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Hydrogeological Assessment
Pine Ridge Estates Subdivision
Raymond Cape Road, Raymond

Date: August 6, 2025

Summary:

The array of wastewater disposal locations on the site plan meets the requirements of the Town of Raymond regarding ground water quality.

Purpose of the assessment:

The purpose of the assessment is to predict the locations and possible effects of wastewater plumes on ground water from the septic systems planned for a residential subdivision. This assessment is done to satisfy the subdivision ordinance of Raymond, *Article 9.13. Impact on Ground Water.*

Information used:

Information used in this study includes library research of published literature, plans of the development by BH2M with elevation contours, and wetlands and soil information by Mark Hampton Associates.

Project summary:

The project is an eleven subdivision of 34.28 acres. Wastewater disposal will be by on-site subsurface wastewater disposal systems. Water will be provided by individual drilled, bedrock water wells.

Summary of geology:

The property is located on the westerly facing slope of a knoll on Raymond Cape,

(see Figure 1). Drainage is westerly to Sebago Lake by way of ground water and wetland flow.

The highest portion of the site is in the northwesterly portion of the property at an elevation of 388 feet. The lowest portion of the site is along Raymond Cape Road at an elevation of 290 feet. Surface slopes range from 1% in wetlands to 33% on occasional steep areas. The average surface slope across the property is 7%. The topography varies across the property, with several low troughs containing wetlands, and small knolls between them.

Carol Hildreth depicted the property (see Figure 2) as deposits of sandy glacial till underlain by shallow bedrock (Ptd) on the *Surficial geology of the Raymond and Naples quadrangles, Maine* (ME Geol.Surv. Open-File Map 97-50).

The site is depicted (see Figure 3) as an association of Hermon sandy loam (HhC) Woodbridge very stony sandy loam (WsB) and Sebago mucky peat (Sp) on the *National Cooperative Soil Survey*. This mapping is generally consistent with the surficial geologic mapping and the on-site soil logs of Hampton, although no shallow bedrock is noted in either.

Bedrock beneath the site is mapped as granite of the Sebago Pluton by John Creasy (see Figure 4) on the *Bedrock Geology of the Naples and Raymond quadrangles, Maine* (ME Geol. Surv. Open-File Report, 96-4).

The property is not mapped as a Significant Sand and Gravel Aquifer by the Maine Geological Survey.

Summary of hydrogeology:

The source of ground water on this site is precipitation. Precipitation falling on this site seeps into the soil and descends until restrictive soil layers or the water table is encountered. Thereupon, the flow of ground water is downgradient toward wetlands and streams. Where ground water encounters open fractures on the bedrock surface, a portion of the water will seep downward into the bedrock to recharge the bedrock aquifer.

On this site the soils are loamy sand in texture and are predominantly medium textured. Bedrock is not shallow. Recharge is average to above average over the site. Based on the guidelines for nitrogen impact assessment published by the Maine DEP, it is reasonable to assume that 33% of all precipitation recharges the soil.

The groundwater flow directions on this property can be assumed to be perpendicular to the topographic contour lines. The estimated hydraulic conductivity of the soil is 6 feet per day. The assumed effective porosity is assumed to be 25%. The hydraulic gradient is estimated to be 3%,

Impact on Groundwater Quality:

Nitrate-nitrogen is the chemical to assess for impact on groundwater. Nitrate-nitrogen is generated by subsurface wastewater disposal systems. It is a conservative contaminant, meaning it does not readily degrade in groundwater, nor does it attenuate or attach itself to soil particles. Nitrate-nitrogen is limited to 10 mg/liter in public drinking water supplies by the Primary Drinking Water Standard and is the limit set by Raymond at the property boundaries of a project.

The analysis of nitrate-nitrogen impacts was calculated by SOLUTRANS, a 32-bit Windows program for modeling three-dimensional solute transport written by Dr. Charles R. Fitts of Fitts Geosolutions and the University of Southern Maine. The program is based on the analytical solutions of Liej *et. al.* (1991 and 1993). The solutions in SOLUTRANS all assume a uniform one-dimensional flow field, but allow three-dimensional dispersion, retardation and first-order decay estimations.

Variables entered into the calculations include a hydraulic conductivity value of 6 feet per day, a hydraulic gradient of 3% and an assumed porosity of 25%. This leads to a seepage velocity of 0.7 feet per day.

Additional variables include flows of 360 gallons per day (four-bedroom homes), an initial wastewater concentration of 40 mg/L NO3-N, retardation of 1, and a decay of zero.

The dispersivity values are not site-specific measurements of the heterogeneities of the soil but are assumed to be uniform and independent of location and time, with lateral dispersivity being 1/3 of longitudinal dispersivity and vertical dispersivity being 1/10 of lateral dispersivity. Dispersivity is governed by the equation: longitudinal dispersivity = (0.0175) x (Length of plume raised to 1.46 power). The plume length analyzed is 150 feet. Therefore, longitudinal dispersivity of 21 feet, lateral dispersivity of 7 feet and vertical dispersivity of 0.7 feet are used.

