



GOLDER

Phase 14 Landfill

Topic: Groundwater Protection

ALISTAIR MACDONALD, P.G.

GOLDER ASSOCIATES INC.

Introduction

Golder Associates Inc. (Golder)

- An international consulting company specializing in the application of earth sciences and engineering to environmental, natural resources, and civil engineering projects.
- Golder has successfully completed projects at over 1,000 solid waste management facilities in 30 countries on six continents.

Alistair Macdonald, P.G., Sr. Program Leader and Principal

- M.S. Hydrogeology, Kent State University
- Licensed professional geologist in Maine, as well as New Hampshire, Alabama, and Oregon and Licensed Site Professional in Massachusetts
- 35+ years of professional experience
- 23+ years of experience at Crossroads Landfill

Brendan Lennon, P.G., Senior Project Geologist

- B.S. Geology, St. Lawrence University
 - Licensed professional geologist in New Hampshire
 - 16+ years of professional experience
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1.0 Site Investigations

2.0 Site Geology

3.0 Site Hydrogeology

4.0 Time of Travel Evaluations

5.0 Proposed Water Quality Monitoring Program

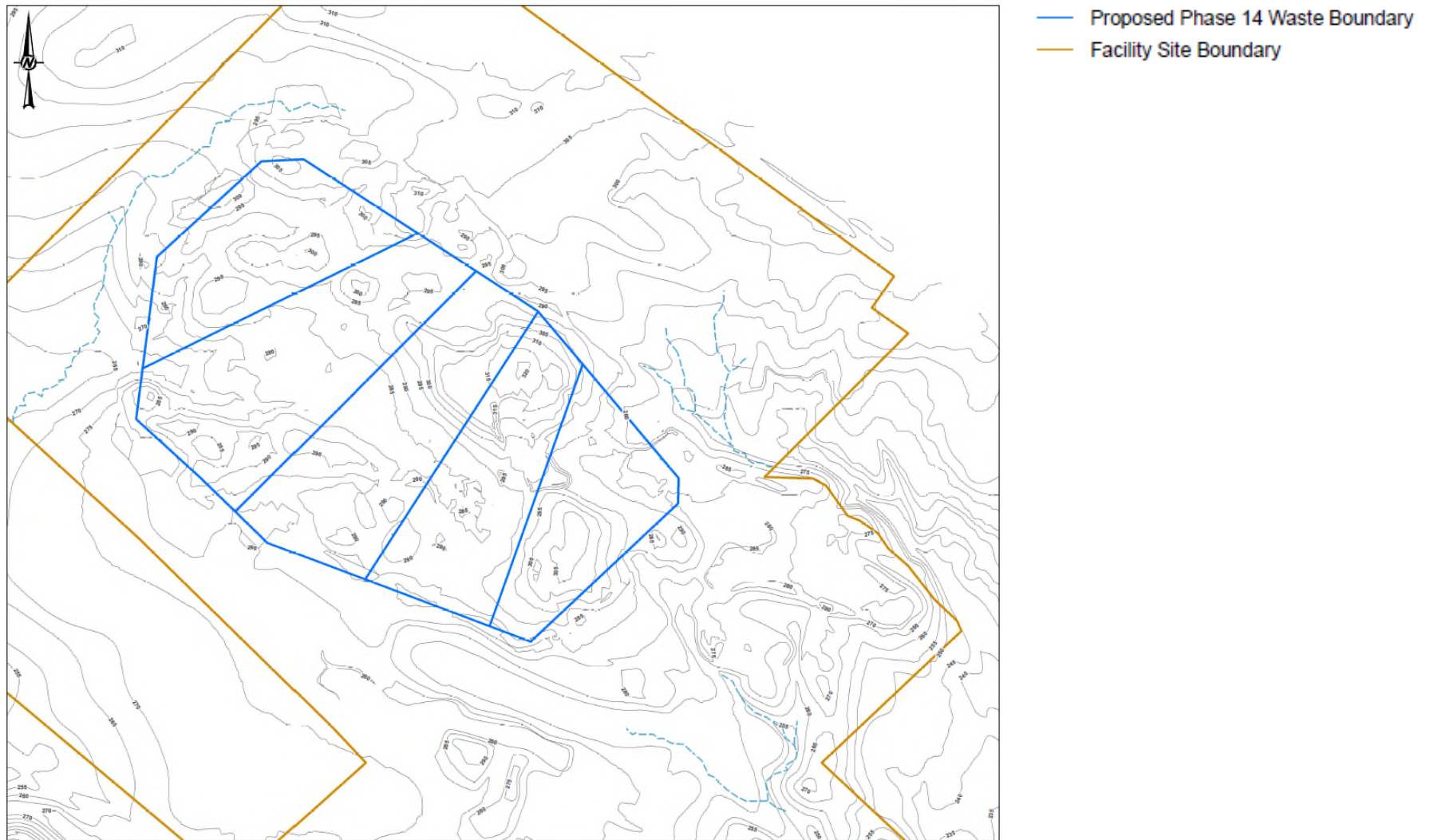
1.0 Site Investigations

OBJECTIVE

To obtain site-specific geologic and hydrogeologic information to support the requirements of Maine SWMR Chapter 401 Section 2.B, 2.C, 2.G, and 2.K

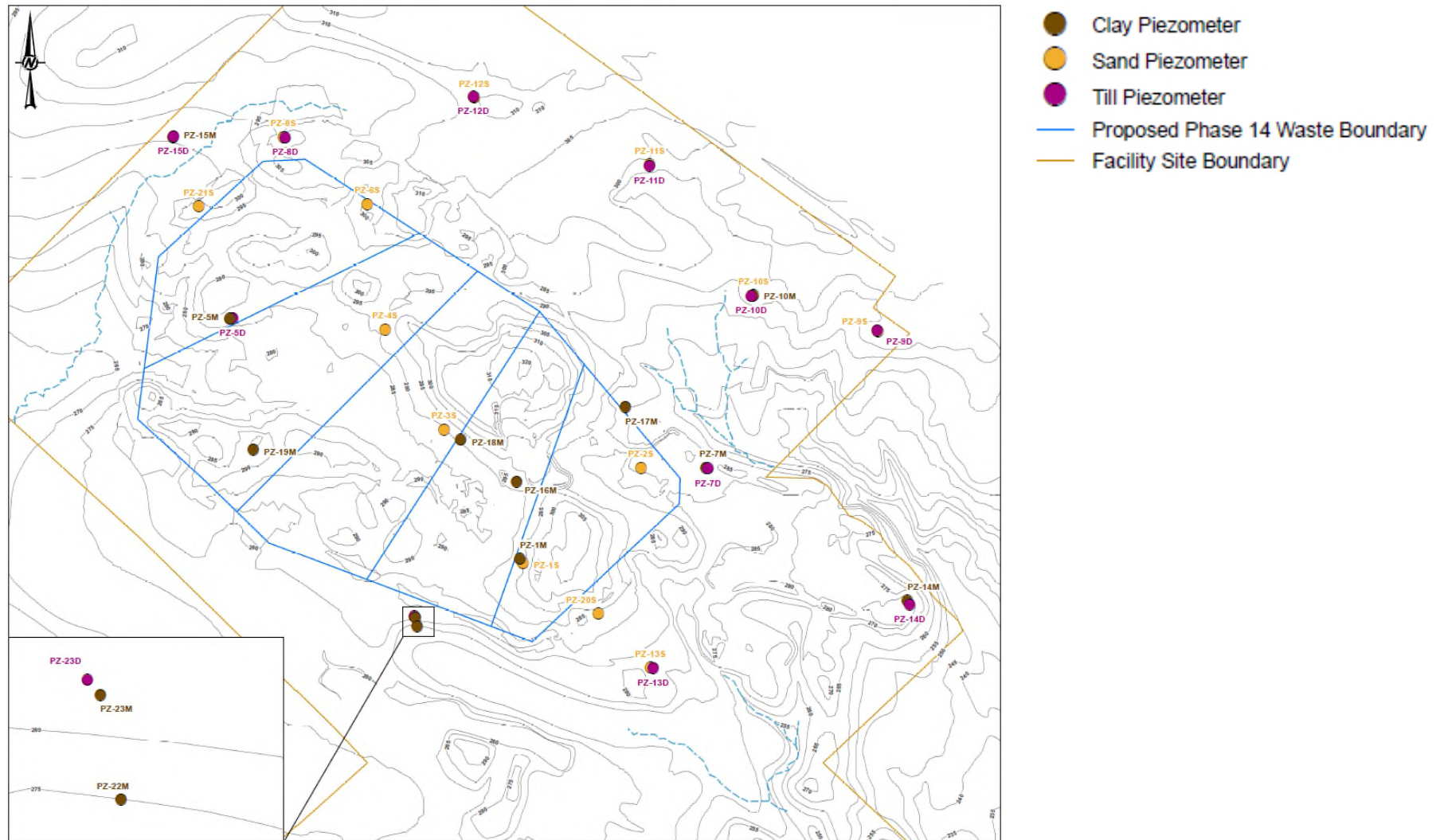
- Characterization of geologic conditions including surficial (overburden) geology and bedrock
- Characterization of hydrogeologic conditions, identification of hydrostratigraphic units and identifying groundwater flow directions
- Completion of time-of-travel calculations
- Development of a water quality monitoring program

