.586	PHT2 Northing		PHT3 Northing	
Plan Length to PHC1	552.7392			Length PHT2 to PHC3	
PHC1 Sta	5+52.7392	PHC2 Sta		PHC3 Sta	
PHT1 Sta	10+38.3347	PHT2 Sta		PHT3 Sta	
PHT1 to PHC2/EXIT	1,340.93 ft	PHT2 to PHC3/EXIT		PHT3 TO EXIT	
Exit Sta.	23+79.27	Exit Sta.		Exit Sta.	

Check	
Delta = $\Delta_{sta} - \Delta_{path}$	
2379.2679	
2379.2679	
0.0000	
Exit Station	
23+79.27	
OK STA	

Pull Geometry

Segment	Plan Forward	Path Forward	Start Elevation	Start Vert. Ang.	Radius	Azimuth
EXIT	243.69 ft	247.45 ft	174.70 ft	-10.00 deg	0 ft	118.6334
PVT2	208.38 ft	209.44 ft	131.73 ft	-10.00 deg	1,200 ft	118.6334
PVC2	888.86 ft	888.86 ft	113.50 ft	0.00 deg	0 ft	118.6334
PHT1	485.60 ft	485.60 ft	113.50 ft	0.00 deg	-2,000 ft	118.6334
PHC1	205.97 ft	205.97 ft	113.50 ft	0.00 deg	0 ft	118.6334
PVT1	249.49 ft	251.33 ft	113.50 ft	0.00 deg	1,200 ft	118.6334
PVC1	97.28 ft	99.45 ft	139.72 ft	12.00 deg	0 ft	118.6334
ENTRY	0.00 ft	0.00 ft	160.40 ft	12.00 deg	0 ft	118.6334
		Total Check =	2,388.10	OK		

VERTICLE PATH DESIGN CALCULATIONS (FT)

ENTRY - Tangent Segment 1		*ENTRY Vert. Curve Segment 2*		*Middle Tangent Segment 3*		*EXIT Vert. Curve Segment 4*		*EXIT Tangent Segment 5*		
Entry Angle	-12.000 deg.	Vertical Radius	1200.00	End Vert Angle	0.000 deg.	Radius	1200.00	Exit Elevation	174.70	
		Δ Vert. Angle, deg.	12.000	Inclined Bottom Tan	NO	Δ Vertical Angle	10.000 deg.	Design Exit Angle	10.00 deg	
Calculate Vertical PCV		**Calculate Vertical PTV**		**Calculate Vertical PCV**		**Calculate Vertical PTV**		**Calculate Exit**		**SUMS**
Plan Length	97.278	Plan Length	249.494	Plan Length	1580.427	Plan Length	208.378	Plan Length	243.691	2,379.27 ft
Rod Length	99.451	Arc Rod Length	251.327	Rod Length	1580.427	Arc Rod Length	209.440	Rod Length	247.450	2,388.10 ft
Vertical Depth	-20.677	Curve Δ Vert Depth	-26.223	Vertical Depth	0.000	Curve Δ Vert Depth	18.231	Vertical Depth	42.969	14.30 ft
		Start Vert Angle	-12.000 ft	Start Vert Angle	0.000 ft	Start Vert Angle	0.000 ft	Start Vert Angle	10.000 ft	
		Lowest Elevation	113.500 ft			Lowest Elevation	113.500 ft	CK Total Cum Depth	14.300 ft	
Start Elevation	160.400 ft	Start Elevation	139.723 ft	Start Elevation	113.500 ft	Start Elevation	113.500 ft	Start Elevation	131.731 ft	
End Elevation	139.723 ft	End Elevation	113.500 ft	End Elevation	113.500 ft	End Elevation	131.731 ft	End Elevation	174.700 ft	
End Vert Angle	-12.000 ft	End Vert Angle	0.000 ft	End Vert Angle	0.000 ft	End Vert Angle	10.000 ft	***Prop. Plan Length***	***2379.268 ft***	

Summary of Drill Calculations

Entry to Exit Elev. Change =	14.30 ft
Minimum Design Elevation =	113.50 ft
Centerline Depth below Entry =	46.90 ft
Centerline Depth below Exit =	61.20 ft
Path Length =	2388.10 ft
Plan Length =	2379.27 ft
Entry Angle =	-12.00 deg
Exit Angle =	10.00 deg
Compound Radius	NO
Minimum Compound Radius =	0 ft

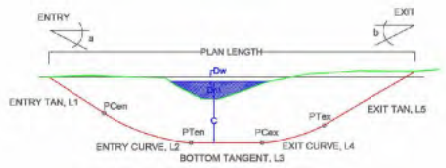
SUMMARY VERTICLE CURVE CALCULATIONS

Entry Sta	0+00.00	PVC1 Sta	0+97.28	PVT1 Sta	3+46.77	PVC2 Sta	19+27.20	PVT2 Sta	21+35.58
PVC1 Sta	0+97.28	PVT1 Sta	3+46.77	PVC2 Sta	19+27.20	PVT2 Sta	21+35.58	Exit Sta	23+79.2679
Cum Plan Length	97.28	Cum Plan Length	346.77	Cum Plan Length	1927.20 ft	Cum Plan Length	2135.58	Cum Plan Length	2379.27
Cum Path Length	99.45146	Cum Path Length	350.78	Cum Path Length	1931.21 ft	Cum Path Length	2140.65	Cum Path Length	2388.0956
Cum Depth	-20.68	Cum Depth	-46.90	Cum Depth	-46.90 ft	Cum Depth	-28.67	Cum Depth	14.30
Easting PVC1	673862.0332	Easting PVT1	673678.2183	Easting PVC2	672352.3892	Easting PVT2	672169.4951	Easting Exit	671955.6065
Northing PVC1	1352265.713	Northing PVT1	1352434.412	Northing PVC2	1353281.533	Northing PVT2	1353381.388	Northing Exit	1353498.165

Stationing Check
OK STATIONING
Plan Length Check
OK CALCULATION
Elevation Change Check
OK CALCULATION

NOTES:

1. Sign convention for vertical angles - positive (+) angles are counterclockwise.
2. Due North is defined as 0 degrees. Clockwise = (+).
2. NAD83 New York State Plane East Zone
3. Elevations are referenced to NAVD88 Datum
5. All calculation locations represent the center of the drill hole.
6. Survey base used for these calculations provided by Owner.
7. Stationing references Project Alignment along centerline of bore.



