

DRAFT FOR PLANNING BOARD REVIEW

**ANALYSIS OF FULL-BUILD
TRAFFIC AND ENVIRONMENTAL IMPACTS
MIDDLETOWN, RI**



DECEMBER 2019

Prepared for: Planning Department
Town of Middletown
350 East Main Road
Middletown, RI 02842

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AVAILABLE DATA - TOWN AND STATE GIS RESOURCES

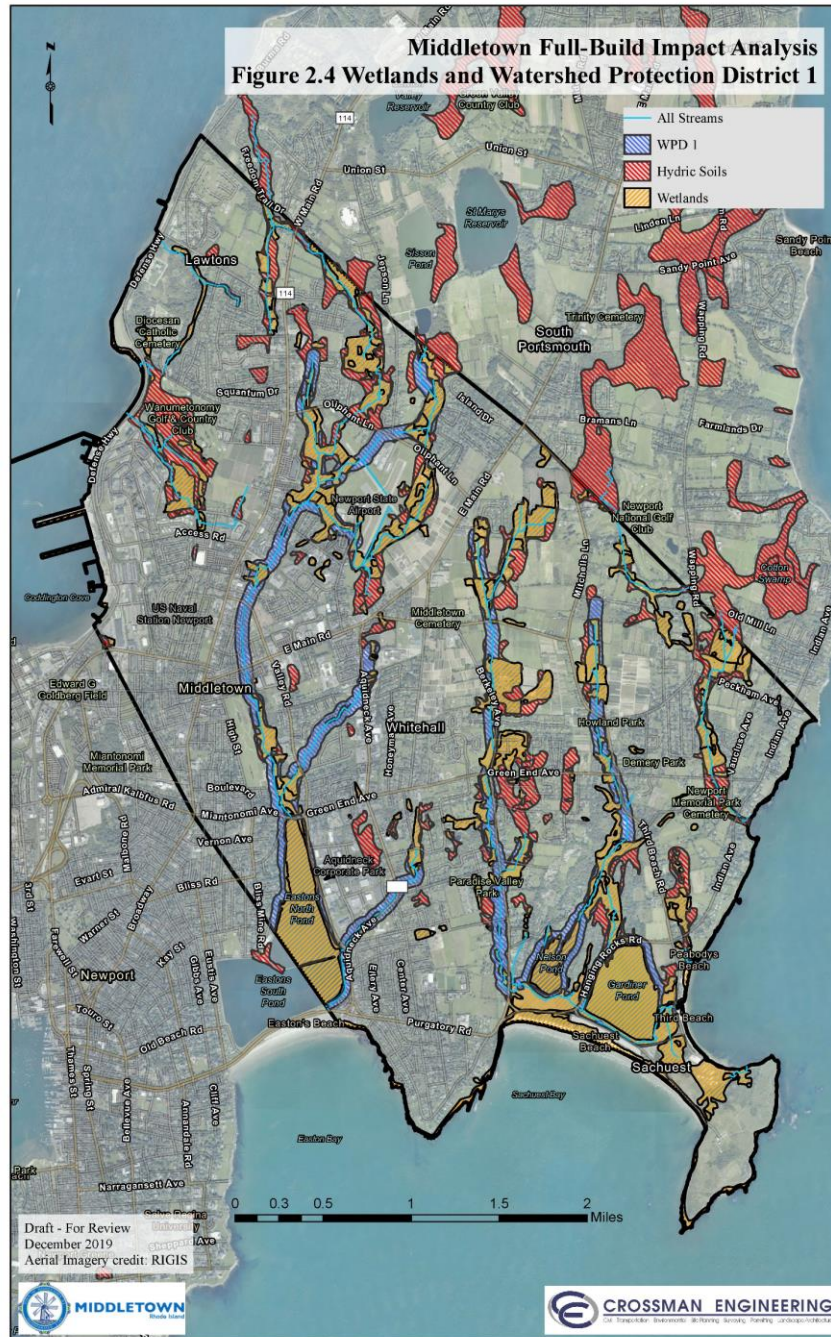
Town Resources

- Impervious Coverage Town-wide on each parcel of land
- Geologic Conditions
- Acreage Composition of Town-wide Soil Types
- Delineation of the Town's four major (Bailey Brook, Paradise Brook, Maidford River and Gardiner Pond) and two minor watersheds (eastern Narragansett Bay and eastern Little Creek Bay).
- Drinking Water Resource Areas
- Approximate Locations of Wetlands and Forested Areas
- Quantification of existing septic systems and known septic system repairs
- RIDOH Well Data from Wapping Road Area
- RIDEM and Town Documentation of TMDL and Impaired Streams and Waterbodies