Site Investigations



Site Investigations

PIEZOMETER LOCATIONS

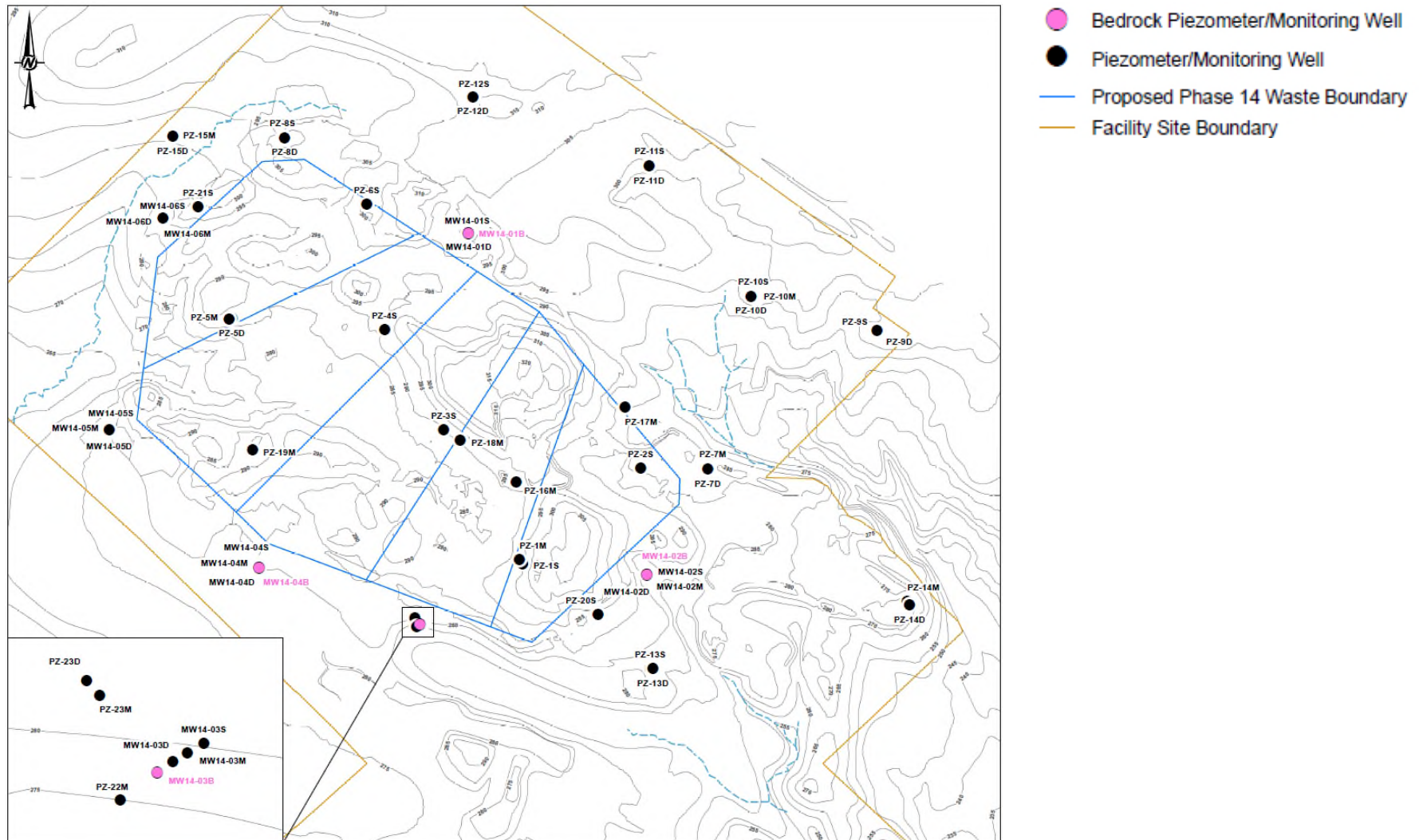


OVERBURDEN MONITORING WELL LOCATIONS



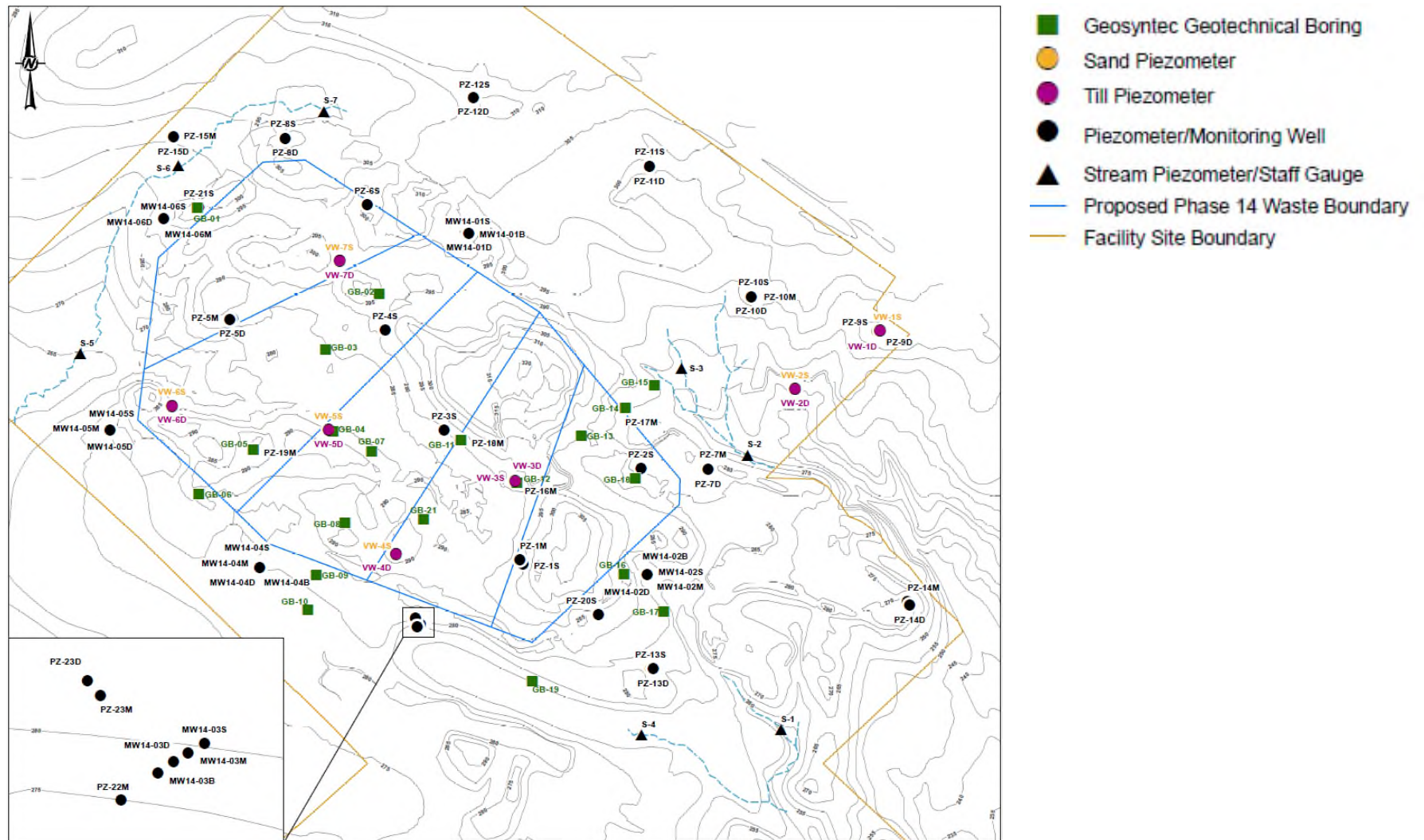
Site Investigations

BEDROCK MONITORING WELL LOCATIONS



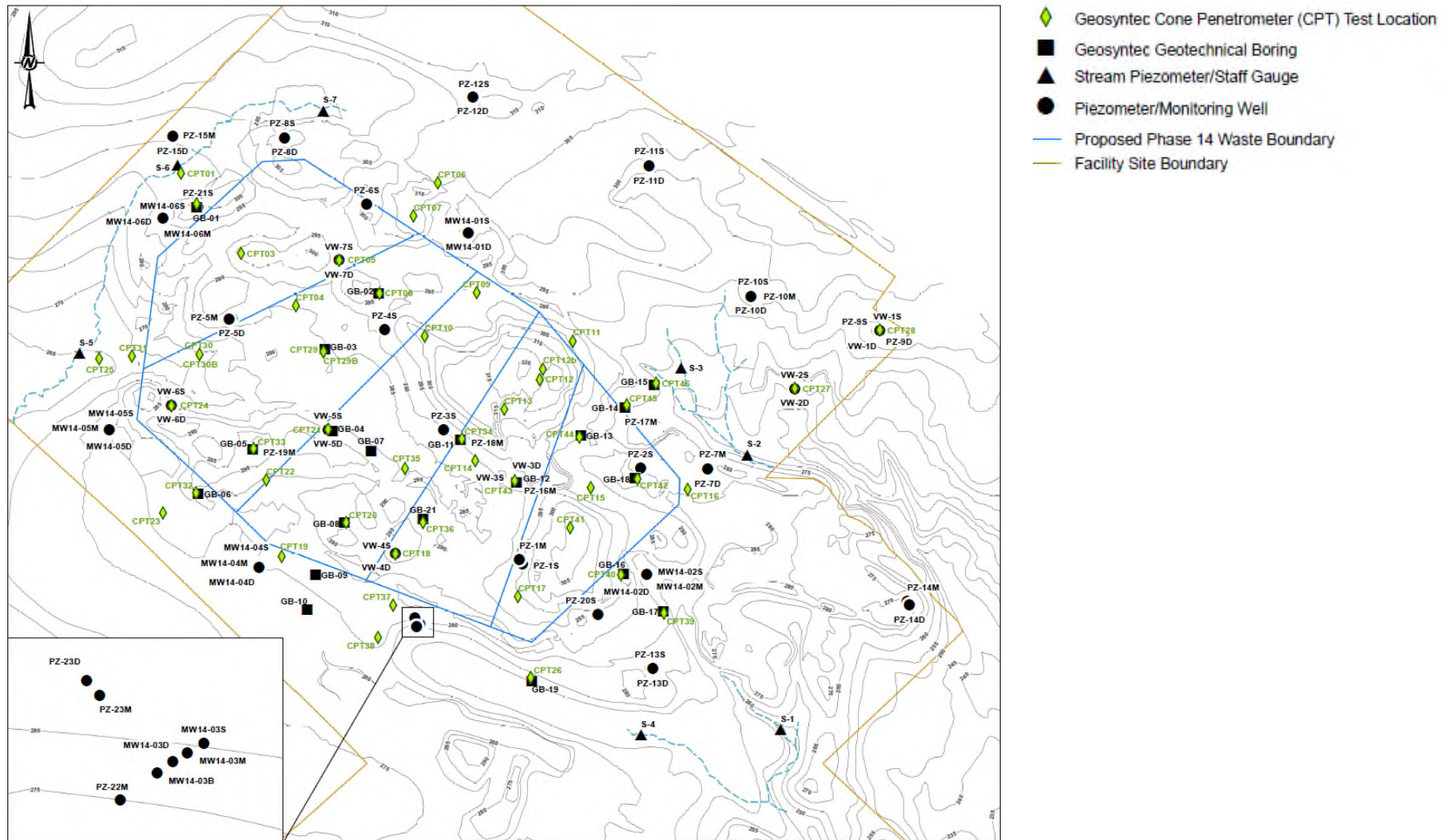
Site Investigations

GEOTECHNICAL BORING LOCATIONS



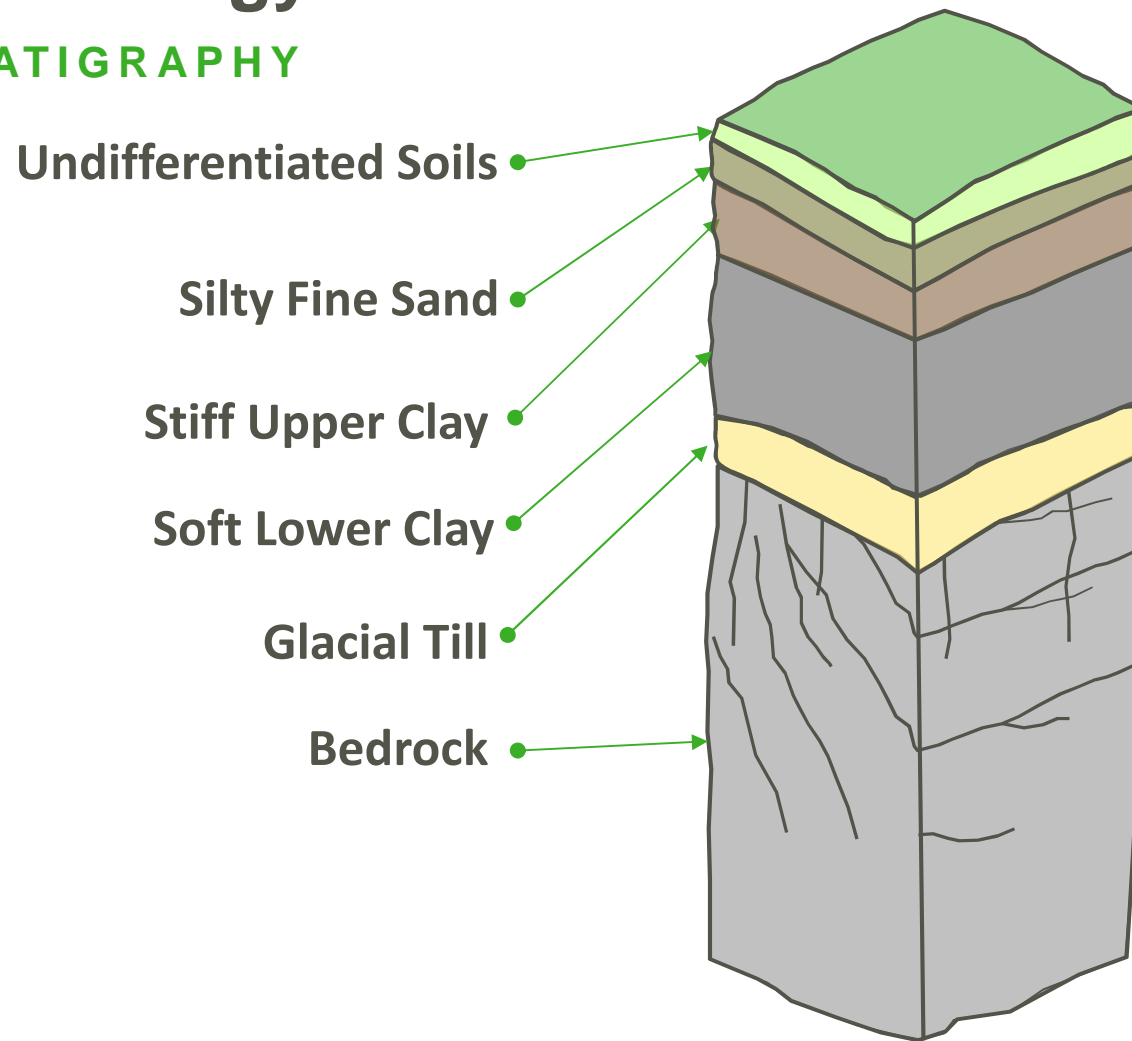
Site Investigations

CONE PENETROMETER TEST (CPT) LOCATIONS



2.0 Site Geology

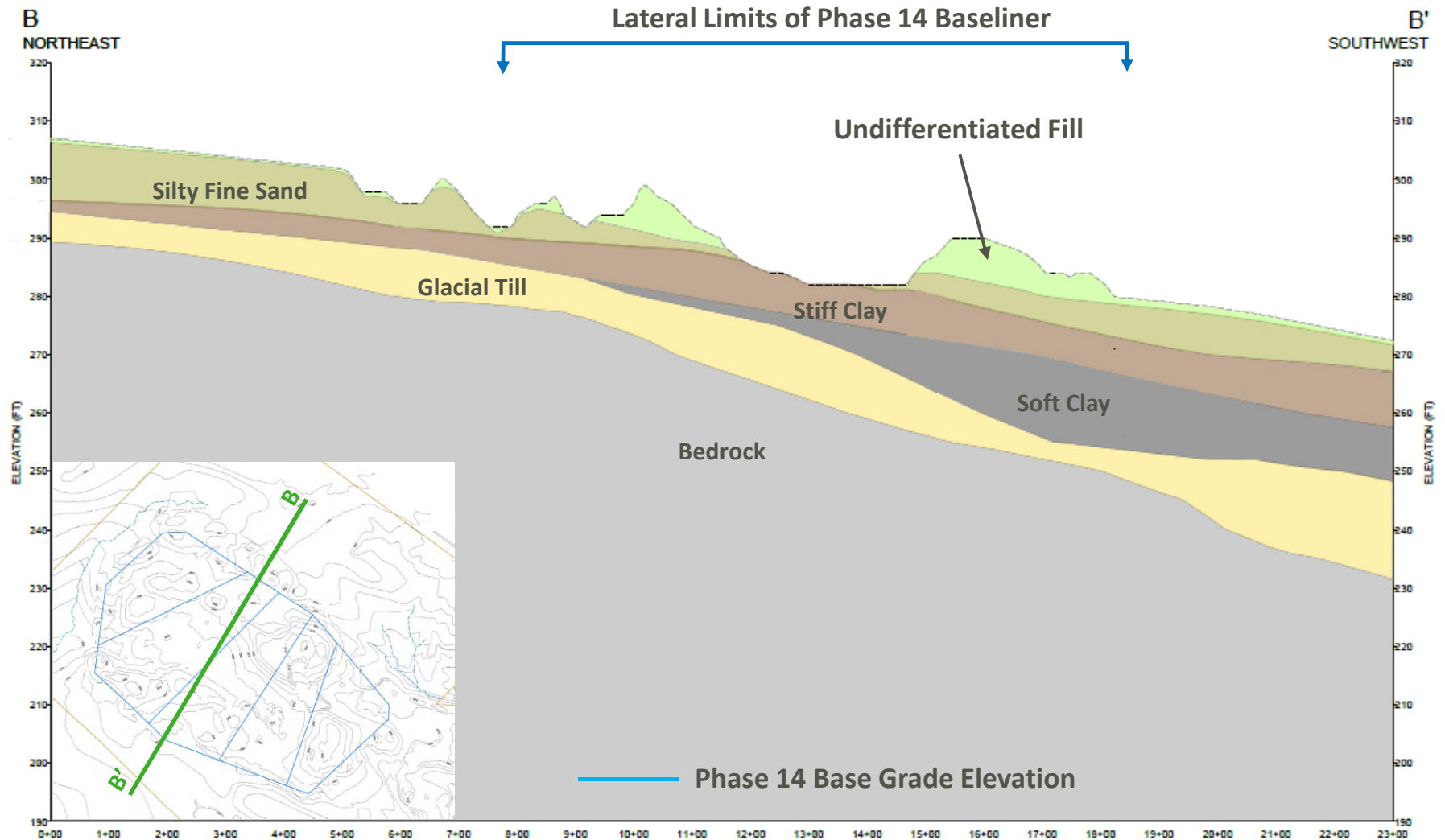