Another feature of this analytical program that simulates numerical modelling is a thickness corrector, which is governed by the equation: Z = (flow) / (7.481) divided by (disposal width) (K)(I).

Calculations were made and reveal the 10 mg/L NO3-N plume will be approximately 50 feet in length. The graph of these results is enclosed.

Using the topographic contour information as a determinant of groundwater flow direction, the calculated 10 plumes were drawn on the plan of the project by Mark Cenci Geologic, Inc. Details at a scale of 1" = 100' are attached to this report.

All 10 mg/liter plumes remain of the project property. Five of the eleven plumes move into wetlands where NO3-N will be reduced to near zero concentration due to bio-chemical denitrification in a saturated, anoxic zone.

Conclusions:

The soil map shows the basic soil types, which are verified by on-site soil logs. Drainage conditions over the property are depicted in the soil logs, the wetland delineation and the soil map.

An analytic computer program was used to calculate the likely extent and shape of wastewater plumes, based on soil types and slopes on the property. This program is not dependent upon precipitation, so drought conditions are included.

Plumes reach an acceptable concentration of NO3-N on the property and five plumes move to wetlands where nitrates will be effectively reduced to zero.

The depicted array of wastewater disposal areas meets the requirements of the Town of Raymond regarding ground water quality. The minimal required separation of 100 feet between water wells and septic disposal areas is sufficient.

Mark Cenci
Licensed Maine Geologist #467

Figure 1.

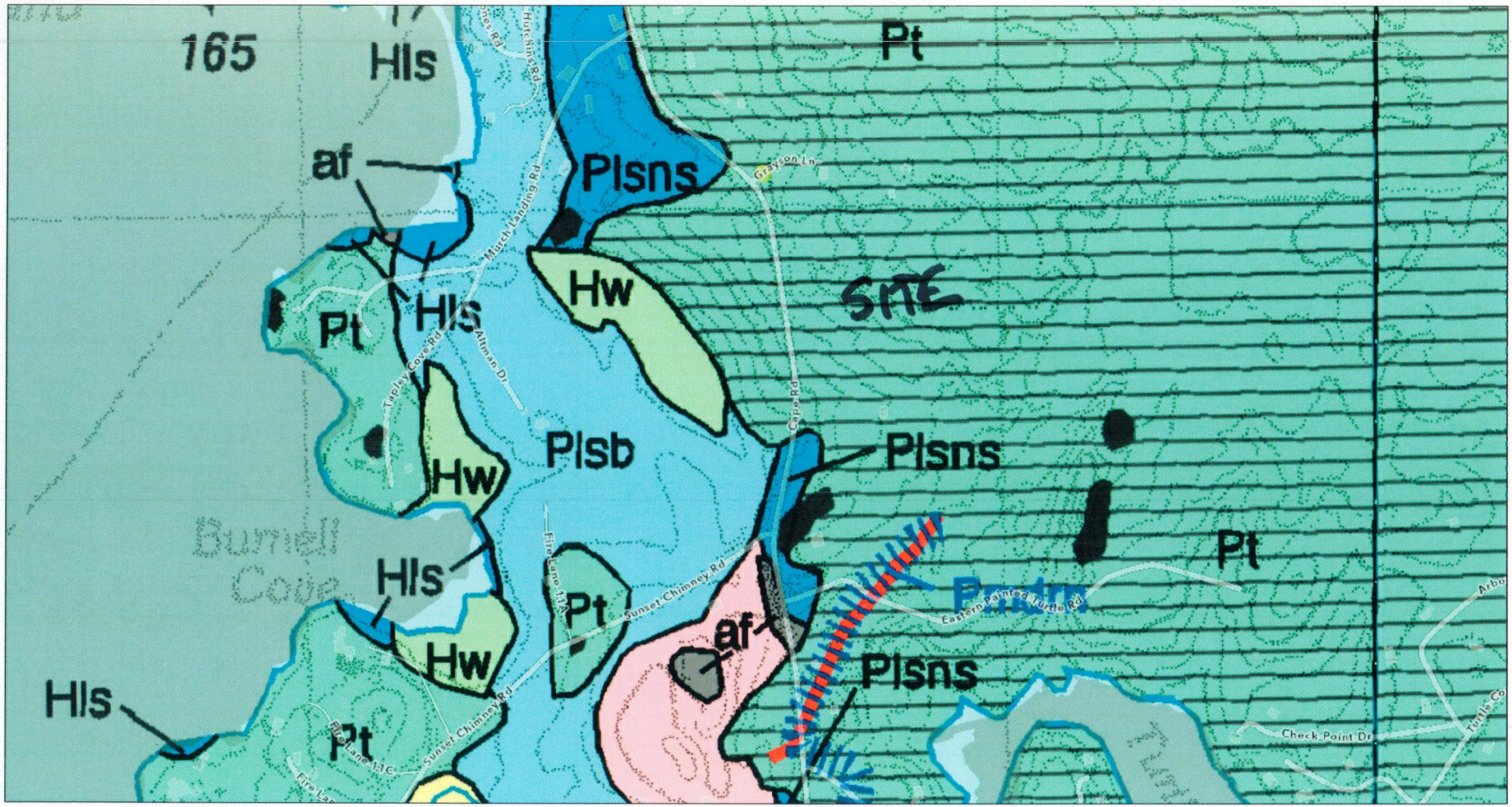
7/28/2025

Inland Waters
Emergent Wetlands
Forest/shrub Wetlands
Wetlands
Normal Index Contours
Normal Intermediate Contours