State Resources

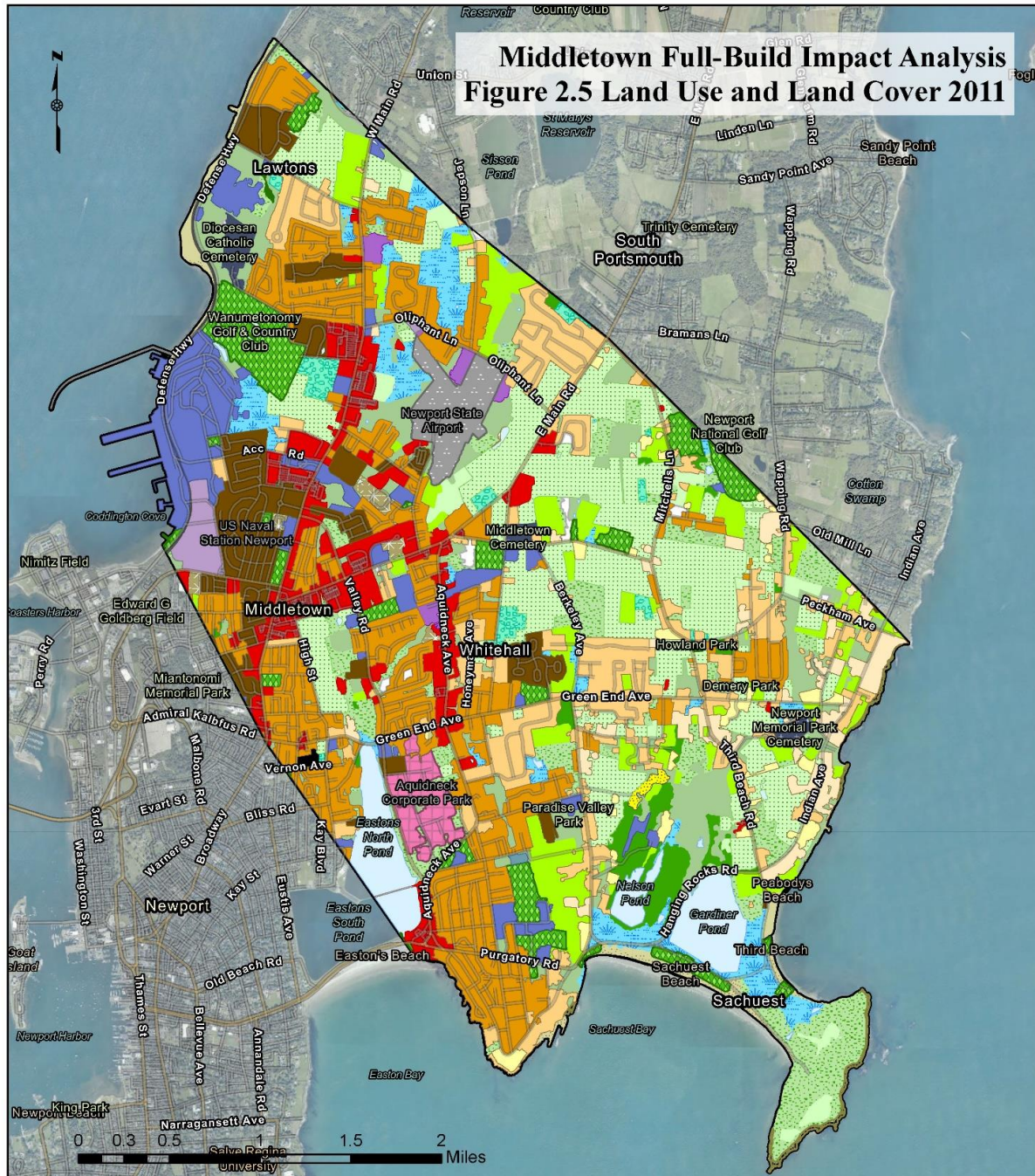
- Land Use and Land Cover data
- Watershed boundary data
- Wetland boundary data
- Wellhead Protection Areas
- Impervious coverage data