SITE STRATIGRAPHY



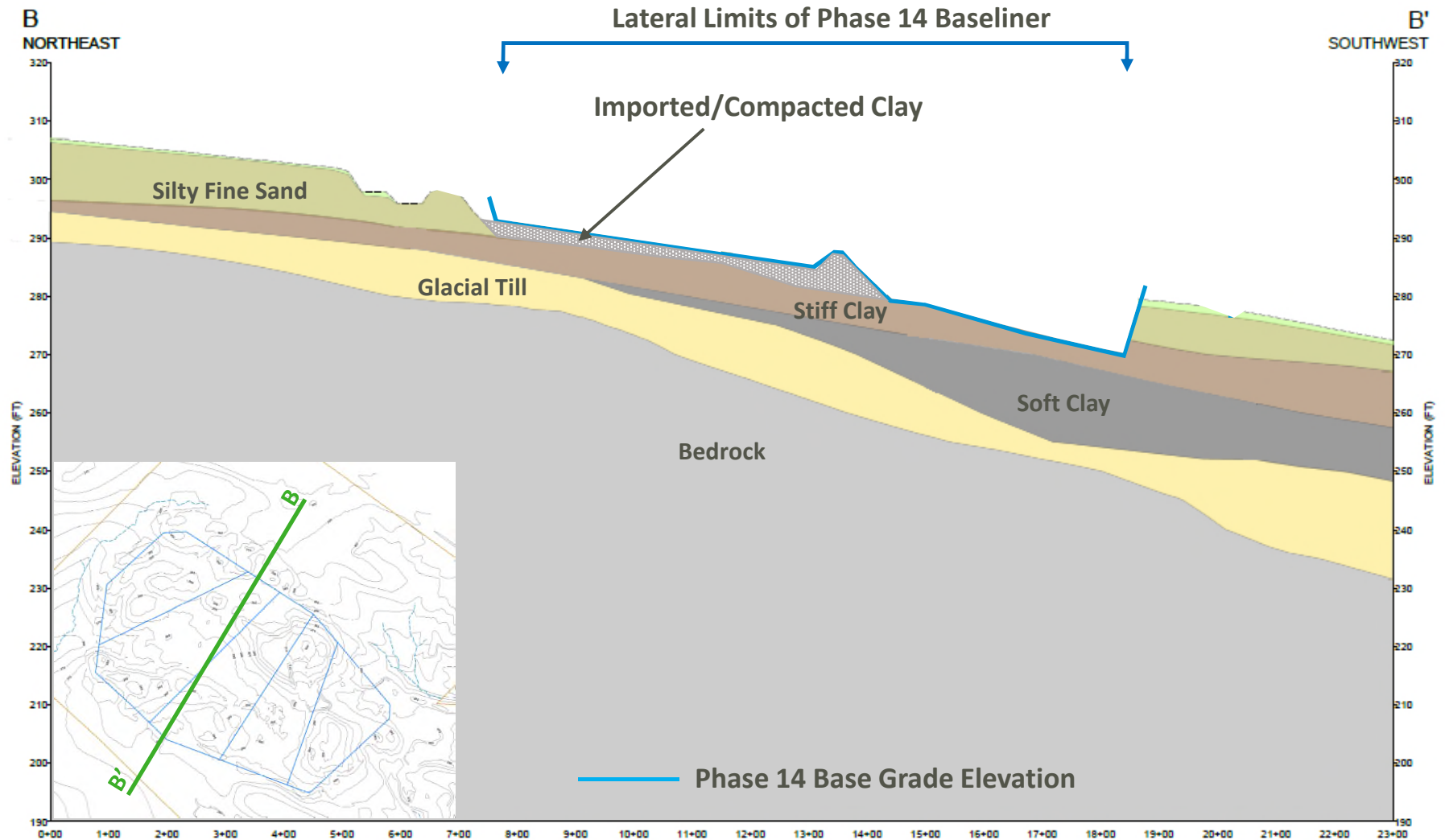
GEOLOGIC PROFILE

Not to Scale

Geologic Cross-section



Geologic Cross-section

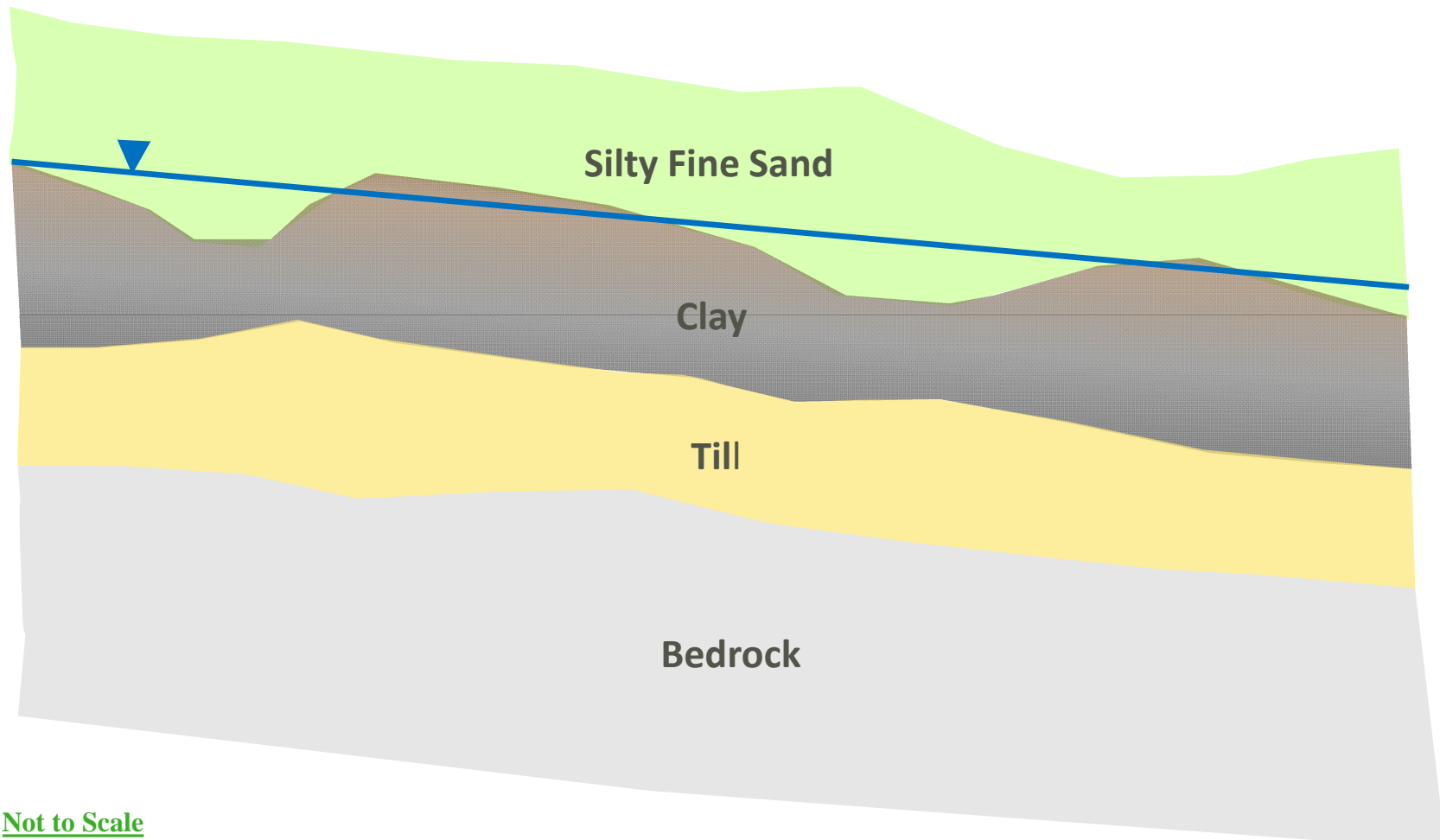


Area with No Soft Lower Clay



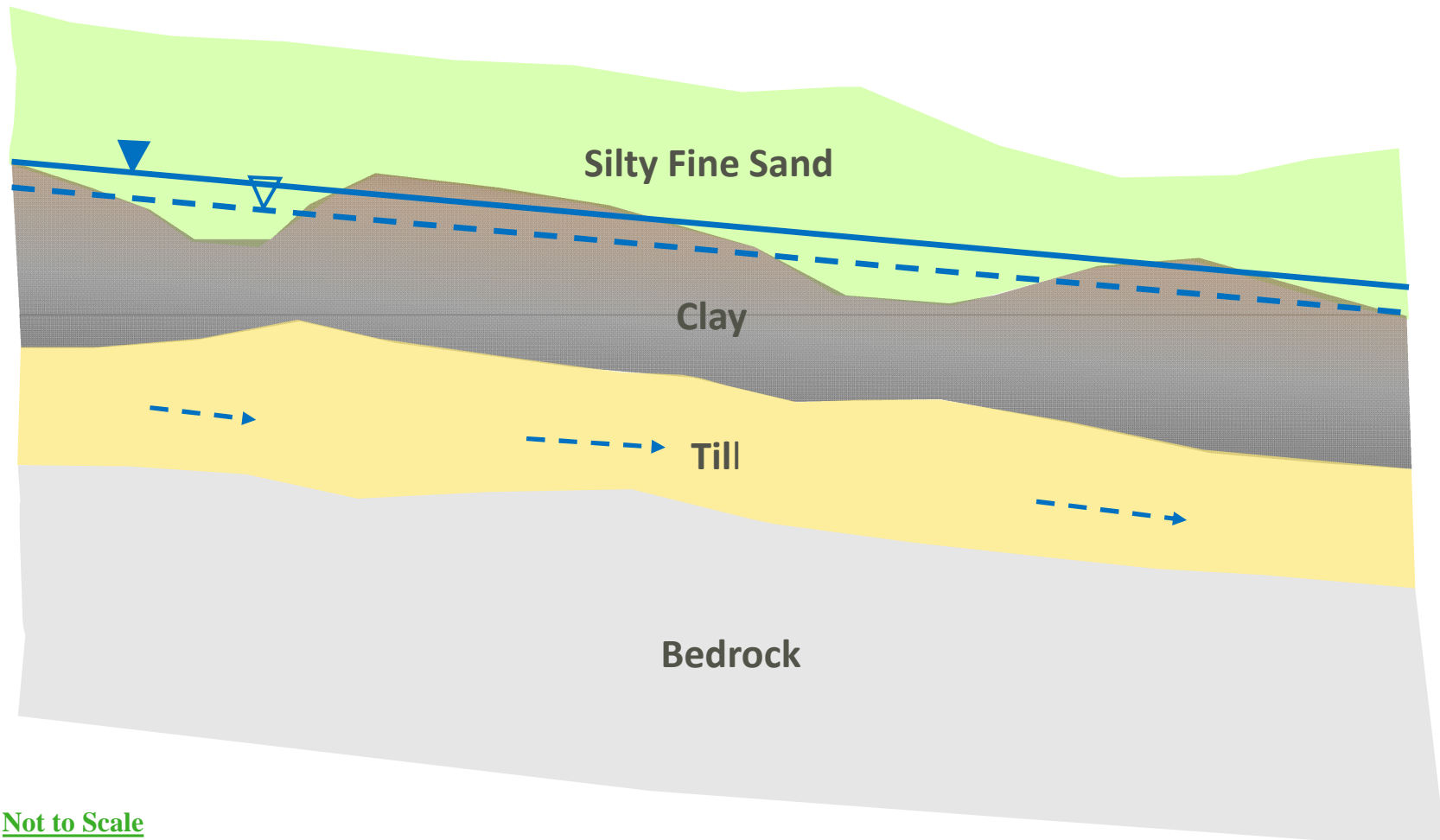
3.0 Site Hydrogeology

HYDROSTRATIGRAPHIC UNITS



3.0 Site Hydrogeology

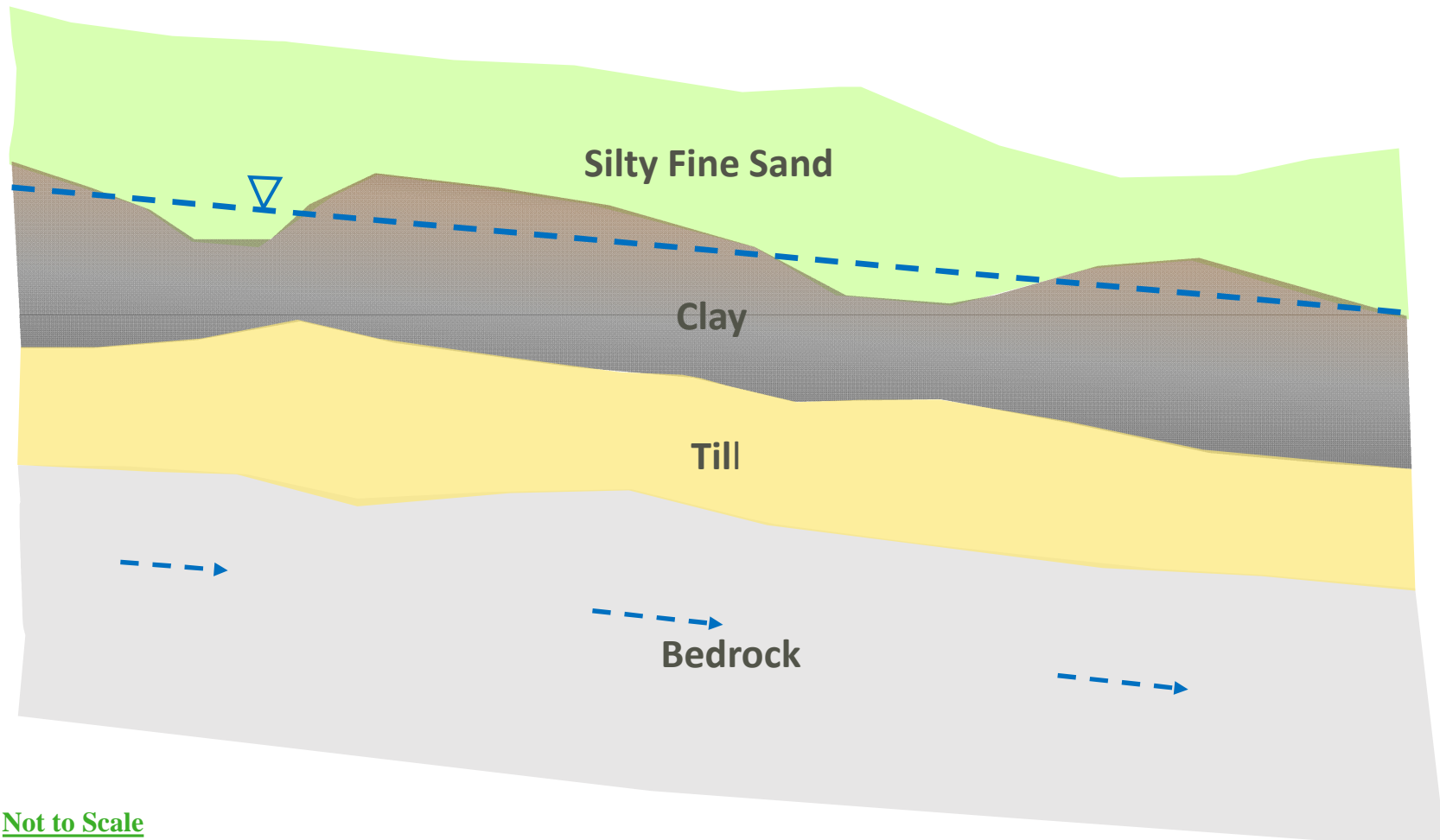
HYDROSTRATIGRAPHIC UNITS



Not to Scale

3.0 Site Hydrogeology

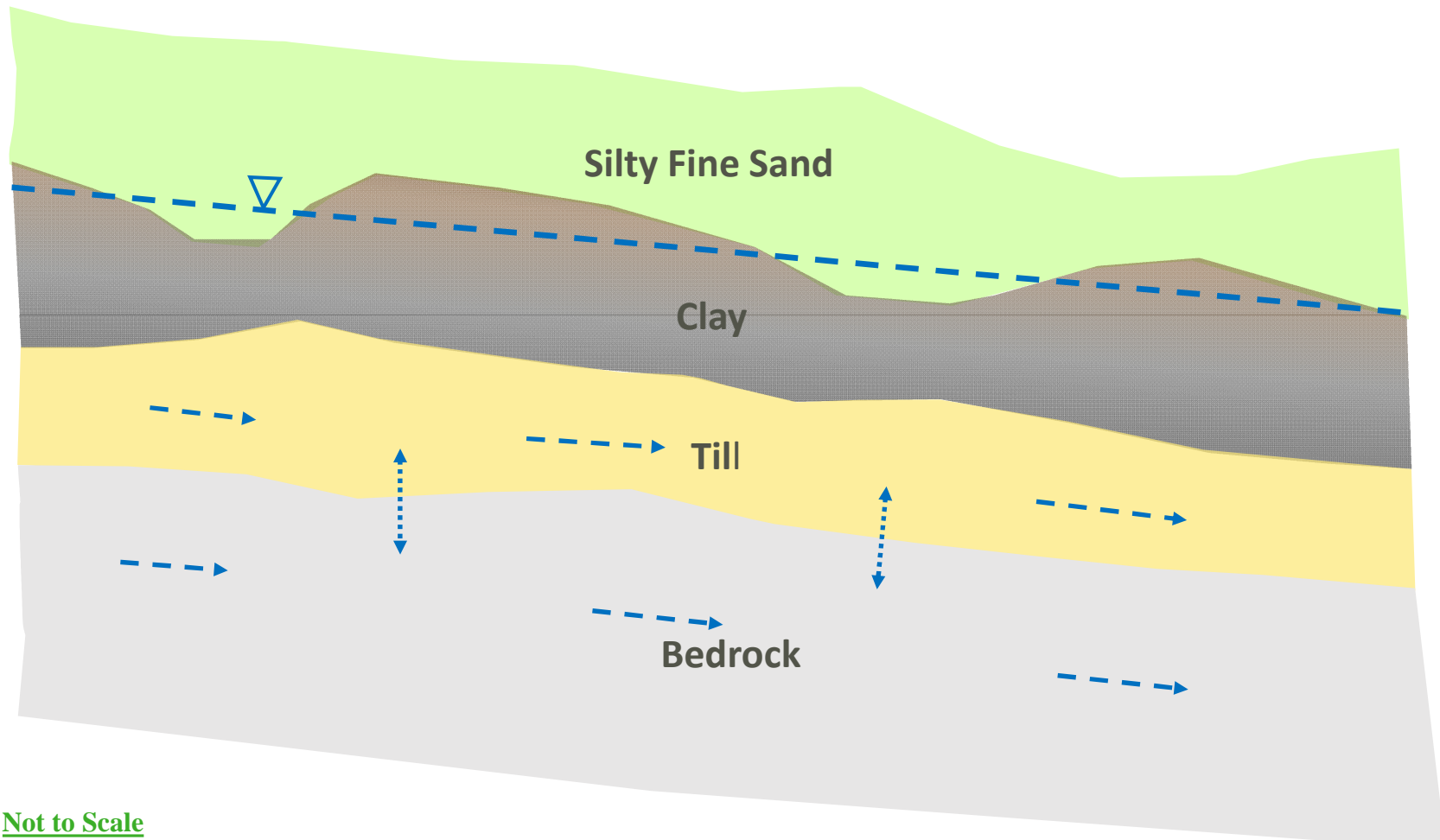