Layers
Red: Band_1
Green: Band_2
Blue: Band_3

USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography

Figure 2. Surficial Geology



7/28/2025, 12:58:37 PM

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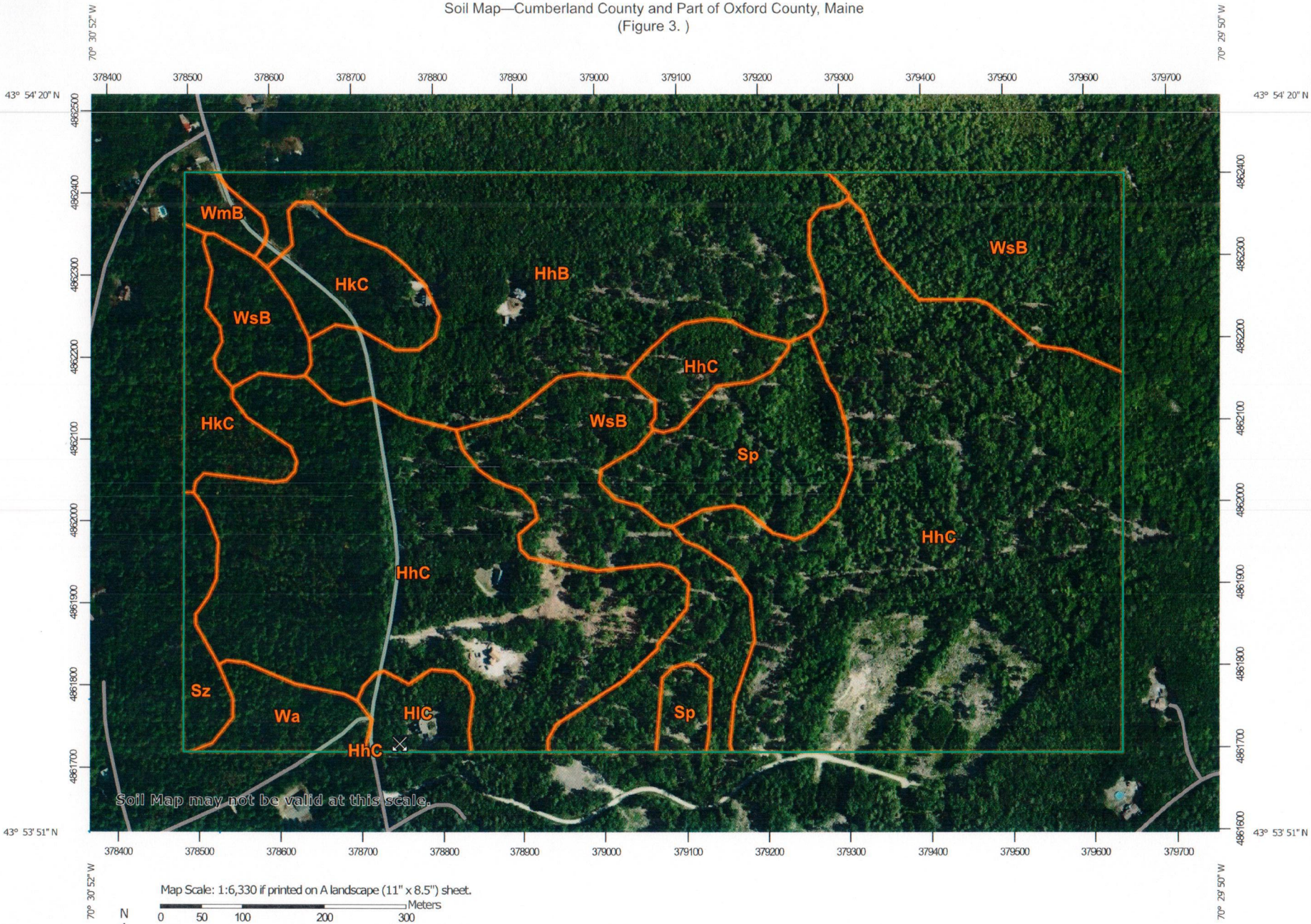
0 0.05 0.1 0.2 mi

0 0.1 0.2 0.4 km

Maine Geological Survey, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User

Soil Map—Cumberland County and Part of Oxford County, Maine
(Figure 3.)