WETLANDS AND WATERSHED PROTECTION DISTRICT 1

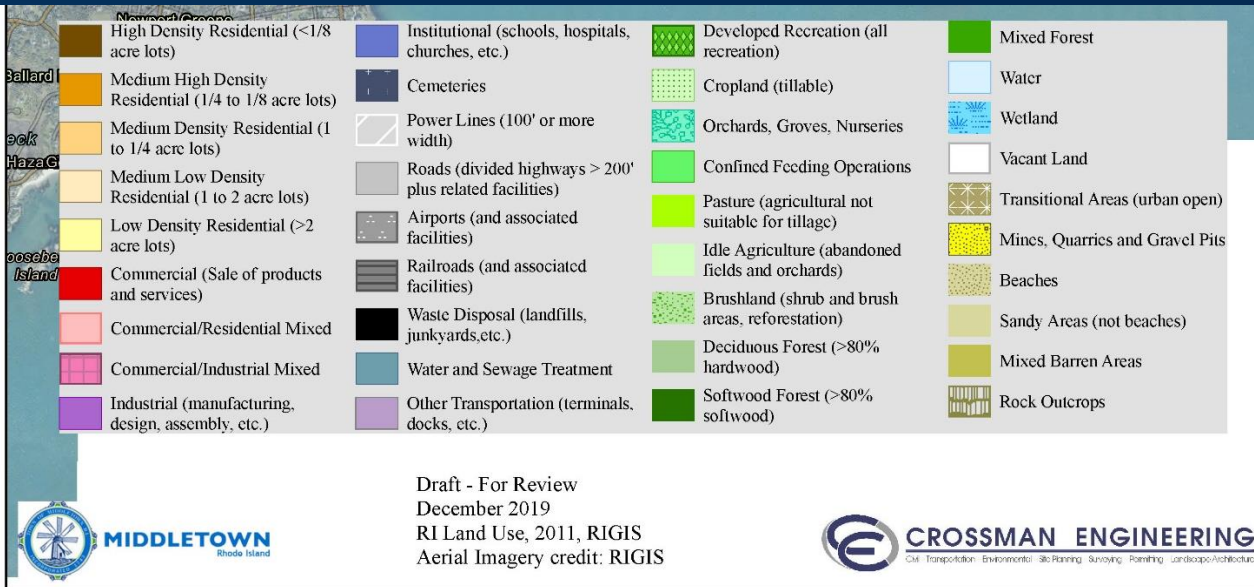


EXISTING LAND USE

Middletown Full-Build Impact Analysis
Figure 2.5 Land Use and Land Cover 2011



EXISTING LAND USE



FULL BUILD DETERMINATION

Residential

- Examine undeveloped land in residential zoning areas and oversized developed lots
- Exclude wetlands
- Exclude conservation easement and other conserved lands – Total 2,333 acres
 - Perpetual conservation restriction or easement (72 parcels, 1,110 acres)
 - Recreation, Conservation, and Open Space area excluding Wanumetonomy, St Mary's Church Open Space, St. George's School "fringe" parcels
 - Included West Main/Coddington Development Center Master Plan

Commercial

- Examine undeveloped land on commercially zoned parcels
- Exclude mapped wetlands
- No vertical "reconfiguration" of existing developments

FULL BUILD DETERMINATION

Residential Lot Yield Formula

$$L = (DA \times 0.8) \div LS$$

L = New Single Family Development Lots

DA = Developable Land Area, excluding wetlands

LS = Lot Size, based upon minimum area required by Zoning

*0.8 is lot yield factor to allow for infrastructure such as street creation, not applied if lot yield is 2 or less

Commercial Space Yield Formula

$$GLA_{Total} = (DA \times 0.9) \times (F)$$

GLA_{Total} = Gross Leasable Building Space

F = Commercial Space Utilization Factor (Table 2.2)

*0.9 is space yield factor to allow for infrastructure such as street creation, applied for large parcels which will require commercial subdivision

FULL BUILD DETERMINATION

Zoning Dimensional Requirements

Zone	General Use	Minimum Lot Size (Sq. Ft.)	Maximum Building-to-Lot Area Ratio	Development Type
R-60	Residential	60,000	15%	Single Family
R-40	Residential	40,000	15%	Single Family
R-30	Residential	30,000	20%	Single Family
R-20	Residential	20,000	20%	Single Family
R-10	Residential	10,000	25%	Single Family
RM	Residential Multifamily	40,000 / 5 (acres)	30% / 35%	Multifamily structure / development
MT	Residential Mobile Home	10 (acres)	20%	Mobile Home Park
GB	General Business	Varies	35%	Varies
LB	Limited Business	20,000	35%	Small-scale shopping center
OB	Office Business	40,000	35%	Non-residential
LI	Light Industrial	40,000	35%	All allowable
OP	Office Park	40,000	35%	All allowable
OS	Open Space	100,000	10%	All allowable

FULL BUILD DETERMINATION

Commercial Space Utilization Factors

- Parking Requirements (Zoning Ordinance Article 13)
- Commercial Landscaping Requirements (Code of Ordinances, Appendix A Subdivision Regulations)
- Building Coverage Allowance (Table 2.1)
- Building Height Restrictions (Zoning Code Article 6, Chapter 603)
- Non-buildable areas, such as wetlands