HYDROSTRATIGRAPHIC UNITS



Not to Scale

3.0 Site Hydrogeology

HYDROSTRATIGRAPHIC UNITS



Not to Scale

Site Hydrogeology

HYDRAULIC CONDUCTIVITY (K) VALUES

Geologic Unit	Geometric Mean Hydraulic Conductivity (cm/s)			
	K _h Estimated from Slug Tests	K _h Estimated from Pumping Test	K _v Estimated from Pumping Test	K _v Estimated from Permeameter Test
Clay	7.74E-07	-	2.17E-07	1.31E-07
Till	7.60E-04	4.30E-05	-	-
Bedrock	3.18E-05	9.92E-05	-	-

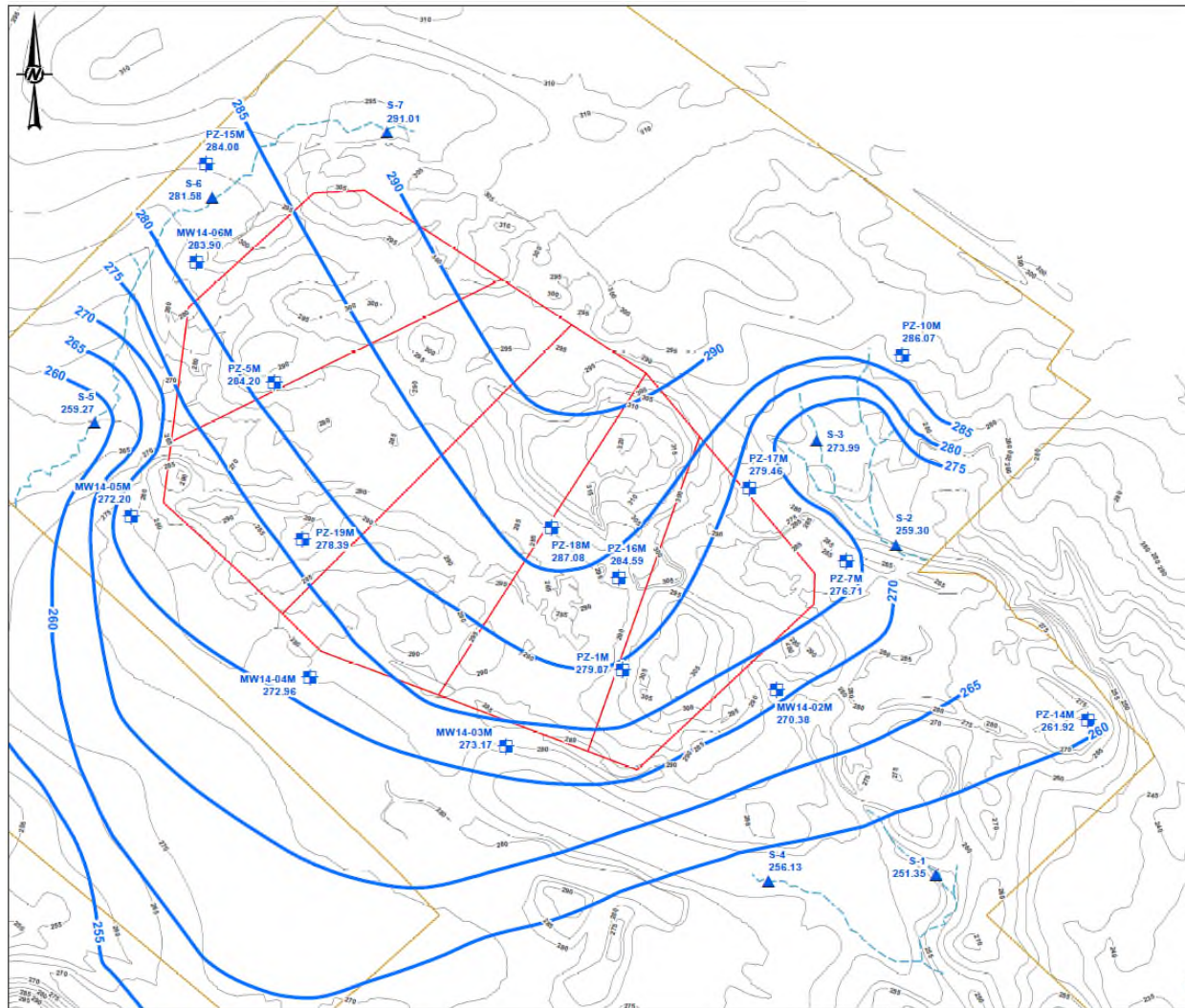
Notes:

cm/sec = centimeters per second

Kh = horizontal hydraulic conductivity

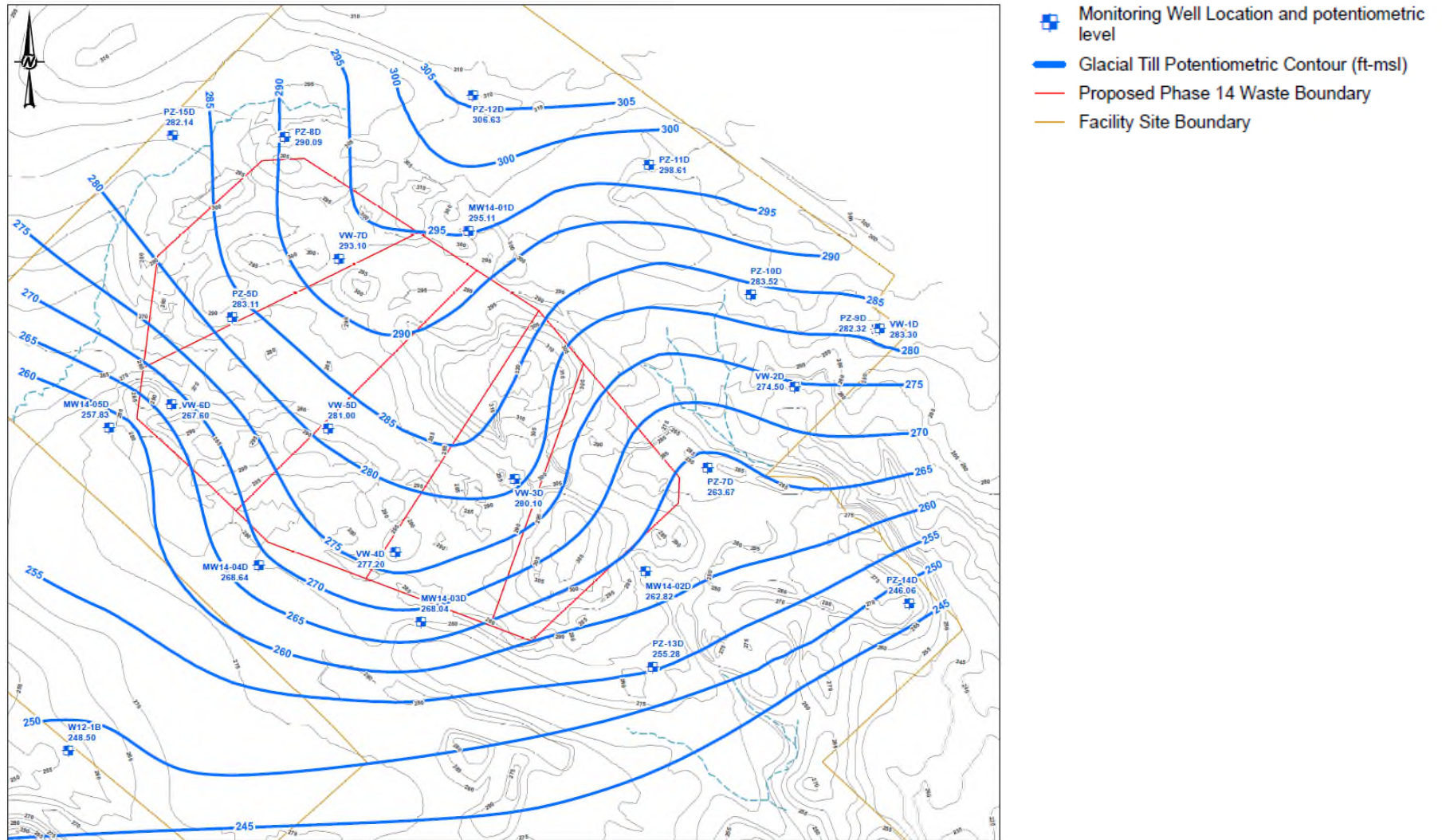
Kv = vertical hydraulic conductivity

Phreatic Surface Contour Map

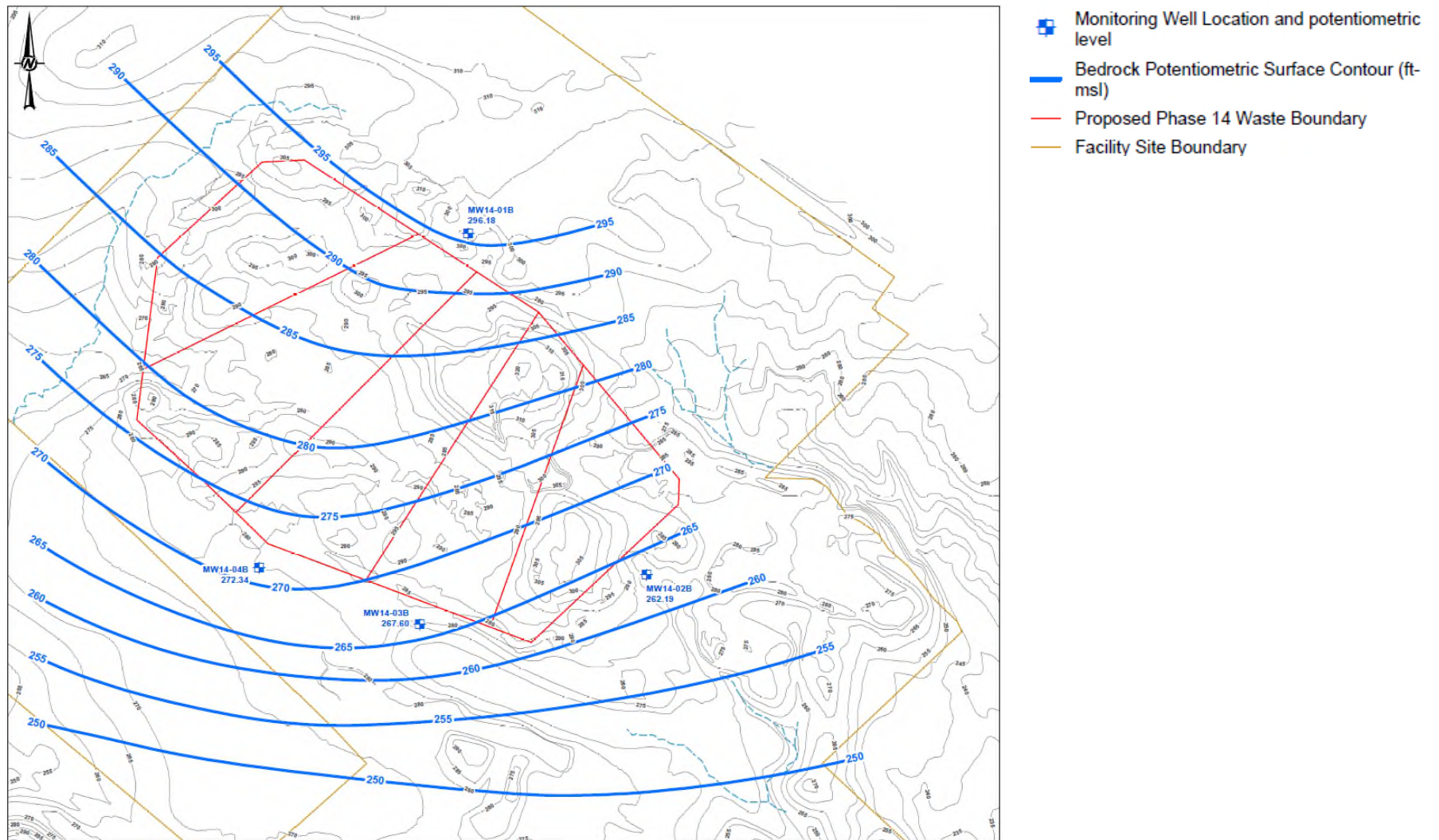


- Monitoring Well Location and Groundwater Elevation
- ▲ Stream Piezometer
- Phreatic Surface Contour (ft-msl)
- Proposed Phase 14 Waste Boundary
- Facility Site Boundary