Map Scale: 1:6,330 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 300 600 1200 1800

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Cumberland County and Part of Oxford County, Maine
Survey Area Data: Version 21, Aug 26, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

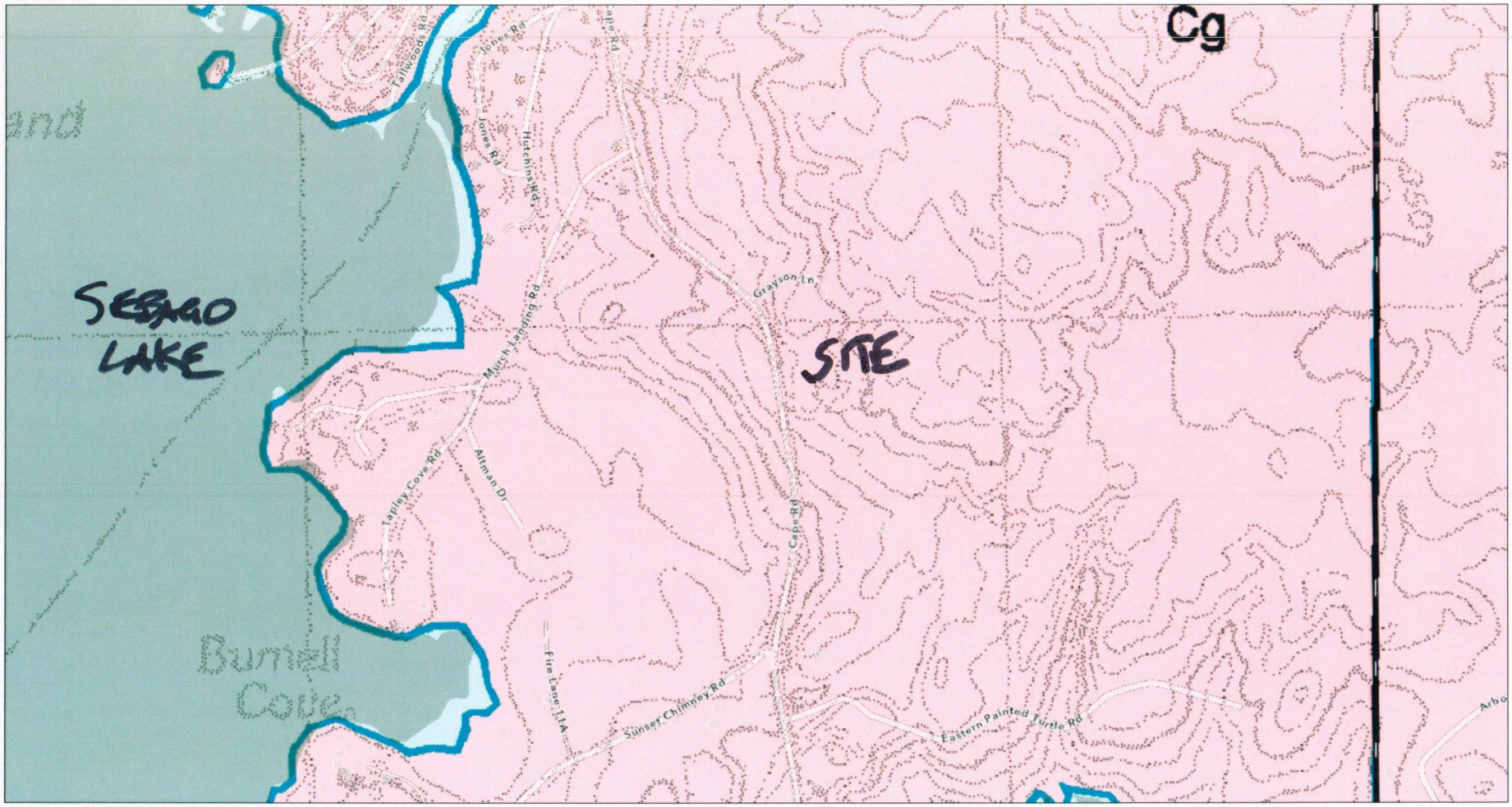
Date(s) aerial images were photographed: Jun 19, 2020—Jul 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HhB	Hermon sandy loam, 0 to 8 percent slopes, very stony	35.9	17.8%
HhC	Hermon sandy loam, 8 to 15 percent slopes, very stony	98.9	49.0%
HkC	Hermon sandy loam, 8 to 20 percent slopes, extremely stony	9.9	4.9%
HlC	Hinckley loamy sand, 8 to 15 percent slopes	3.0	1.5%
Sp	Sebago mucky peat	12.2	6.1%
Sz	Swanton fine sandy loam	2.9	1.4%
Wa	Walpole fine sandy loam	3.7	1.9%
WmB	Windsor loamy sand, 0 to 8 percent slopes	1.6	0.8%
WsB	Woodbridge very stony fine sandy loam, 0 to 8 percent slopes	33.6	16.7%
Totals for Area of Interest		**201.8**	**100.0%**