Indicates inputs

Indicates status on internal design checks

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Champlain Hudson Power Express
Segment 9 (Pkg. 5B) - CSX: Selkirk Railyard Bypass
Schenectady County, NY

TABLE 1
DESIGN DRILL PATH CALCULATIONS
HDD 89 Circuit #1

Revision 1
Print Date: 4/19/2024

D:\CHPE\[89 FPVC Circuit 1 NEW.xlsx]T5 PVC Pull

Pull Geometry

Lengths (Path)			V. Angle	Azimuth	EL	Radius, R
Tail	L_{tail}	100.0 ft			Overbend	1,200.0 ft
EXIT	L1 =	247.5 ft	10.000	118.633	174.700	0.0 ft
PVT2	L2 =	209.4 ft	10.000	118.633	131.731	1,200.0 ft
PVC2	L3 =	888.9 ft	0.000	118.633	113.500	0.0 ft
PHT1	L4 =	485.6 ft	0.000	118.633	113.500	2,000.0 ft
PHC1	L5 =	206.0 ft	0.000	118.633	113.500	0.0 ft
PVT1	L6 =	251.3 ft	0.000	118.633	113.500	1,200.0 ft
PVC1	L7 =	99.5 ft	-12.000	118.633	139.723	0.0 ft
ENTRY	L8 =	0.0 ft	-12.000	118.633	160.400	0.0 ft
	L9 =					
	L10 =					
	L11 =					
	L12 =					

Drag Force = L_{tail}*ν_G = 10

LT = 2488.1 ft

INPUT: Assumed Friction Factors

ν_G =	0.10	dry + rollers
ν_b =	0.25	drill fluid in hole
ν_c =	0.30	in hole no fluid

INPUT: Assumed Hydrokinetic Drag

τ_f = 0.005 psi Drill Fluid Shear Stress

INPUT: Pipe Properties

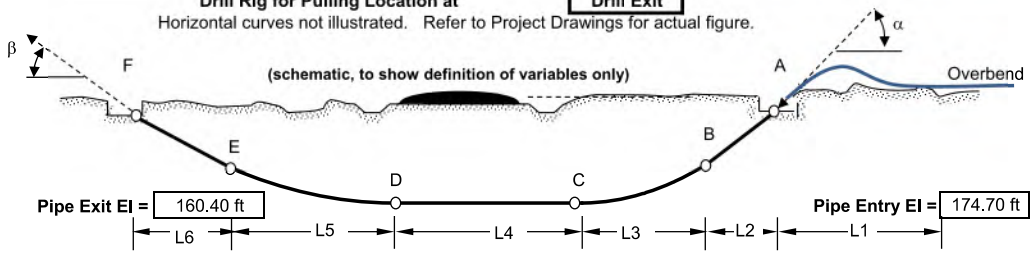
Material	fPVC		DIPS
Safe Pull Max. Stress, σ_{PM}	2,800 psi	UGSI,Inc.	
Pile/Bundle Diam.	8.6 in	PIPE	PIPE/BUNDLE
Material Density, γ	89.83 pcf		
Outside Diameter, D_{OD}	8.63 in	Pipe or Bundle	
Min. Wall Thickness, t_m	0.510 in	For design installation pull stress	
DR = D_O/t_{min} =	17.0	D_{OD} Stress	8.63 inches
Avg. Inside Diameter, D_{IA}	7.55 in	Bundle Multiplier F_D	1.0000
Duration of Installation	24 Hrs		
Pullback Modulus, E_T =	400,000 psi	@T =	73 Deg F
Poisson Ratio, μ =	0.38		
Ovality Factor, f_o =	0.76	3%	
Buckling Safety, N =	2		

INPUT: Assumed Fluid Densities/Elevations

Ballast Density, γ_B =	62.43 pcf		***Estimated for pull***
Drill Fluid Density, γ_{DF} =	78.00 pcf	10.43 ppg	***Estimated for pull***
Drill fluid elevation, H_F =	158.00 ft	**INPUT**	
Ballast Water El., H_W =	158.00 ft	**INPUT**	
Lowest Invert El., El_m =	113.50 ft		
Pipe Entry Ground Slope =	0.0 deg		

Drill Rig for Pulling Location at **Drill Exit**

Horizontal curves not illustrated. Refer to Project Drawings for actual figure.