Mixed Use Development

- Based on Zoning Ordinance Article 27A
- Retail space at 35% of developed space
- Residential Use at 35% of developed space, units determined at 1,000 Sq. Ft. / Unit
- Office at 30% of developed space

Category	GLA ¹	Comment
Industrial ²	0.34	Warehouse
Office	0.34	Office Building
Retail	0.30	Shopping Plaza
Mixed Use ³	0.40	35% Residential, 35% Retail, 30% Office

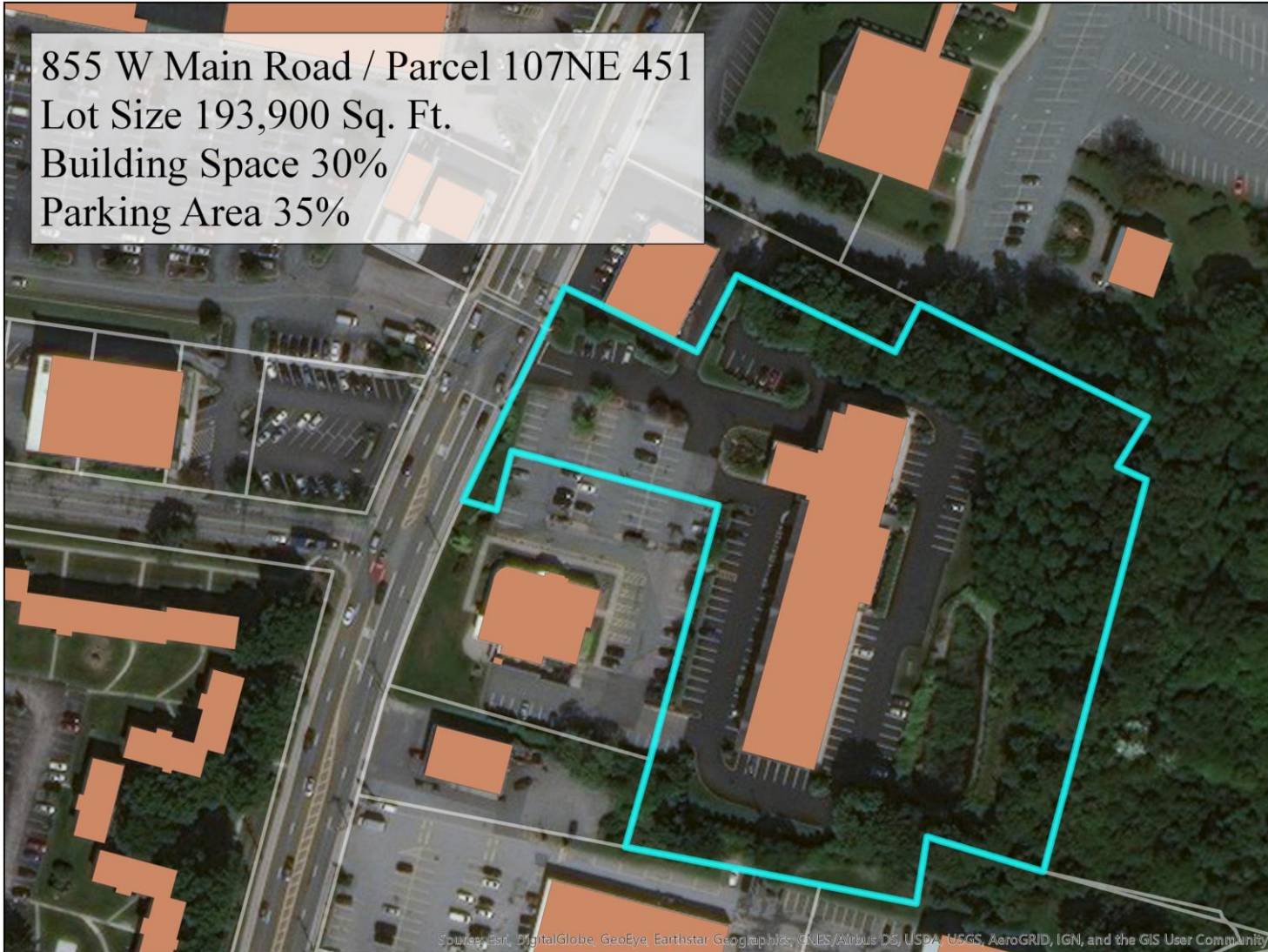
1 Gross leasable floor area as a fraction of developable land area
2 Single-story industrial GLA factor may be closer to 0.25. Values reflect two-story office

development permitted in Light Industrial zoning district.