Figure 4. Bedrock Geology



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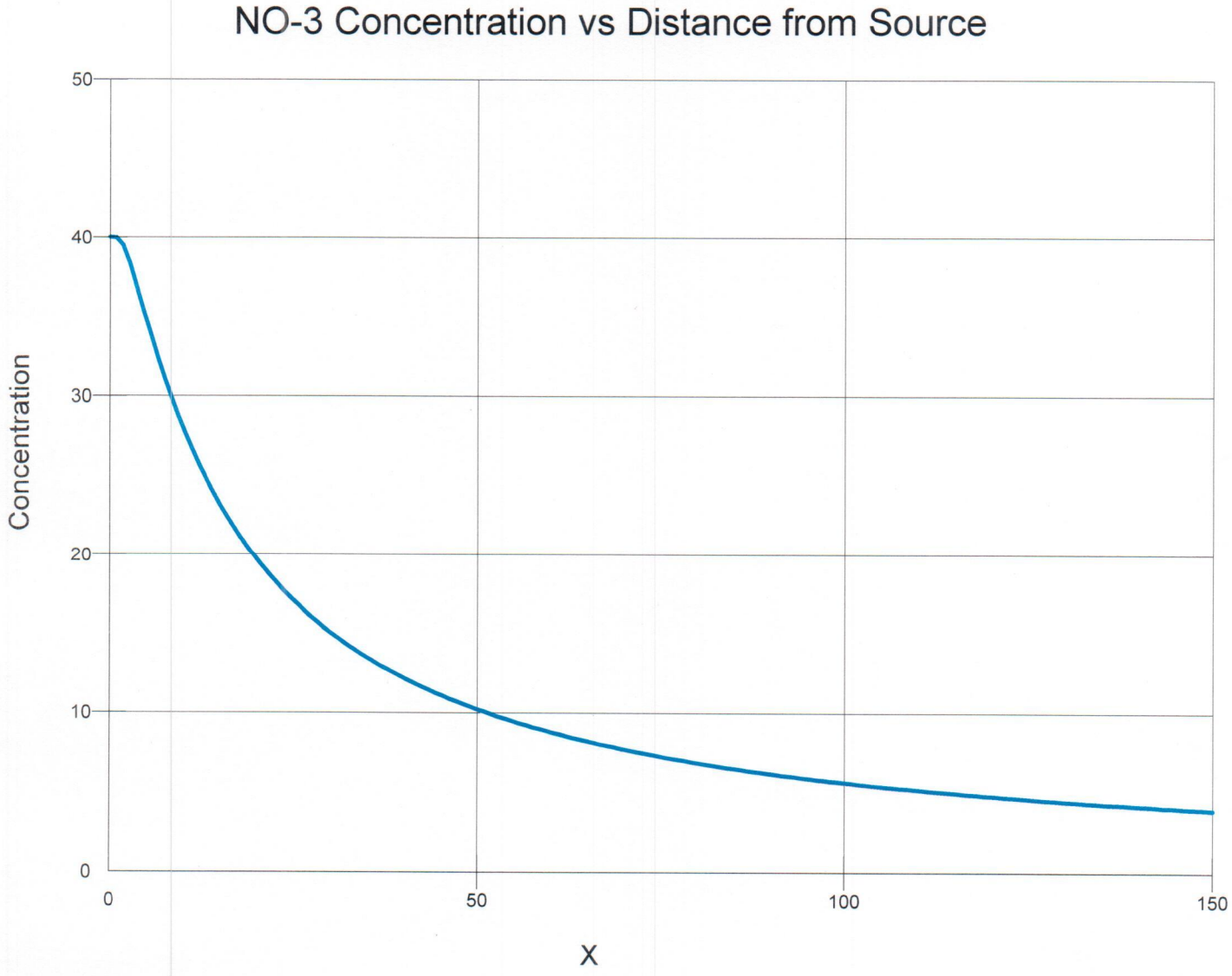