Calculated Pull Force

POINT	Pull Force F_D No Ballast	Max Tensile Stress, σ_T	ASSESS $\sigma_T < \sigma_{PM}$	Pull Force F_B Ballasted	Max Tensile Stress, σ_T	ASSESS $\sigma_T < \sigma_{PM}$	ASSESS F_x < SPS Air	ASSESS F_x < SPS Ballast
EXIT	2,135 lb	164 psi	OK	2,135 lb	164 psi	OK	42.5	42.5
PVT2	3,399 lb	381 psi	OK	2,676 lb	326 psi	OK	26.7	33.9
PVC2	4,973 lb	382 psi	OK	3,160 lb	243 psi	OK	18.2	28.7
PHT1	8,620 lb	735 psi	OK	3,896 lb	371 psi	OK	10.5	23.3
PHC1	13,420 lb	1032 psi	OK	5,307 lb	408 psi	OK	6.8	17.1
PVT1	13,224 lb	1136 psi	OK	5,111 lb	513 psi	OK	6.9	17.7
PVC1	15,644 lb	1202 psi	OK	5,810 lb	447 psi	OK	5.8	15.6
ENTRY	16,220 lb	1247 psi	OK	5,968 lb	459 psi	OK	5.6	15.2
Maximum applied pull Stress, σ_T =		1247 psi	OK		Max. = 513 psi	OK		
		Unballasted Stress =	OK		Ballasted Stress	OK		

Maximum tensile stress during pullback = $\sigma_t = (F_T/\pi t_m(D_{OD}-t_m))+E_T D_{OD}/2R$ PPI Ch 12 Eq 16

Calculated Material Design Limits For Designed Drill Path

Ultimate Pull Strength, UPS =	90,676 lb	UPS = $\sigma_U \pi D_{OD}^2((1/DR)-(1/DR^2))$	σ_U = 7,000 psi
UniBel Safe Pull Strength @ FS = 2.5	36,270 lb	SPS = UPS/FS	σ_A = 2,800 psi

ASSESS Pull Restricted Buckling Capacity, $P_{PA} > \Delta P$ invert

Allowable Short Term Unconstrained Buckling, P_A =	86.74 psi	$P_A = (2E_T/(1-\mu^2))(1/(DR-1))^3(f_o/N)$
Pull Stress Reduction, F_R =	0.9530219	$F_R = (5.57-(r+1.09)^2)^{1/2}-1.09$
r =	0.0916	$r = \sigma_T/2SPS$
Allowable Unconstrained Buckling Capacity, $P_{PA} = P_A F_R$ =	**82.670**	
ΔP_B unballasted = $(H_F-El_m)*\gamma_{DF}$ =	24.1 psi	ACCEPT
ΔP_B ballasted = $H_F*\gamma_{DF}-H_W*\gamma_B$ =	4.8 psi	ACCEPT

Drill Hole Diameter Assumed for Calculations

D_H = 14.0 in D_O<8" Use $D_H=D_O+4$"; 8"<D_O<24" Use $D_H=1.5*D_O$; D_O>24" Use $D_H=D_O+12$"

Calculated Pipe and Fluid Properties

OD Perimeter Length, P	27.1 in2/LF
Wall Section Area, A_W	13.72 in^2
Volume Outside, V_{DO}	0.406 cf/LF
Volume Inside, V_{DI}	0.311 cf/LF
Drag Coefficient, q_d =	1.63 lb/ft

Calculated Effective Weights (Buoyant Forces)

	Pipe	Air Filled	Ballasted
On Ground, w_a/w_{af} =		8.56 Lb/LF	27.97 Lb/LF
In Hole with Drill Fluid, w_b/w_{bf} =		-23.12 Lb/LF	-3.71 Lb/LF

NOTES: 1 - Calculations were done in general accordance with ASTMF-1962 as modified to account for invert tangent section, independent vertical curves, and fluid drag. ASTM applies hydrokinetic pressure as shear per unit pipe length requiring a back calculation to determine actual pull force based on average pipe area.

Pump Rate during Pull	200 gpm
DH Volume	1.07 cf/LF
Open Hole Velocity	25.01 ft/min
Annular Velocity	40.34 ft/min

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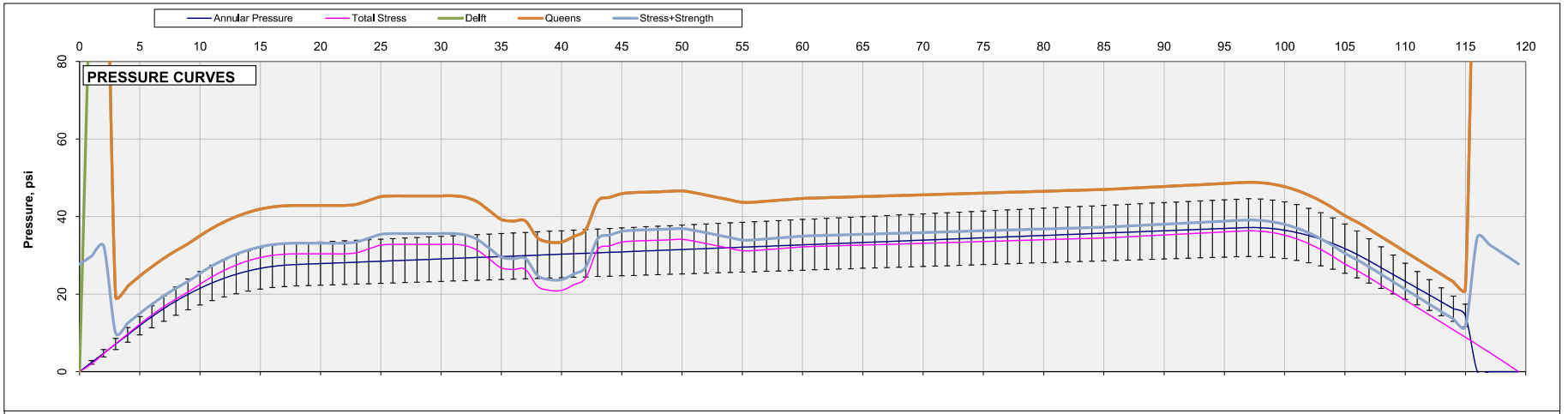
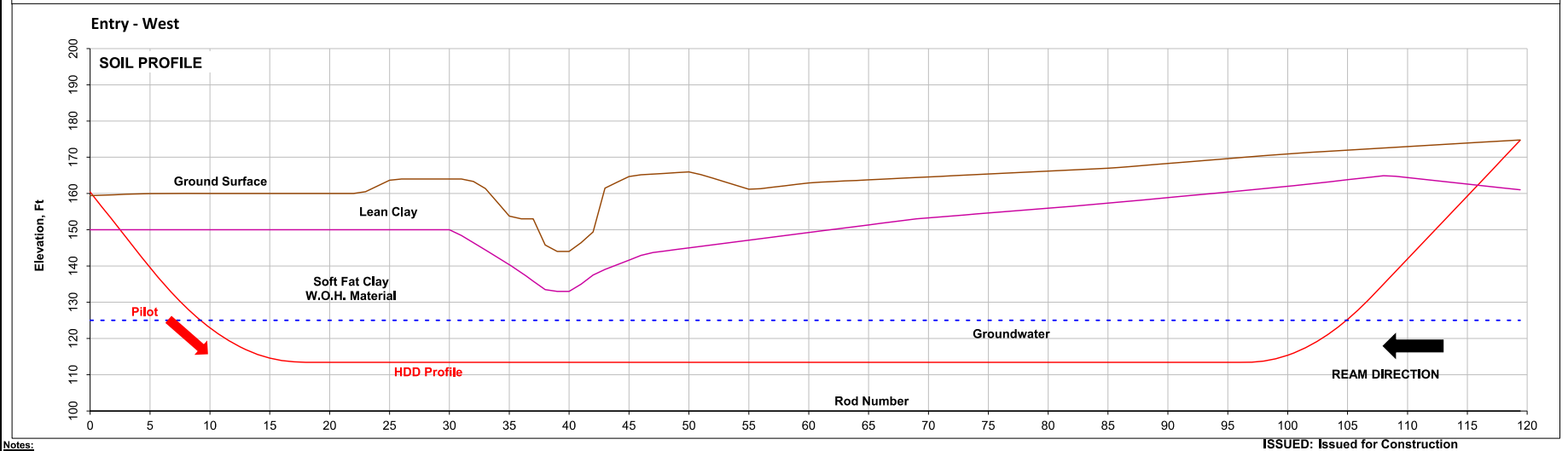
Champlain Hudson Power Express
Segment 9 (Pkg. 5B) - CSX: Selkirk Railyard Bypass
Schenectady County, NY