3 Mixed Use GLA factor reflects two-story development.

Commercial Space Utilization Existing (examples)

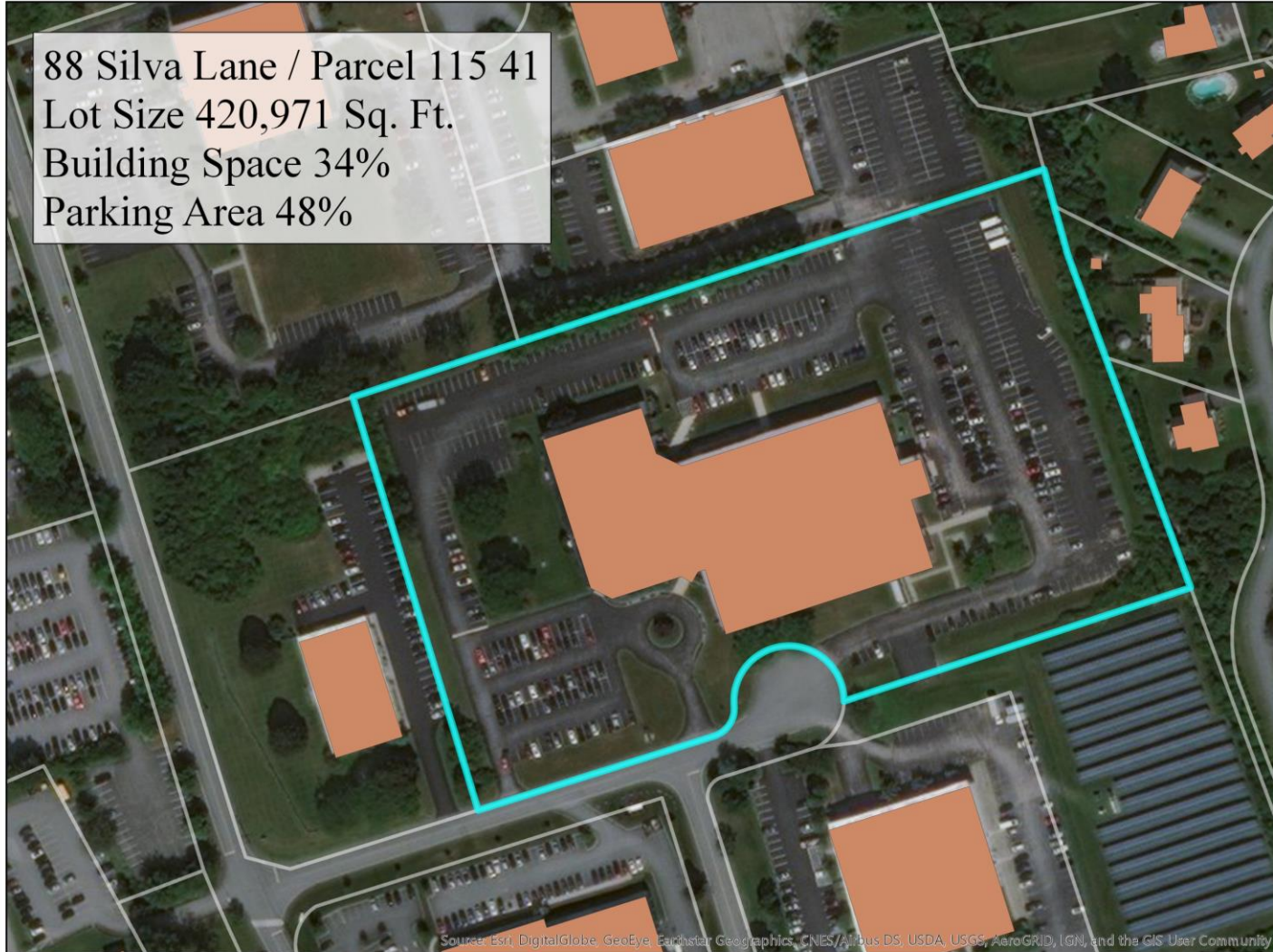
855 W Main Road / Parcel 107NE 451
Lot Size 193,900 Sq. Ft.
Building Space 30%
Parking Area 35%



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Commercial Space Utilization Existing (examples)

88 Silva Lane / Parcel 115 41
Lot Size 420,971 Sq. Ft.
Building Space 34%
Parking Area 48%



RESIDENTIAL FULL BUILD RESULTS

Zone	Existing Dwelling Units	Additional Dwelling Units, Full-Build	Total Dwelling Units
R-10	2,724	250	2,974
R-20	1,672	226	1,898
R-30	276	247	523
R-40	878	414	1,292
R-60	267	174	441
Mobile / Transient	89	0	89
Multifamily	1,185	0	1,185
OS ¹	6	125	131
COM ^{2, 5}	348	423	674 ⁴
P ^{3, 5}	354	57	411
Total	7,799	1,916	9,618