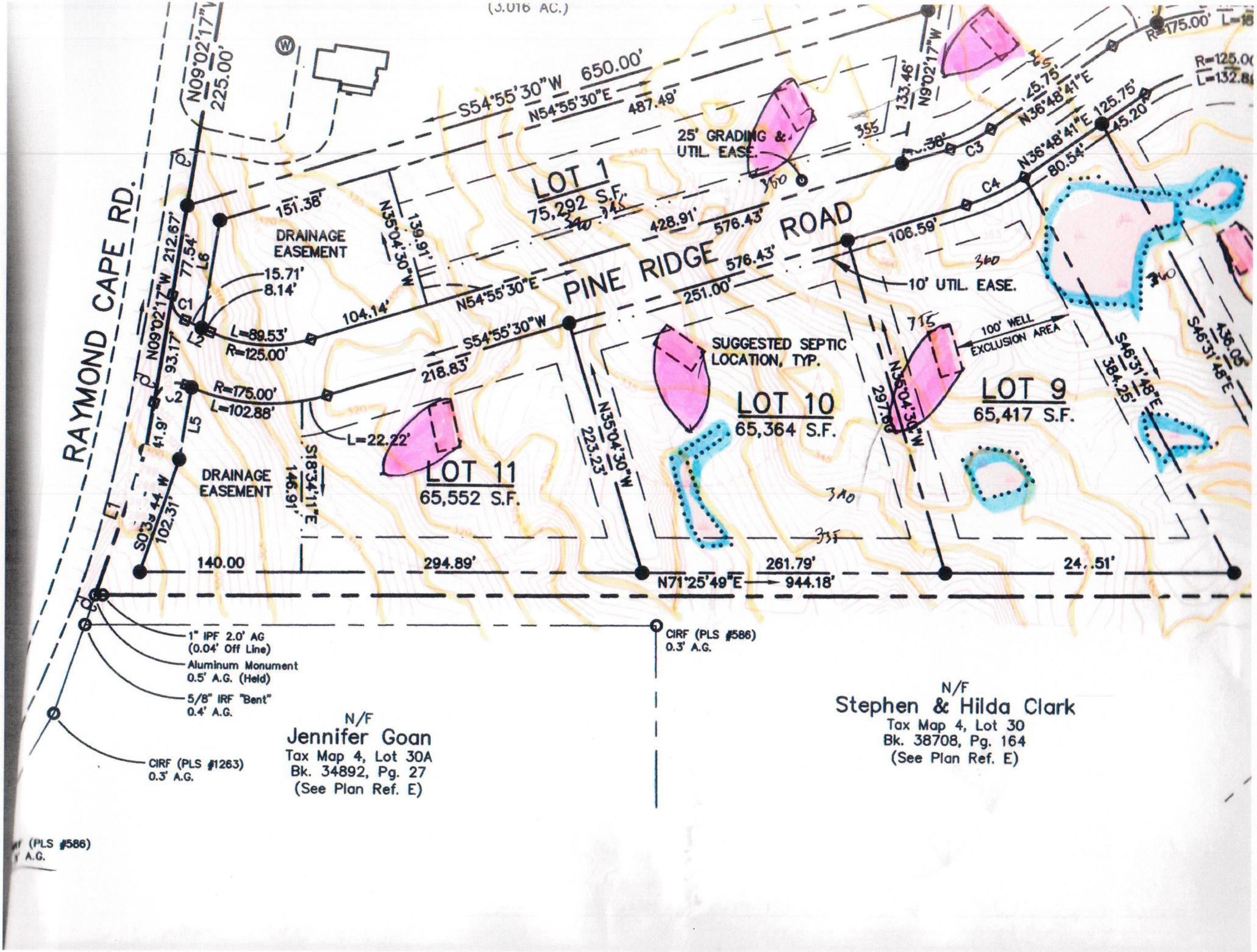
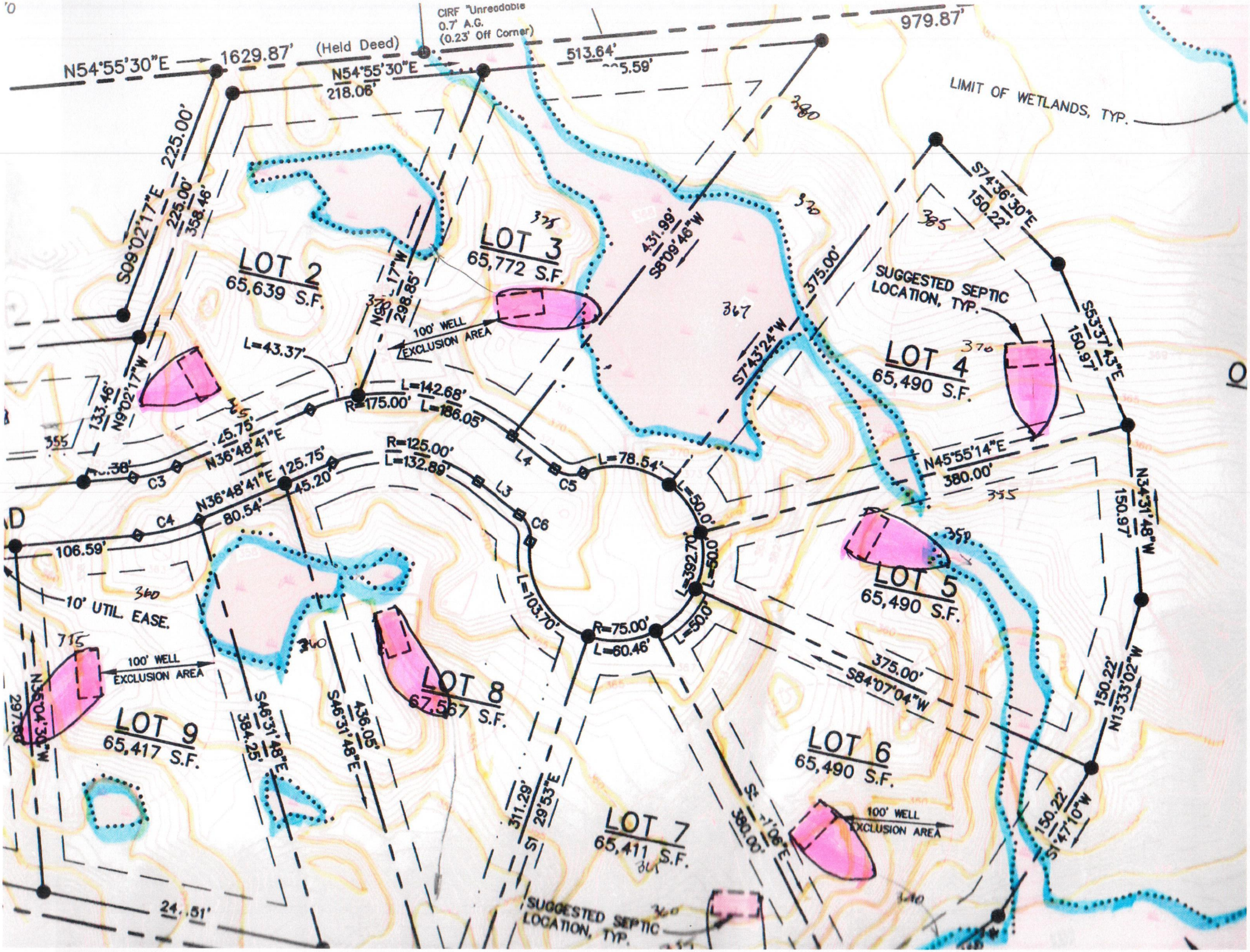
0 0.05 0.1 0.2 mi