TABLE 3 - PULL ASSESSMENT
ANTICIPATED PULLING FORCE - PVC PULL
HDD 89 Circuit #1
Wetlands Crossing

Revision 1 TBD

D:\CHPE\[89 FPVC Circuit 1 NEW.xlsx]T5 PVC Pull





Notes:

1. Geology is interpreted from project data
2. Rod length: 20 feet
3. The error bars are at 20% and represent Drill Fluid low and high density range.
4. Ground surface data obtained from project survey data
5. Subsurface data from Geotechnical Report.

Basis of annulur pressure calculations

9.00 in	Pilot Hole Diameter
78.0 pcf	Unit Weight Drill Fluid
200 gal/min	Pump Rate
3.50 in	Drill Rod Diameter
20	Ft per rod
20%	for APC curve

Bore Logs:

K-194.0-3.8
KB-194.0-3.9B
K-194.0-3.9
K-194.0-4.0
SY-9
K-194.0-4.2
K-194.0-4.3
KB-194.0-4.4

Print Date ; 2/5/2024 14:55

ISSUED: Issued for Construction

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Champlain Hudson Power Express
Segment 9 (Pkg. 5B) - CSX: Selkirk Railyard Bypass
Schenectady County, NY

ANNULAR PRESSURE AND FORMATION PRESSURE CURVES
HDD 89 Circuit #1
Wetlands Crossing

Revision 2

FIGURE 1

BRIERLEY ASSOCIATES
Creating Space Underground

HORIZONTAL DIRECTIONAL DRILL DESIGN

PROJECT: Champlain Hudson Power Express
Segment 9 (Pkg. 5B) - CSX: Selkirk Railyard Bypass
Schenectady County, NY

CROSSING: **HDD 89 Circuit #2**
Wetlands Crossing

ISSUE: **Issued For Construction**

Contents:

Table 1	DESIGN SUMMARY, ASSUMPTIONS, CONDITIONS
Table 2	DESIGN DRILL PATH CALCULATION
Table 3	ANTICIPATED PULLING FORCE - CONSTANT FORCE
Figure 1	APC AND FPC CURVES AND ASSUMED GEOLOGIC SECTION

Prepared For: Kiewit

Prepared By: Brierley Associates
167 S. River Road, Suite 8
Bedford, NH 03110
603.206.5775 (O)

Project No: 322004-000
Print Date: 18-Apr-2024

Date	ID	DESCRIPTION	BY
10/23/2022	0	Design Submittal	ABL
3/23/2023	1	Issued for Construction	NHS
4/18/2024	2	Pipe Material Revisions	NHS

DRILL PATH DESIGN CALCULATIONS

			PROJECT STA	23+85.09	
Entry Plan Length	0+00.00	Entry Station	0+00.00	MHW Elev.	0.00 ft
Exit Plan Length	23+85.09	Exit Station	23+85.09	Mudline Elev.	-35.00 ft
Station entry to exit: (+1) increase, (-1) Decrease			1	Lowest centerline Elev.	113.60 ft
				Acceptible Depth	ACCEPT
	East	North	Elevation	Depth to Mudline =	196.00 ft
HDD North End*	673948.1053	1352214.2862	161.00 ft	Clearance Depth =	-148.60 ft
HDD South End*	671965.1547	1353515.7390	175.00 ft	Measured Station Length =	2,385.09 ft
Azimuth Entry to Exit	N 303.277745 E	Straight Length =	2,371.89 ft	Calculated Plan Length =	2,385.09 ft
Horizontal Curves	East	North	Radius (ft)	QC - Station = Plan	ACCEPT
PI-1	673357.8482	1352755.3655	2,000.00 ft	Number of Horizontal Curves, N =	1
PI-2				Assumed Exit Overbend Radius =	1200
PI-3				Total Bend =	22.0 deg.