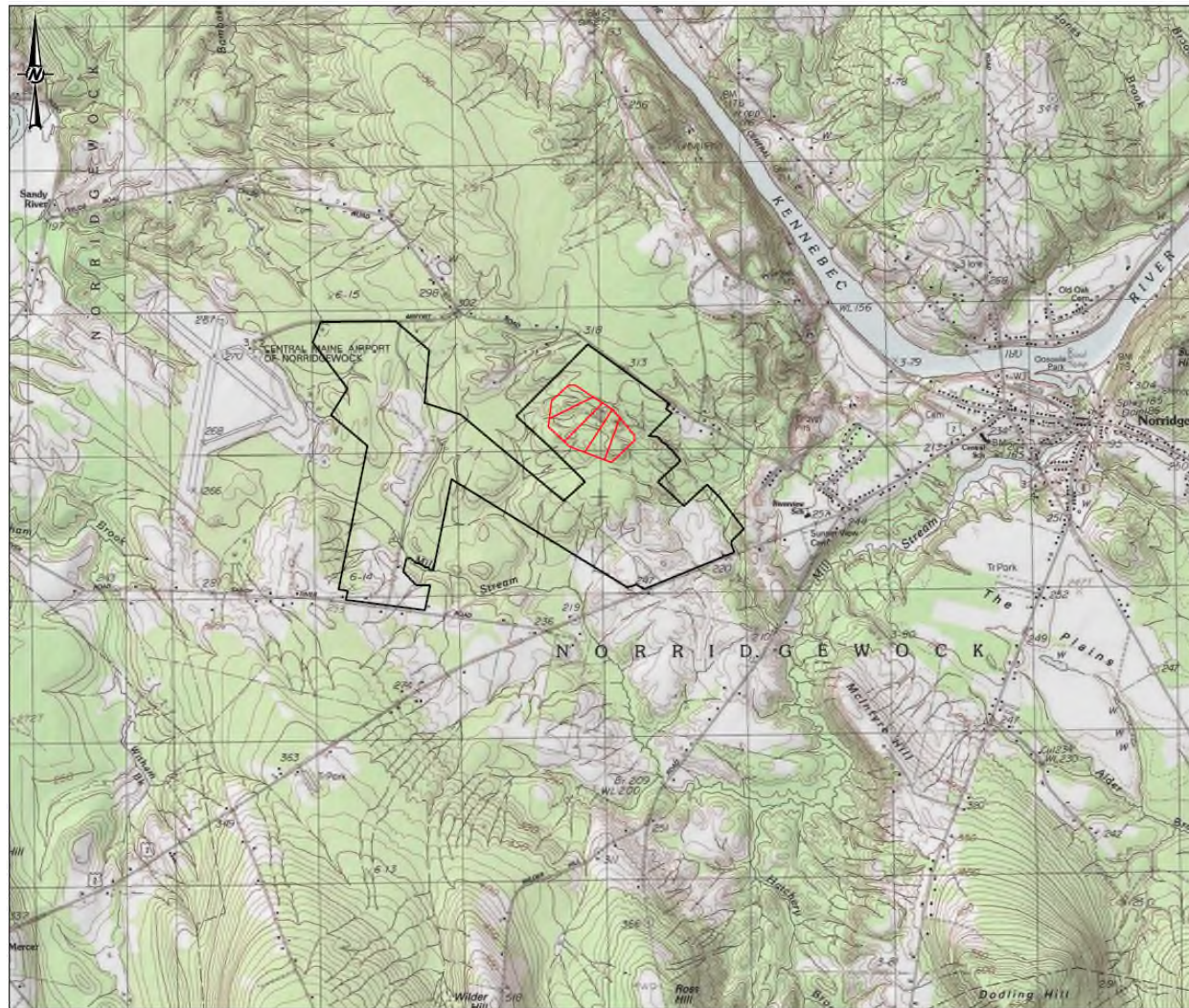
Glacial Till Potentiometric Surface



Bedrock Potentiometric Surface

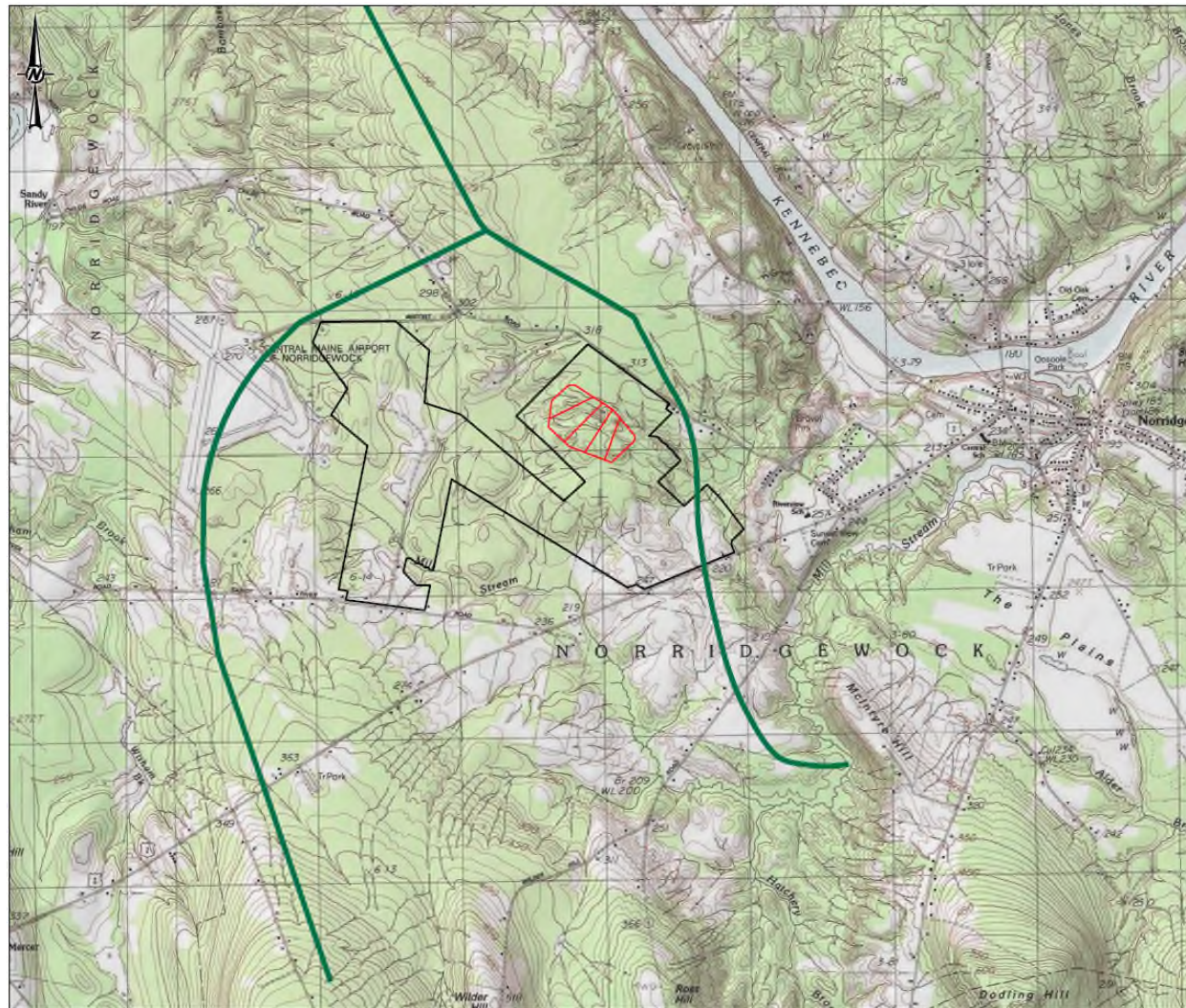


Regional Groundwater Flow



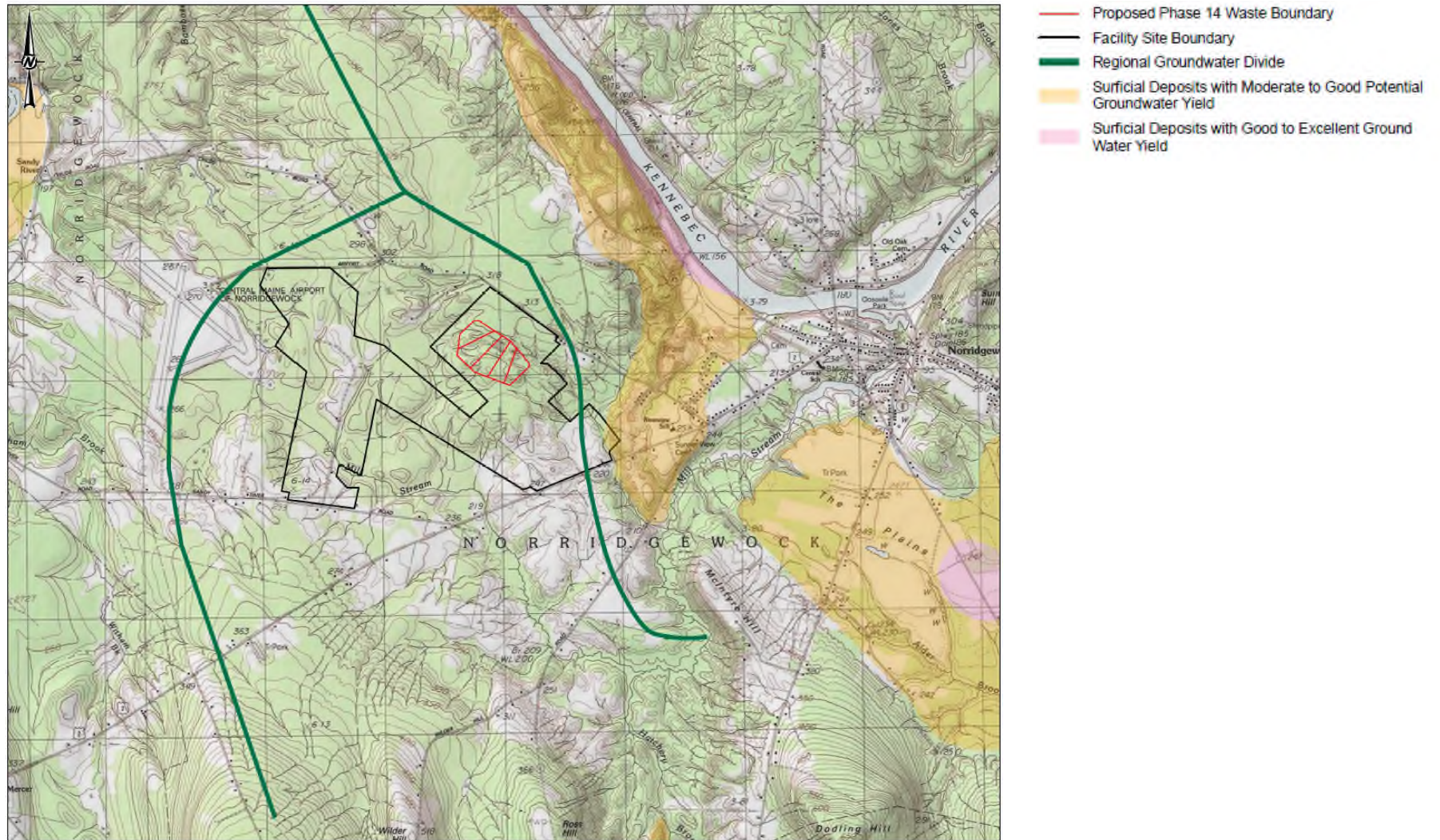
- Proposed Phase 14 Waste Boundary
- Facility Site Boundary

Regional Groundwater Flow

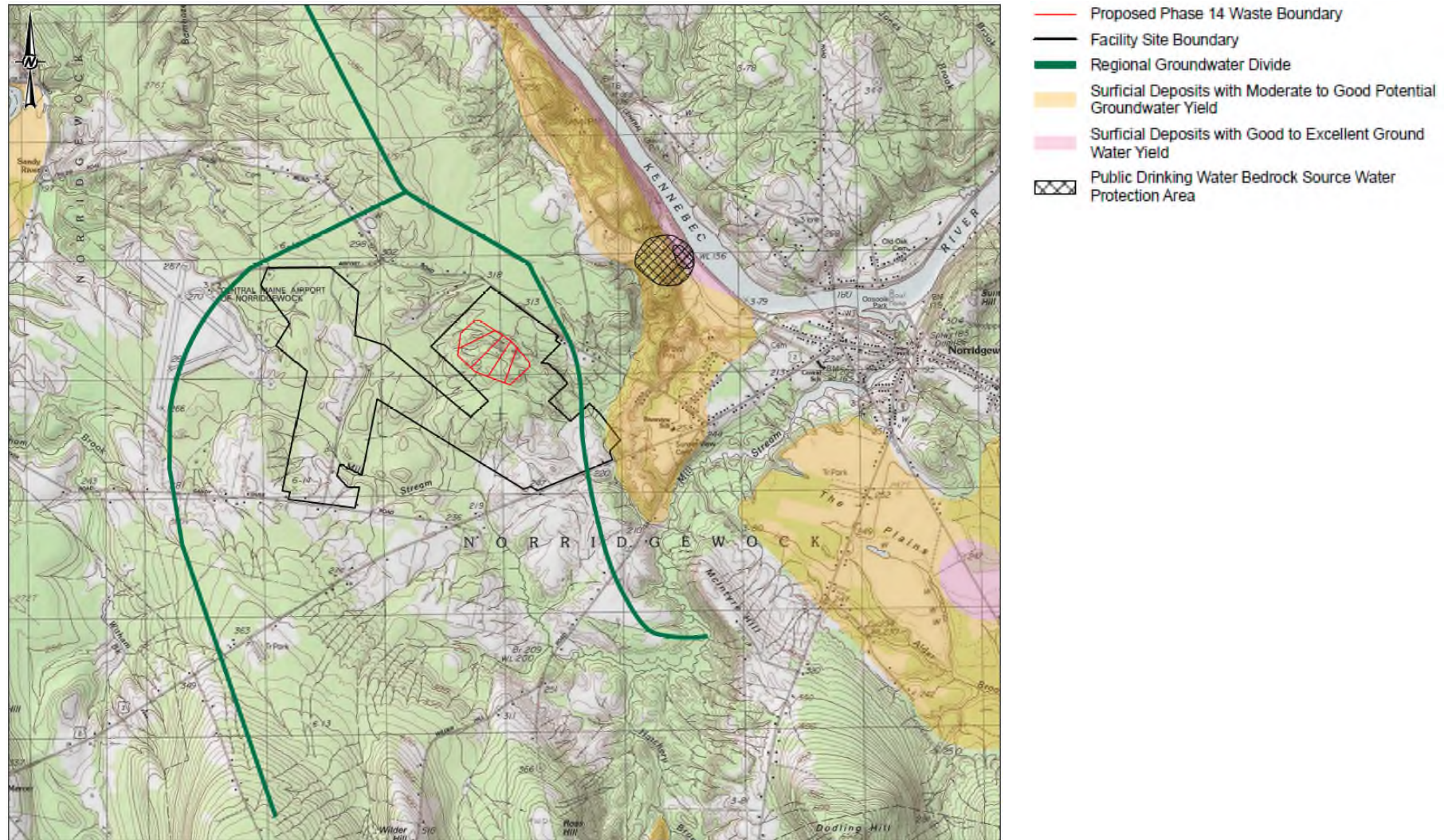


- Proposed Phase 14 Waste Boundary
- Facility Site Boundary
- Regional Groundwater Divide

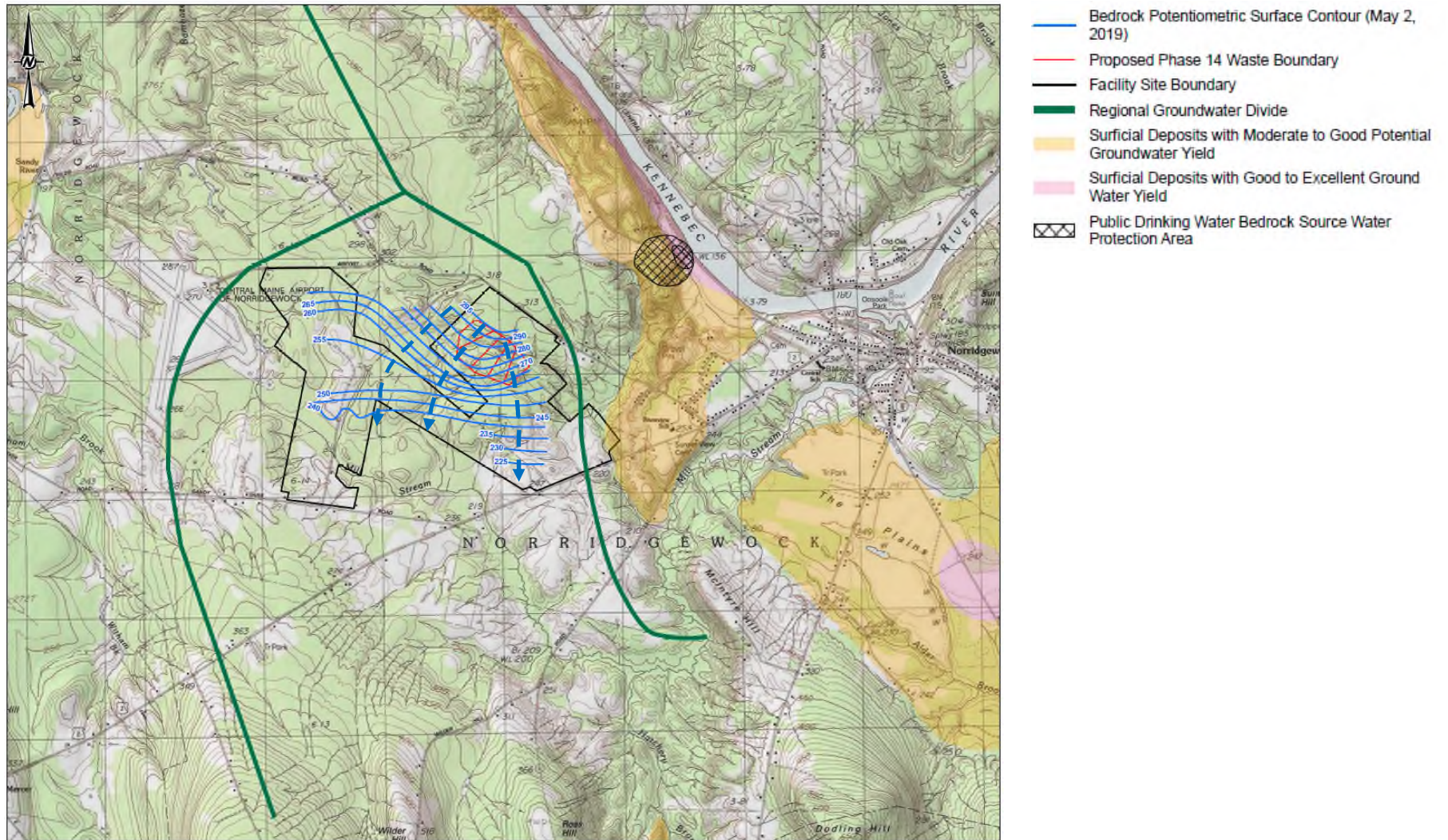
Regional Groundwater Flow



Regional Groundwater Flow



Regional Groundwater Flow



Summary

PHASE 14 GEOLOGIC AND HYDROGEOLOGIC CONDITIONS

- Prevailing dip direction of geologic units to south-southeast/southwest
- All units generally thicken to the south-southeast
- Prevailing groundwater flow directions to south-southeast/southwest, not towards the Significant Sand and Gravel Aquifer or the Town water supply
- Conditions consistent with previously permitted areas of the Crossroads Facility