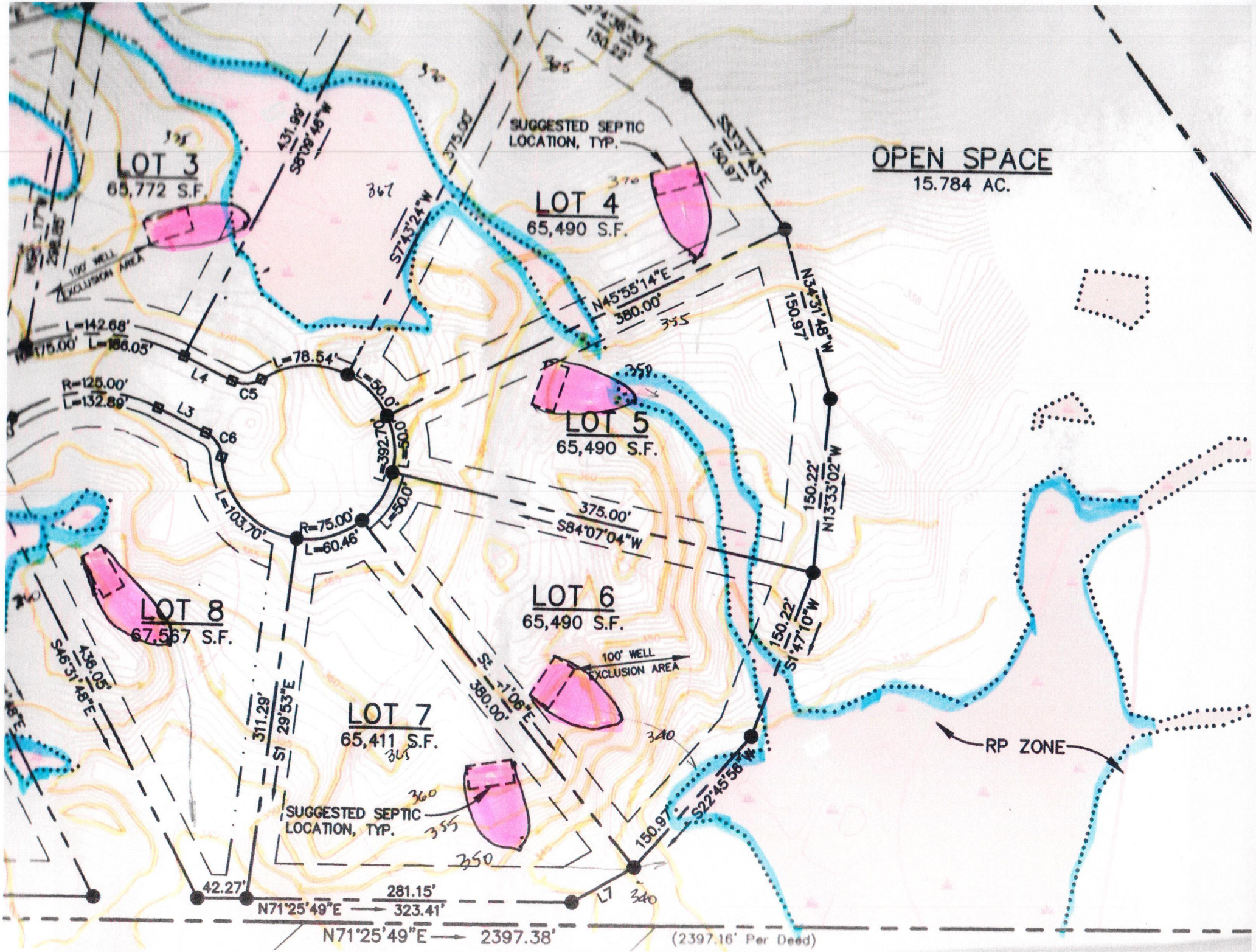
0 0.1 0.2 0.4 km

Maine Geological Survey, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User


NO-3 Concentration vs Distance from Source
Concentration
50
40
30
20
10
0
0
50
100
150
X