**North entry is defined as center of drill bit intersecting an elevation plane at given location. South entry is the center of casing at given location/elevation.*

Path Geometry

Segment	Plan Forward	Path Forward	Start Elevation	Start Vert. Ang.	Radius	Start Az.
ENTRY	99.63 ft	101.86 ft	161.00 ft	-12.00 deg	0 ft	312.5109899
PVC1	249.49 ft	251.33 ft	139.82 ft	-12.00 deg	1,200 ft	312.5109899
PVT1	208.21 ft	208.21 ft	113.60 ft	0.00 deg	0 ft	312.5109899
PHC1	484.42 ft	484.42 ft	113.60 ft	0.00 deg	-2,000 ft	312.5109899
PHT1	890.14 ft	890.14 ft	113.60 ft	0.00 deg	0 ft	298.6333629
PVC2	208.38 ft	209.44 ft	113.60 ft	0.00 deg	1,200 ft	298.6333629
PVT2	244.83 ft	248.60 ft	131.83 ft	10.00 deg	0 ft	298.6333629
EXIT	0.00 ft	0.00 ft	175.00 ft	10.00 deg	0 ft	298.6333629

PIPE ENTRY Drill EXIT INPUT: 'Drill Entry' or 'Drill Exit'

HORIZONTAL PLAN CALCULATIONS (FT)

Horizontal Curve 1	*(+) = clockwise*	*Horizontal Curve 2*		*Horizontal Curve 3*	
Entry Azimuth,deg =	312.5109899	Entry Azimuth,deg =		Entry Azimuth,deg =	
Exit Azimuth,deg =	N298.6334E	Exit Azimuth,deg =		Exit Azimuth,deg =	
Angle, A, deg =	-13.878 deg.	Angle, A, deg =		Angle, A, deg =	
Arc Length, L_A =	484.4206	Arc Length, L_A, ft =		Arc Length, L_A, ft =	
PHC1 Easting	673537.271	PHC2 Easting		PHC3 Easting	*Check*
PHC1 Northing	1352590.891	PHC2 Northing		PHC3 Northing	*Delta = Δ_{sta} - Δ_{path}*
PHT1 Easting	673144.2138	PHT2 Easting		PHT3 Easting	2385.0949
PHT1 Northing	1352872.004	PHT2 Northing		PHT3 Northing	2385.0949
Plan Length to PHC1	557.3297			Length PHT2 to PHC3	0.0000
PHC1 Sta	5+57.3297	PHC2 Sta		PHC3 Sta	
PHT1 Sta	10+41.7502	PHT2 Sta		PHT3 Sta	Exit Station
PHT1 to PHC2/EXIT	1,343.34 ft	PHT2 to PHC3/EXIT		PHT3 TO EXIT	23+85.09
Exit Sta.	23+85.09	Exit Sta.		Exit Sta.	OK STA

Pull Geometry

Segment	Plan Forward	Path Forward	Start Elevation	Start Vert. Ang.	Radius	Azimuth
EXIT	244.83 ft	248.60 ft	175.00 ft	-10.00 deg	0 ft	118.6334
PVT2	208.38 ft	209.44 ft	131.83 ft	-10.00 deg	1,200 ft	118.6334
PVC2	890.14 ft	890.14 ft	113.60 ft	0.00 deg	0 ft	118.6334
PHT1	484.42 ft	484.42 ft	113.60 ft	0.00 deg	-2,000 ft	118.6334
PHC1	208.21 ft	208.21 ft	113.60 ft	0.00 deg	0 ft	118.6334
PVT1	249.49 ft	251.33 ft	113.60 ft	0.00 deg	1,200 ft	132.5110
PVC1	99.63 ft	101.86 ft	139.82 ft	12.00 deg	0 ft	132.5110
ENTRY	0.00 ft	0.00 ft	161.00 ft	12.00 deg	0 ft	132.5110
	Total Check =	2,393.99	OK			

VERTICLE PATH DESIGN CALCULATIONS (FT)

NORTH - Tangent Segment 1		*NORTH Vert. Curve Segment 2*		*Middle Tangent Segment 3*		*SOUTH Vert. Curve Segment 4*		*SOUTH Tangent Segment 5*		SUMS
Entry Angle	-12.000 deg.	Vertical Radius	1200.00	End Vert Angle	0.000 deg.	Radius	1200.00	Exit Elevation	175.00	
		Δ Vert. Angle, deg.	12.000	Inclined Bottom Tan	NO	Δ Vertical Angle	10.000 deg.	Design Exit Angle	10.00 deg	
Calculate Vertical PCV		**Calculate Vertical PTV**		**Calculate Vertical PCV**		**Calculate Vertical PTV**		**Calculate Exit**		
Plan Length	99.631	Plan Length	249.494	Plan Length	1582.767	Plan Length	208.378	Plan Length	244.825	2,385.09 ft
Rod Length	101.856	Arc Rod Length	251.327	Rod Length	1582.767	Arc Rod Length	209.440	Rod Length	248.602	2,393.99 ft
Vertical Depth	-21.177	Curve Δ Vert Depth	-26.223	Vertical Depth	0.000	Curve Δ Vert Depth	18.231	Vertical Depth	43.169	14.00 ft
		Start Vert Angle	-12.000 ft	Start Vert Angle	0.000 ft	Start Vert Angle	0.000 ft	Start Vert Angle	10.000 ft	
		Lowest Elevation	113.600 ft			Lowest Elevation	113.600 ft	CK Total Cum Depth	14.000 ft	
Start Elevation	161.000 ft	Start Elevation	139.823 ft	Start Elevation	113.600 ft	Start Elevation	113.600 ft	Start Elevation	131.831 ft	
End Elevation	139.823 ft	End Elevation	113.600 ft	End Elevation	113.600 ft	End Elevation	131.831 ft	End Elevation	175.000 ft	
End Vert Angle	-12.000 ft	End Vert Angle	0.000 ft	End Vert Angle	0.000 ft	End Vert Angle	10.000 ft	*Prop. Plan Length*	*2385.095 ft*	