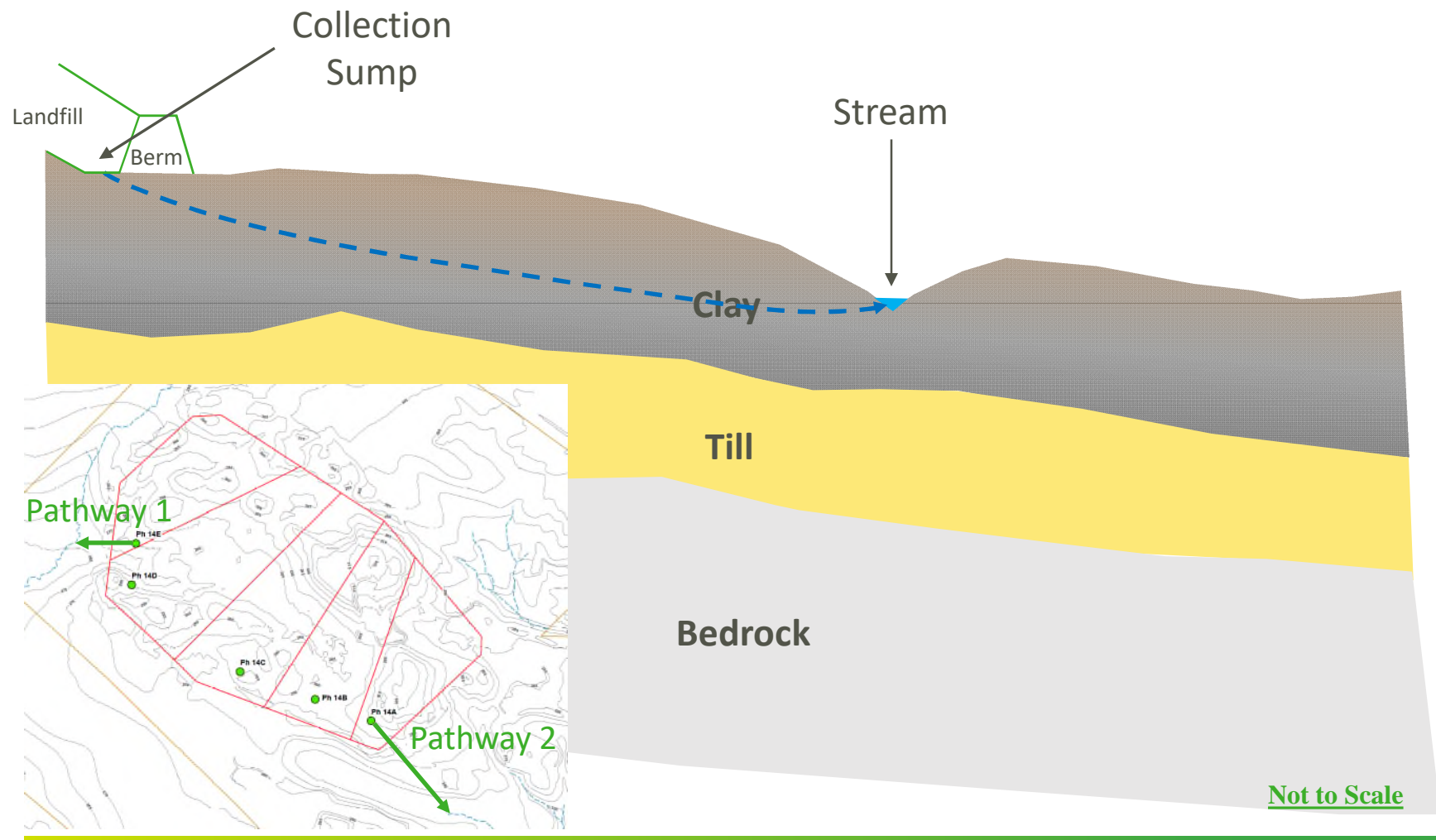
4.0 Time of Travel Analysis

OVERVIEW

- Identify Potential Sensitive Receptors
- Identify Pathways
- Identify Input Parameters
- Complete Calculations

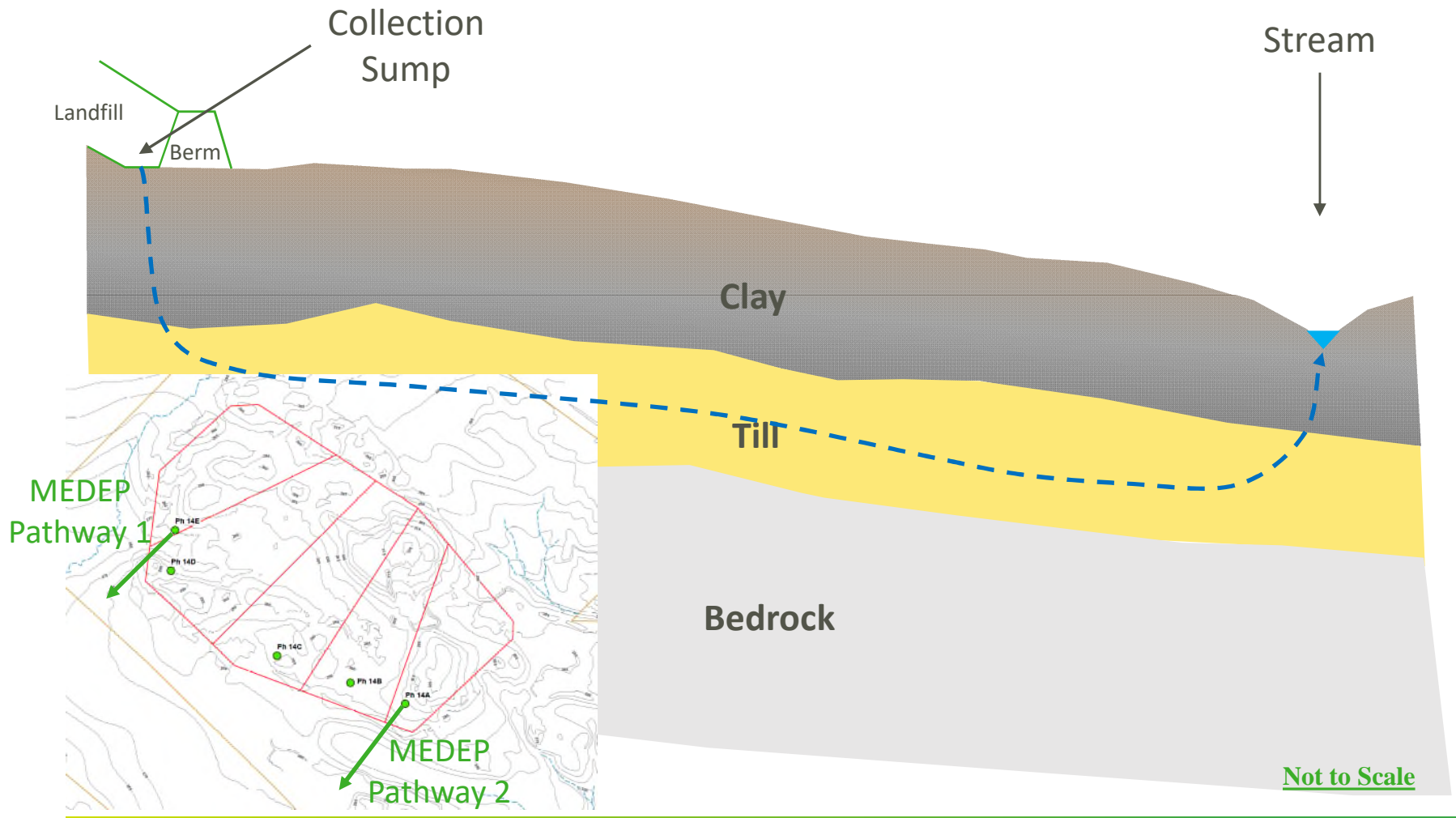
Potential Pathways 1 and 2

FLOW TO STREAM THROUGH CLAY



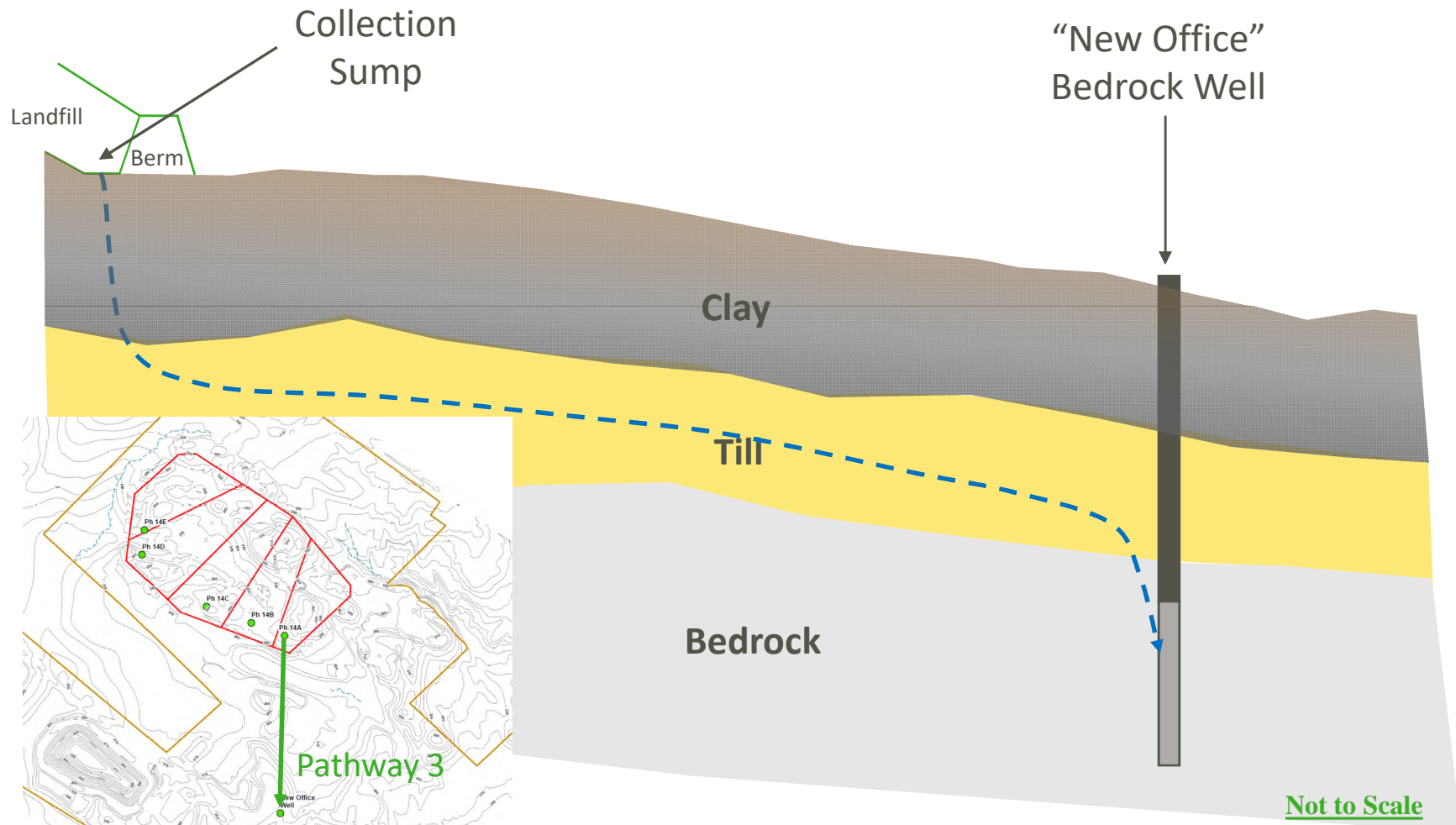
MEDEP Theorized Pathways 1 and 2

FLOW TO STREAM THROUGH TILL



Potential Pathway 3

FLOW TO “NEW OFFICE” BEDROCK WELL



Time of Travel Analysis

AVERAGE CONDITIONS INPUT PARAMETERS

Time of Travel Results Using Average Conditions Input Values	
Pathway	Time of Travel
Pathway 1	955 years
Pathway 2	2,050 years
Pathway 3	111 years
MEDEP Pathway 1	115 years
MEDEP Pathway 2	190 years

Time of Travel Analysis

HIGH-END CONDITIONS INPUT PARAMETERS

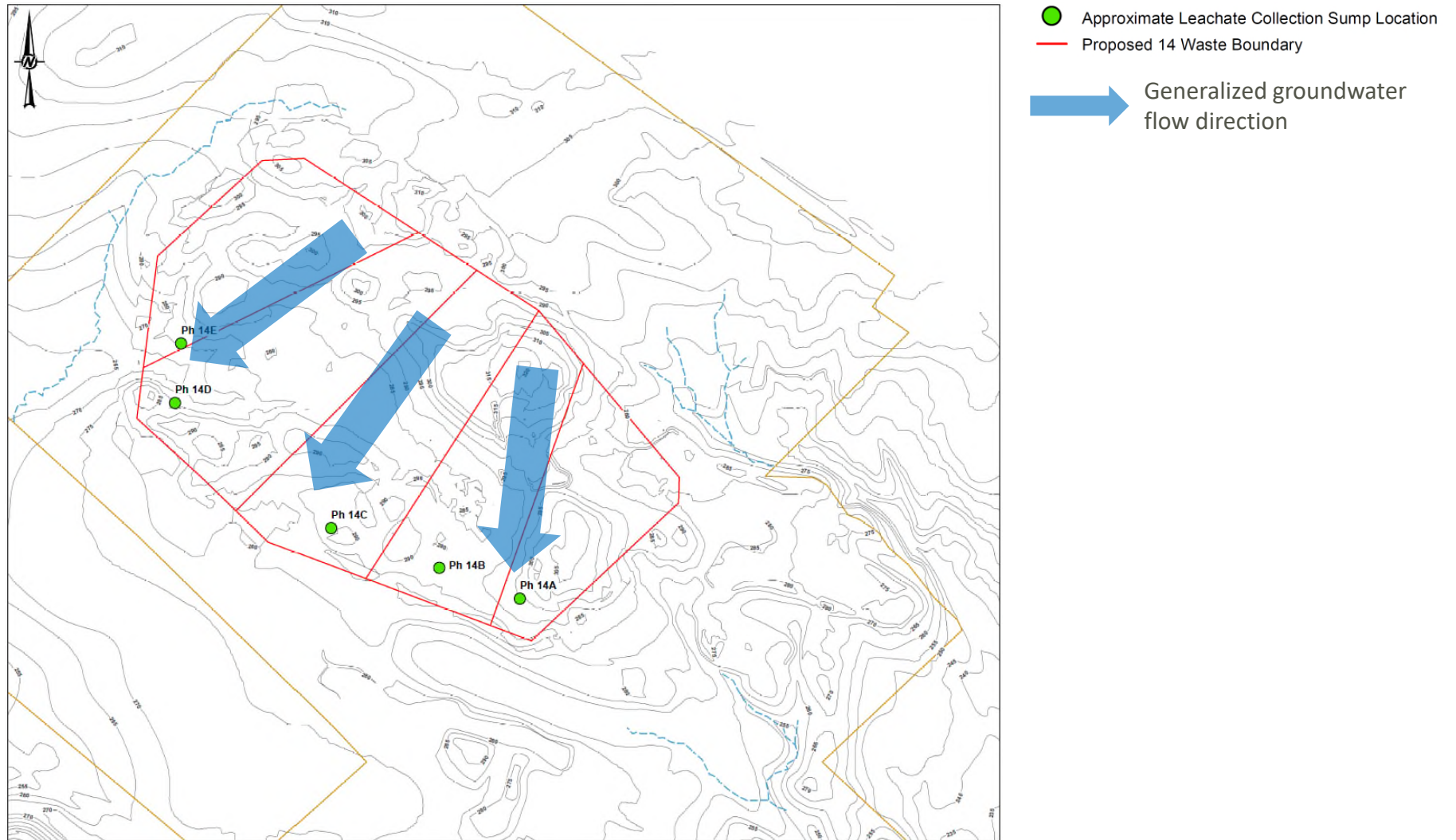
Time of Travel Results Using High-End Conditions	
Pathway	Time of Travel
Pathway 1	44 years
Pathway 2	95 years
Pathway 3	6.8 years
MEDEP Pathway 1	16 years
MEDEP Pathway 2	27.4 years