(3.016 AC.)
RAYMOND CAPE RD.
PINE RIDGE ROAD
N09°02'17"W 225.00'
S54°55'30"W 650.00'
N54°55'30"E 487.49'
N9°02'17"W 133.46'
R=175.00' L=18
R=125.0(L=132.8(
25' GRADING & UTIL. EASE.
LOT 1
75,292 S.F.
151.38'
DRAINAGE EASEMENT
N35°04'30"W 139.91'
428.91'
576.43'
N36°48'41"E 125.75'
45.20'
80.54'
C3
C4
106.59'
10' UTIL. EASE.
N09°02'17"W 212.67'
77.54'
L6
15.71'
8.14'
C1
L=89.53'
R=125.00'
104.14'
N54°55'30"E
251.00'
S54°55'30"W
218.83'
SUGGESTED SEPTIC LOCATION, TYP.
100' WELL EXCLUSION AREA
LOT 10
65,364 S.F.
LOT 9
65,417 S.F.
S46°31'48"E 384.25'
S46°31'48"E
436.0
93.17'
C2
R=175.00'
L=102.88'
L5
L=22.22'
S18°34'11"E 146.91'
N35°04'30"W 223.23'
297.00'
DRAINAGE EASEMENT
LOT 11
65,552 S.F.
S03°44'W 102.31'
41.9'
140.00
294.89'
261.79'
N71°25'49"E 944.18'
24..51'
1" IPF 2.0' AG
(0.04' Off Line)
Aluminum Monument
0.5' A.G. (Held)
5/8" IRF "Bent"
0.4' A.G.
CIRF (PLS #1263)
0.3' A.G.
CIRF (PLS #586)
0.3' A.G.
N/F
Jennifer Goan
Tax Map 4, Lot 30A
Bk. 34892, Pg. 27
(See Plan Ref. E)
N/F
Stephen & Hilda Clark
Tax Map 4, Lot 30
Bk. 38708, Pg. 164
(See Plan Ref. E)
(PLS #586)
A.G.


CIRF "Unreadable
0.7' A.G.
(0.23' Off Corner)
N54°55'30"E 1629.87' (Held Deed)
N54°55'30"E 218.06'
513.64'
979.87'
LIMIT OF WETLANDS, TYP.
S09°02'17"E 225.00'
225.00'
358.46'
N9°02'17"W 133.46'
LOT 2
65,639 S.F.
LOT 3
65,772 S.F.
431.99'
S8°09'48"W
375.00'
S74°36'30"E 150.22'
SUGGESTED SEPTIC LOCATION, TYP.
S53°37'43"E 150.97'
LOT 4
65,490 S.F.
S7°43'24"W
N37°17'W 298.85'
100' WELL EXCLUSION AREA
L=43.37'
R=175.00'
L=142.68'
L=186.05'
45.75'
N36°48'41"E
125.75'
45.20'
R=125.00'
L=132.89'
L4
C5
L=78.54'
L=50.0'
N45°55'14"E 380.00'
N34°31'48"W 150.97'
C3
C4
80.54'
106.59'
L3
C6
L=392.70'
L=50.0'
LOT 5
65,490 S.F.
10' UTIL. EASE.
L=103.70'
R=75.00'
L=60.46'
L=50.0'
375.00'
S84°07'04"W
N13°33'02"W 150.22'
100' WELL EXCLUSION AREA
N35°04'30"W 297.88'
LOT 9
65,417 S.F.
S46°31'48"E 384.25'
S46°31'48"E 436.05'
LOT 8
67,567 S.F.
LOT 6
65,490 S.F.
311.29'
S1°29'53"E
LOT 7
65,411 S.F.
S1°11'06"E 380.00'
100' WELL EXCLUSION AREA
S51°47'10"W 150.22'
24.51'
SUGGESTED SEPTIC LOCATION, TYP.


LOT 3
65,772 S.F.
LOT 4
65,490 S.F.
LOT 5
65,490 S.F.
LOT 6
65,490 S.F.
LOT 7
65,411 S.F.
LOT 8
67,567 S.F.
OPEN SPACE
15.784 AC.
SUGGESTED SEPTIC LOCATION, TYP.
SUGGESTED SEPTIC LOCATION, TYP.
100' WELL EXCLUSION AREA
100' WELL EXCLUSION AREA
RP ZONE
431.98' S9°09'46"W
S7°43'24"W
S37°57'41"E 150.97'
N45°55'14"E 380.00'
N34°31'48"W 150.97'
N13°33'02"W 150.22'
S1°47'10"W 150.22'
375.00' S84°07'04"W
S1°51'06"E 380.00'
S22°45'58"W 150.97'
436.05' S46°31'48"E
311.29' S1°29'53"E
42.27'
281.15'
N71°25'49"E 323.41'
N71°25'49"E 2397.38'
(2397.16' Per Deed)
L=142.68'
R=175.00' L=186.05'
L=78.54'
L=50.0'
L=392.70'
R=125.00' L=132.89'
L=103.70'
R=75.00' L=60.46'
L=50.0'
L3
L4
C5
C6