Summary of Drill Calculations

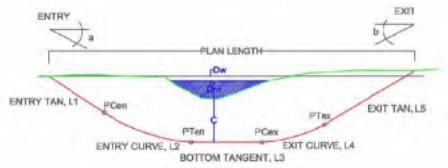
Entry to Exit Elev. Change = 14.00 ft
Minimum Design Elevation = 113.60 ft
Centerline Depth below North = 47.40 ft
Centerline Depth below South = 61.40 ft
Path Length = 2393.99 ft
Plan Length = 2385.09 ft
North Angle = -12.00 deg
South Angle = 10.00 deg
Compound Radius NO
Minimum Compound Radius = 0 ft

SUMMARY VERTICLE CURVE CALCULATIONS

Entry Sta	0+00.00	PVC1 Sta	0+99.63	PVT1 Sta	3+49.12	PVC2 Sta	19+31.89	PVT2 Sta	21+40.27
PVC1 Sta	0+99.63	PVT1 Sta	3+49.124550	PVC2 Sta	19+31.89	PVT2 Sta	21+40.27	Exit Sta	23+85.0949
Cum Plan Length	99.63	Cum Plan Length	349.12	Cum Plan Length	1931.89 ft	Cum Plan Length	2140.27	Cum Plan Length	2385.09
Cum Path Length	101.85633	Cum Path Length	353.18	Cum Path Length	1935.95 ft	Cum Path Length	2145.39	Cum Path Length	2393.9926
Cum Depth	-21.18	Cum Depth	-47.40	Cum Depth	-47.40 ft	Cum Depth	-29.17	Cum Depth	14.00
Easting PVC1	673874.6629	Easting PVT1	673690.7489	Easting PVC2	672362.9329	Easting PVT2	672180.0389	Easting Exit	671965.1547
Northing PVC1	1352281.61	Northing PVT1	1352450.201	Northing PVC2	1353298.563	Northing PVT2	1353398.418	Northing Exit	1353515.739

Stationing Check
OK STATIONING
Plan Length Check
OK CALCULATION
Elevation Change Check
OK CALCULATION

NOTES:
1. Sign convention for vertical angles - positive (+) angles are counterclockwise.
2. Due North is defined as 0 degrees. Clockwise = (+).
3. Coordinates not provided, placeholders only.
3. Elevations are referenced to NAVD88 Datum
5. All calculation locations represent the center of the drill hole.
6. Survey base used for these calculations provided by Owner.
7. Stationing references Project Alignment along centerline of bore.



Indicates inputs
Indicates status on internal design checks

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Segment 9 (Pkg. 5B) - CSX: Selkirk Railyard Bypass
Schenectady County, NY

TABLE 1
DESIGN DRILL PATH CALCULATIONS
HDD 89 Circuit #2

Revision 0
Print Date: 4/19/2024

D:\CHPE\[89 FPVC Circuit 2.xlsx]T5 PVC Pull

Pull Geometry

Lengths (Path)			V. Angle	Azimuth	EL	Radius, R
Tail	L_{tail}	100.0 ft			Overbend	1,200.0 ft
EXIT	L1 =	248.6 ft	10.000	118.633	175.000	0.0 ft
PVT2	L2 =	209.4 ft	10.000	118.633	131.831	1,200.0 ft
PVC2	L3 =	890.1 ft	0.000	118.633	113.600	0.0 ft
PHT1	L4 =	484.4 ft	0.000	118.633	113.600	2,000.0 ft
PHC1	L5 =	208.2 ft	0.000	118.633	113.600	0.0 ft
PVT1	L6 =	251.3 ft	0.000	118.633	113.600	1,200.0 ft
PVC1	L7 =	101.9 ft	-12.000	118.633	139.823	0.0 ft
ENTRY	L8 =	0.0 ft	-12.000	118.633	161.000	0.0 ft
	L9 =					
	L10 =					
	L11 =					
	L12 =					

Drag Force = L_{tail}*ν_G = 10

LT = 2494.0 ft

INPUT: Assumed Friction Factors

ν_G =	0.10	dry + rollers
ν_b =	0.25	drill fluid in hole
ν_c =	0.30	in hole no fluid

INPUT: Assumed Hydrokinetic Drag

τ_f = 0.005 psi Drill Fluid Shear Stress

INPUT: Pipe Properties

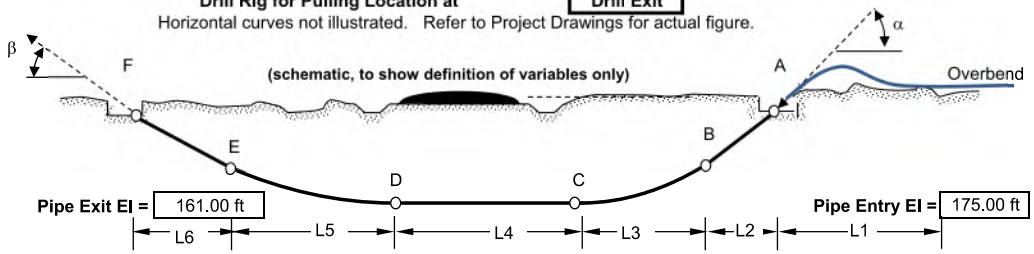
Material	fPVC		DIPS
Safe Pull Max. Stress, σ_{PM}	2,800 psi	UGSI,Inc.	
Pile/Bundle Diam.	15.0 in	PIPE	PIPE/BUNDLE
Material Density, γ	89.83 pcf		
Outside Diameter, D_{OD}	8.63 in	Pipe or Bundle	
Min. Wall Thickness, t_m	0.510 in	For design installation pull stress	
DR = D_O/t_{min} =	17.0	D_{OD} Stress	8.63 inches
Avg. Inside Diameter, D_{IA}	7.55 in	Bundle Multiplier F_D	1.0000
Duration of Installation	24 Hrs		
Pullback Modulus, E_T =	400,000 psi	@T =	73 Deg F
Poisson Ratio, μ =	0.38		
Ovality Factor, f_o =	0.76	3%	
Buckling Safety, N =	2		