1 OS is Open Space; Additional Dwelling Units reflect redevelopment of Wanumetonomy Country Club

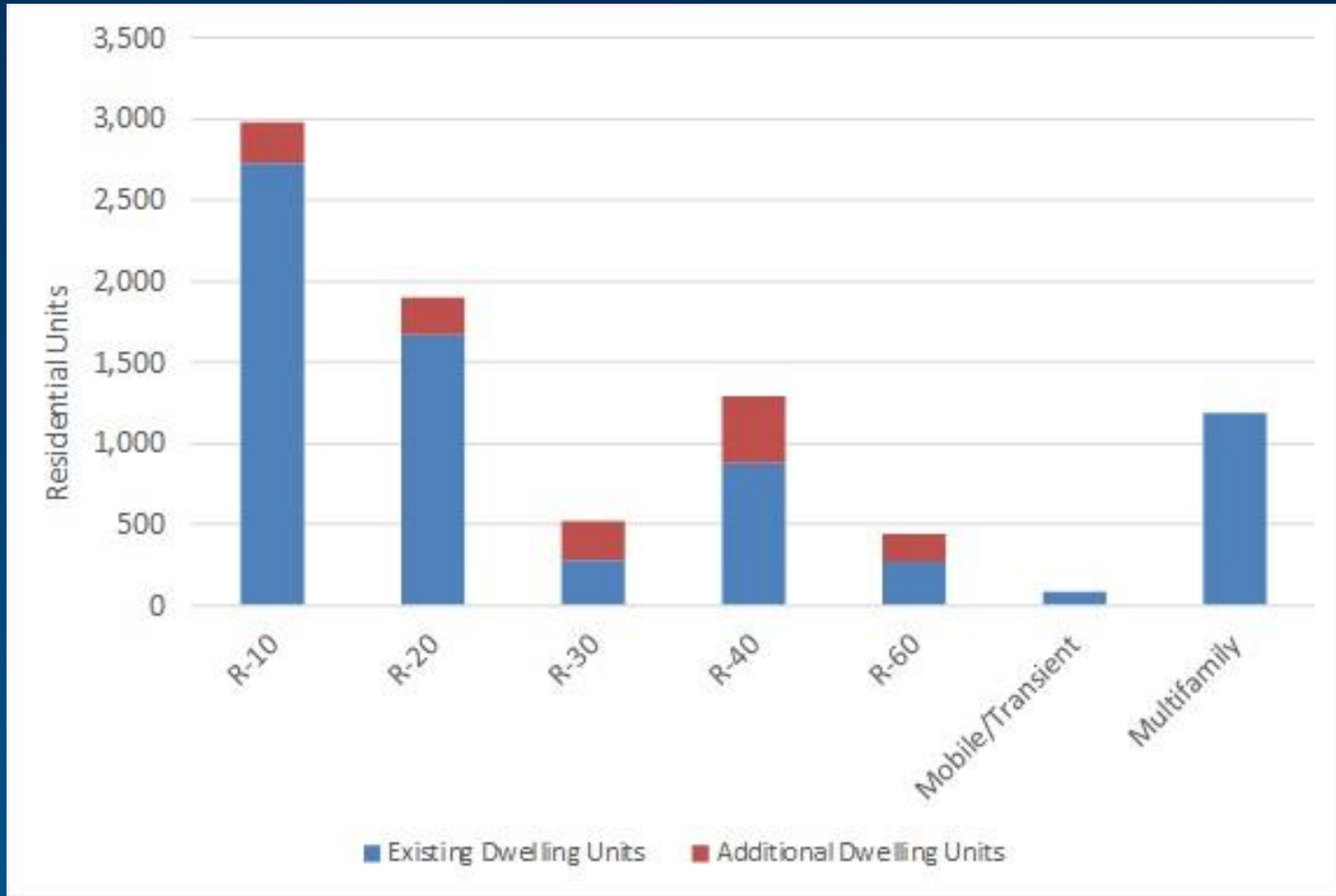
2 COM is General Business, Limited Business, Office Business, Office Park, and Light Industrial