5.0 Proposed Water Quality Monitoring Program

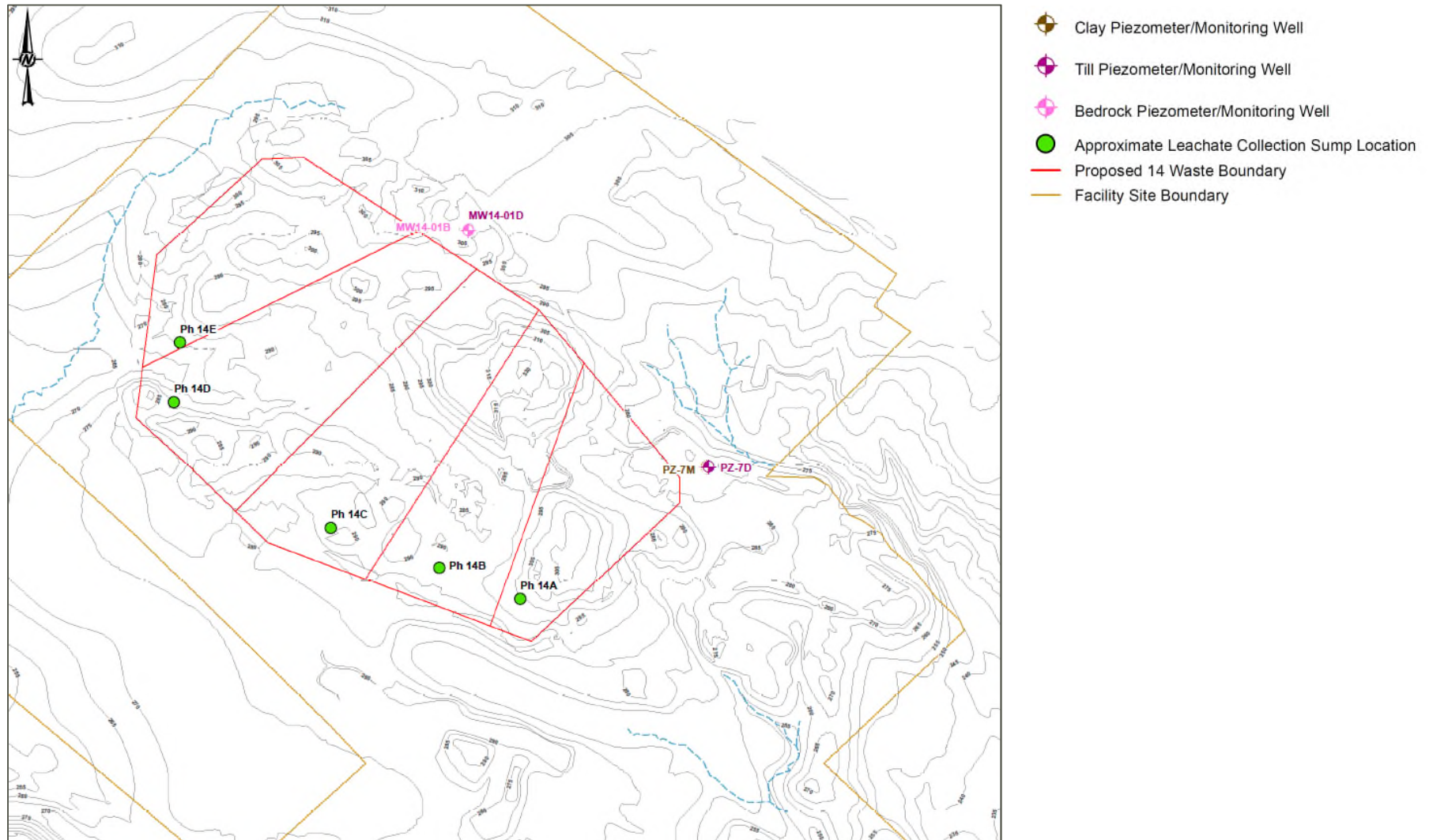
Site Characterization Monitoring - to establish the parameters to be monitored, and their concentrations as currently found in ground and surface water in the vicinity of the solid waste facility

Detection Monitoring - to detect changes in water quality throughout the active life of the facility and through the closure and post closure periods.

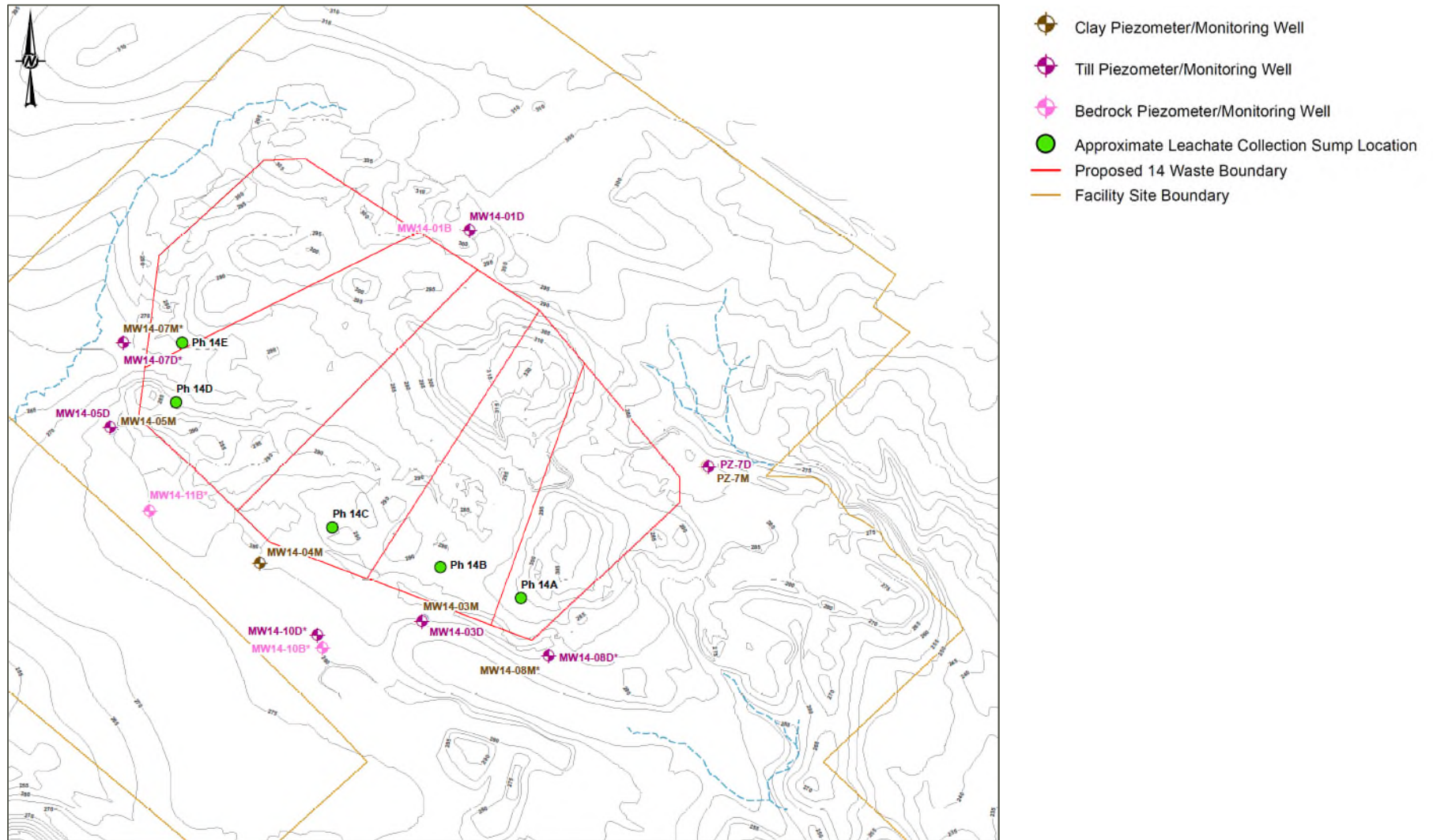
Proposed Water Quality Monitoring Program



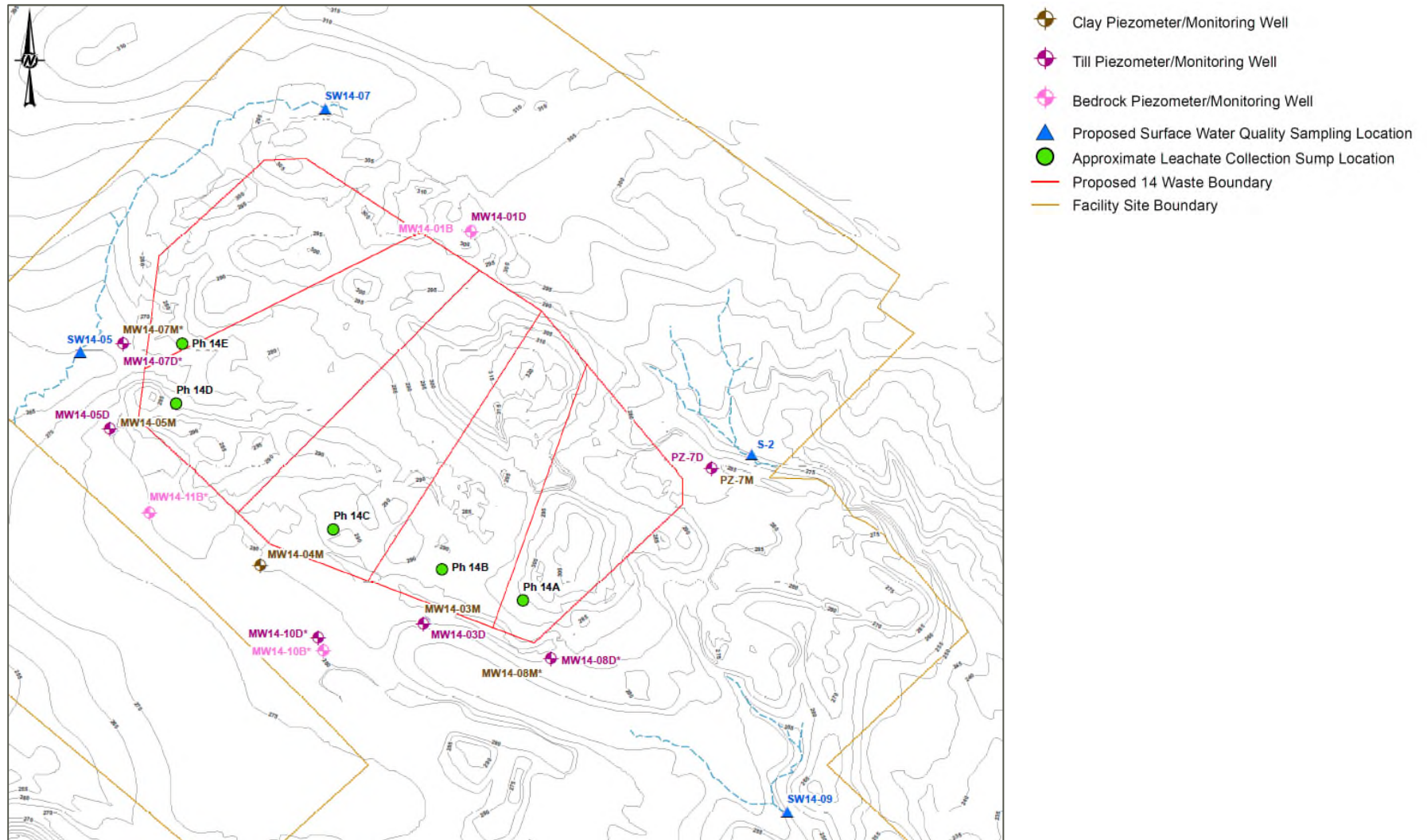
Proposed Water Quality Monitoring Program



Proposed Water Quality Monitoring Program



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Proposed Water Quality Monitoring Program

SAMPLING SCHEDULE/FREQUENCY

Site Characterization Monitoring – Summer 2021 to Fall 2023

- 4 sampling events prior to waste placement
- 8 sampling events total
- Water Quality Reports in Summer 2022 and Fall / Winter 2023

Detection Monitoring – Begin 2024

- Tri-annual (3 times per year) sampling
- Annual reporting

Summary

GEOLOGIC AND HYDROGEOLOGIC CONDITIONS

- Presence of Presumpscot clays beneath the entire Phase 14 footprint provides a natural barrier to underlying water bearing units
- The prevailing groundwater flow direction is generally to the south and towards previously permitted landfill units. The groundwater beneath Phase 14 does not flow towards the public water supply protection areas or the significant sand and gravel aquifers mapped by Maine Geological Survey

Summary

GEOLOGIC AND HYDROGEOLOGIC CONDITIONS

- The location of Phase 14 and the combination of engineered systems, the natural geologic and hydrogeologic conditions, and frequent, long-term water quality monitoring will ensure that Phase 14:
 - Will not pose an unreasonable risk to potential sensitive receptors (i.e., stream and aquifers)
 - Will not pose a threat to the Town or other water supplies