INPUT: Assumed Fluid Densities/Elevations

Ballast Density, γ_B =	62.43 pcf		***Estimated for pull***
Drill Fluid Density, γ_{DF} =	78.00 pcf	10.43 ppg	***Estimated for pull***
Drill fluid elevation, H_F =	158.00 ft	**INPUT**	
Ballast Water El., H_W =	158.00 ft	**INPUT**	
Lowest Invert El., El_m =	113.60 ft		
Pipe Entry Ground Slope =	0.0 deg		

Drill Rig for Pulling Location at **Drill Exit**

Horizontal curves not illustrated. Refer to Project Drawings for actual figure.



Calculated Pull Force

POINT	Pull Force F_D No Ballast	Max Tensile Stress, σ_T	ASSESS $\sigma_T < \sigma_{PM}$	Pull Force F_B Ballasted	Max Tensile Stress, σ_T	ASSESS $\sigma_T < \sigma_{PM}$	ASSESS F_x < SPS Air	ASSESS F_x < SPS Ballast
EXIT	2,140 lb	164 psi	OK	2,140 lb	164 psi	OK	42.4	42.4
PVT2	3,751 lb	408 psi	OK	2,821 lb	337 psi	OK	24.2	32.1
PVC2	5,867 lb	451 psi	OK	3,531 lb	271 psi	OK	15.5	25.7
PHT1	10,984 lb	916 psi	OK	4,891 lb	448 psi	OK	8.3	18.5
PHC1	17,492 lb	1345 psi	OK	7,027 lb	540 psi	OK	5.2	12.9
PVT1	17,294 lb	1449 psi	OK	6,829 lb	645 psi	OK	5.2	13.3
PVC1	20,582 lb	1582 psi	OK	7,896 lb	607 psi	OK	4.4	11.5
ENTRY	21,358 lb	1642 psi	OK	8,136 lb	625 psi	OK	4.2	11.1
Maximum applied pull Stress, σ_T =		1642 psi	OK		Max. = 645 psi	OK		
		Unballasted Stress =	OK		Ballasted Stress	OK		

Maximum tensile stress during pullback = $\sigma_t = (F_T/\pi t_m(D_{OD}-t_m))+E_T D_{OD}/2R$ PPI Ch 12 Eq 16

Calculated Material Design Limits For Designed Drill Path

Ultimate Pull Strength, UPS =		90,676 lb	UPS = $\sigma_U \pi D_{OD}^2((1/DR)-(1/DR^2))$ σ_U = 7,000 psi
UniBel Safe Pull Strength @ FS =	2.5	36,270 lb	SPS = UPS/FS σ_A = 2,800 psi

ASSESS Pull Restricted Buckling Capacity, $P_{PA} > \Delta P$ invert

Allowable Short Term Unconstrained Buckling, P_A =	86.74 psi	$P_A = (2E_T/(1-\mu^2))(1/(DR-1))^3(f_o/N)$
Pull Stress Reduction, F_R =	0.9392013	$F_R = (5.57-(r+1.09)^2)^{1/2}-1.09$
r =	0.1151	$r = \sigma_T/2SPS$
Allowable Unconstrained Buckling Capacity, $P_{PA} = P_A F_R$ =	**81.471**	
ΔP_B unballasted = $(H_F-El_m)*\gamma_{DF}$ =	24.1 psi	ACCEPT
ΔP_B ballasted = $H_F*\gamma_{DF}-H_W*\gamma_B$ =	4.8 psi	ACCEPT

Drill Hole Diameter Assumed for Calculations

D_H = 14.0 in D_O<8" Use $D_H=D_O+4$"; 8"<D_O<24" Use $D_H=1.5*D_O$; D_O>24" Use $D_H=D_O+12$"

Calculated Pipe and Fluid Properties

OD Perimeter Length, P	27.1 in2/LF
Wall Section Area, A_W	18.81 in^2
Volume Outside, V_{DO}	0.532 cf/LF
Volume Inside, V_{DI}	0.401 cf/LF
Drag Coefficient, q_d =	1.63 lb/ft

Calculated Effective Weights (Buoyant Forces)

	Pipe	Air Filled	Ballasted
On Ground, w_a/w_{af} =		8.56 Lb/LF	33.61 Lb/LF
In Hole with Drill Fluid, w_b/w_{bf} =		-32.92 Lb/LF	-7.88 Lb/LF

NOTES: 1 - Calculations were done in general accordance with ASTMF-1962 as modified to account for invert tangent section, independent vertical curves, and fluid drag. ASTM applies hydrokinetic pressure as shear per unit pipe length requiring a back calculation to determine actual pull force based on average pipe area.