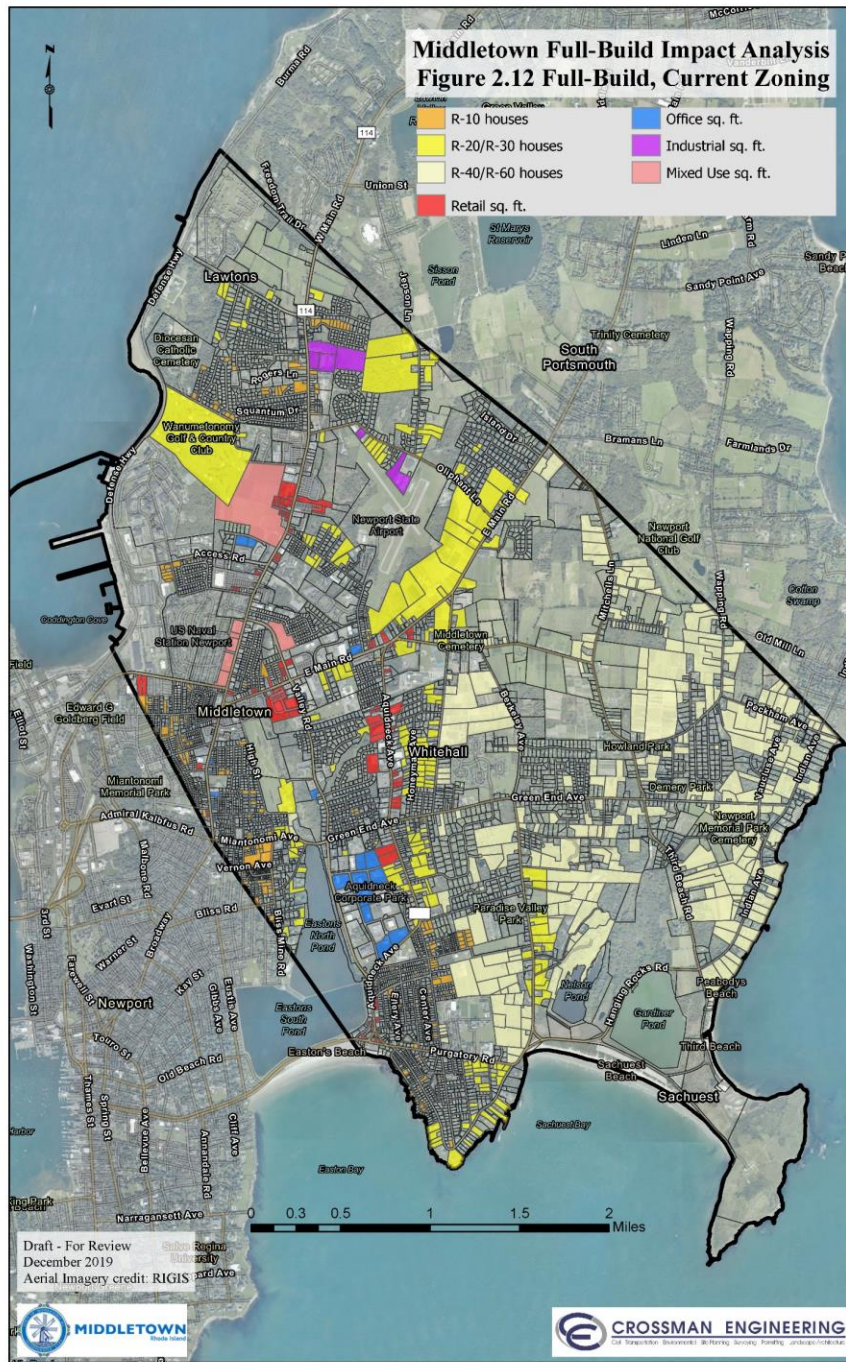
3 P is Public

4 Not a direct sum. Some existing residential units in commercial zones are converted to commercial space through build-out

5 Future development in commercial and public zones is part of mixed-use development described in Commercial full-build results section

RESIDENTIAL FULL BUILD RESULTS





RESIDENTIAL FULL BUILD RESULTS

Alternative Scenarios ²

	Full-Build with Current Zoning	Exclude Marginal Lots	Re-zone R- 40/R-60 to R- 100 Zoning	Exclude Watershed Protection District 1	Implement All Alternatives ²
R-10	250	191 (59)	250	234 (16)	179 (71)
R-20	226	157 (69)	226	163 (63)	111 (115)
R-30	247	230 (17)	247	215 (32)	201 (46)
R-40	414	373 (41)	184 (230)	362 (52)	146 (268)
R-60	174	153 (21)	104 (70)	154 (20)	82 (92)
Mobile / Transient	0	0	0	0	0
Multifamily	0	0	0	0	0
OS	125	125	125	61 (64)	61 (64)
COM¹	423	423	423	390 (33)	390 (33)
P¹	57	57	57	57	57
Total	1,916	1,709 (207)	1,616 (300)	1,636 (280)	1,227 (689)