Pump Rate during Pull	200 gpm
DH Volume	1.07 cf/LF
Open Hole Velocity	25.01 ft/min
Annular Velocity	49.78 ft/min

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BRIERLEY ASSOCIATES
Creating Space Underground

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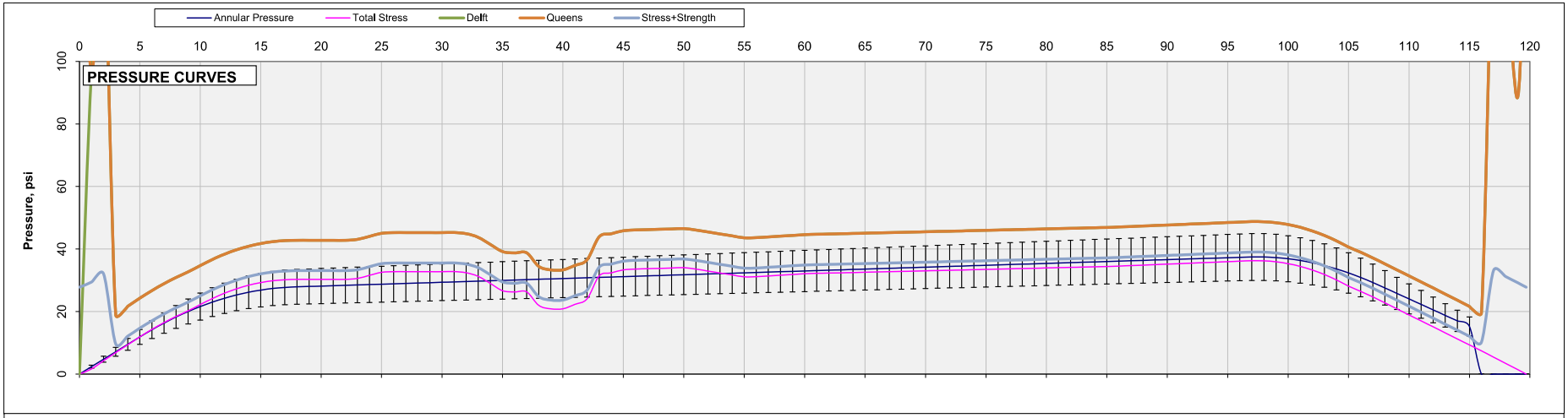
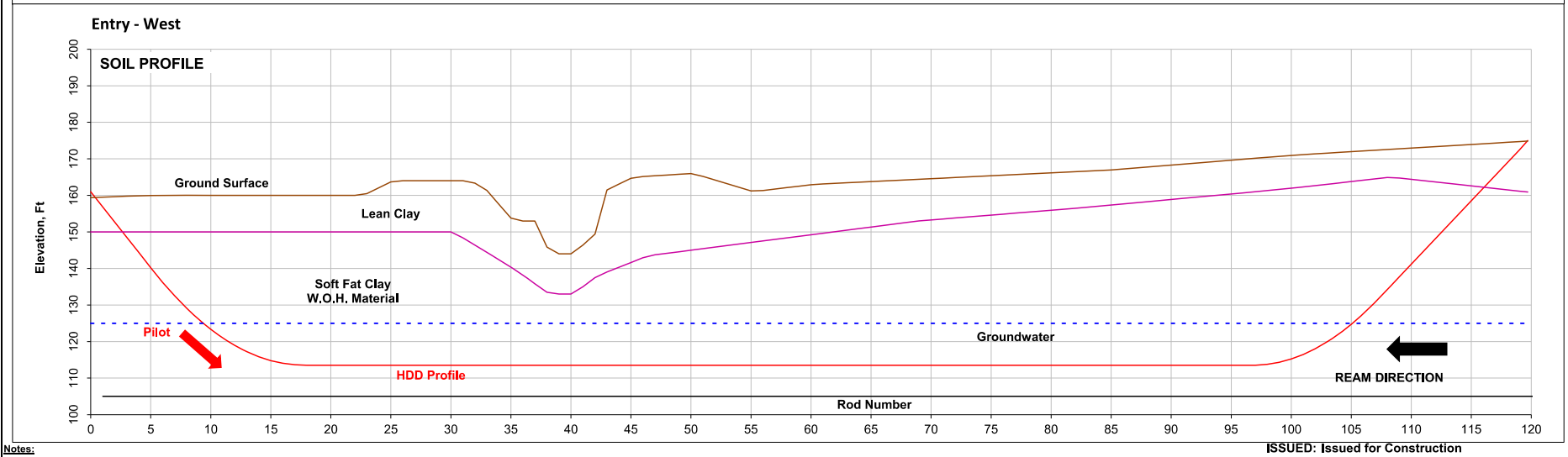
Champlain Hudson Power Express
Segment 9 (Pkg. 5B) - CSX: Selkirk Railyard Bypass
Schenectady County, NY

TABLE 3 - PULL ASSESSMENT
ANTICIPATED PULLING FORCE - PVC PULL
HDD 89 Circuit #2
Wetlands Crossing

Revision 1 TBD

D:\CHPE\[89 FPVC Circuit 2 NEW.xlsx]T5 PVC Pull





Notes:

1. Geology is interpreted from project data
2. Rod length: 20 feet
3. The error bars are at 20% and represent Drill Fluid low and high density range.
4. Ground surface data obtained from project survey data
5. Subsurface data from Geotechnical Report.

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Basis of annulur pressure calculations

9.00 in	Pilot Hole Diameter
78.0 pcf	Unit Weight Drill Fluid
200 gal/min	Pump Rate
3.50 in	Drill Rod Diameter
20	Ft per rod
20%	for APC curve

Bore Logs:

K-194.0-3.8
KB-194.0-3.9B
K-194.0-3.9
K-194.0-4.0
SY-9
K-194.0-4.2
K-194.0-4.3
KB-194.0-4.4

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ANNULAR PRESSURE AND FORMATION PRESSURE CURVES
HDD 89 Circuit #2
Wetlands Crossing

Revision 2

FIGURE 1