COMMERCIAL FULL BUILD RESULTS

Alternative Scenarios ³

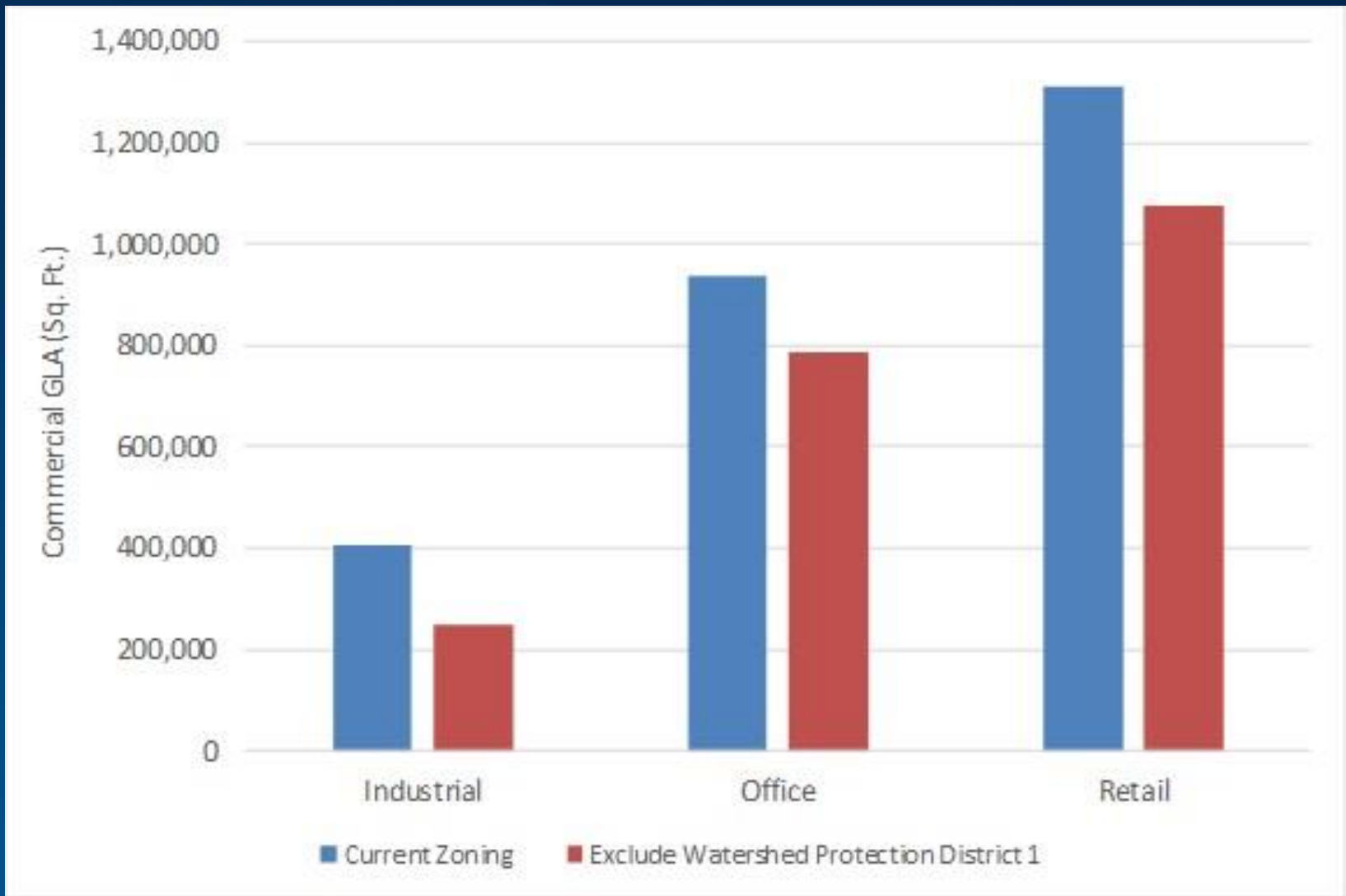
Zone ¹	Full-Build with Current Zoning	Exclude Marginal Lots ²	Re-zone R-40/R-60 to R-100 Zoning ²	Exclude Watershed Protection District 1	Implement All Alternatives ³
Industrial	406,241			249,676 (156,565)	249,676 (156,565)
Office	936,304			785,969 (150,335)	785,969 (150,335)
Retail	1,311,497			1,075,611 (235,886)	1,075,611 (235,886)
Total	2,654,042	-	-	2,111,256 (542,786)	2,111,256 (542,786)

1 Results for Residential development in mixed use category provided in Residential full-build results section.

2 Results for Exclude Marginal Lots and Re-zone R-40/R-60 to R-100 Zoning alternatives are unchanged for the Commercial full-build

3 Values in parentheses represent the reduction in additional commercial space from the full-build scenario

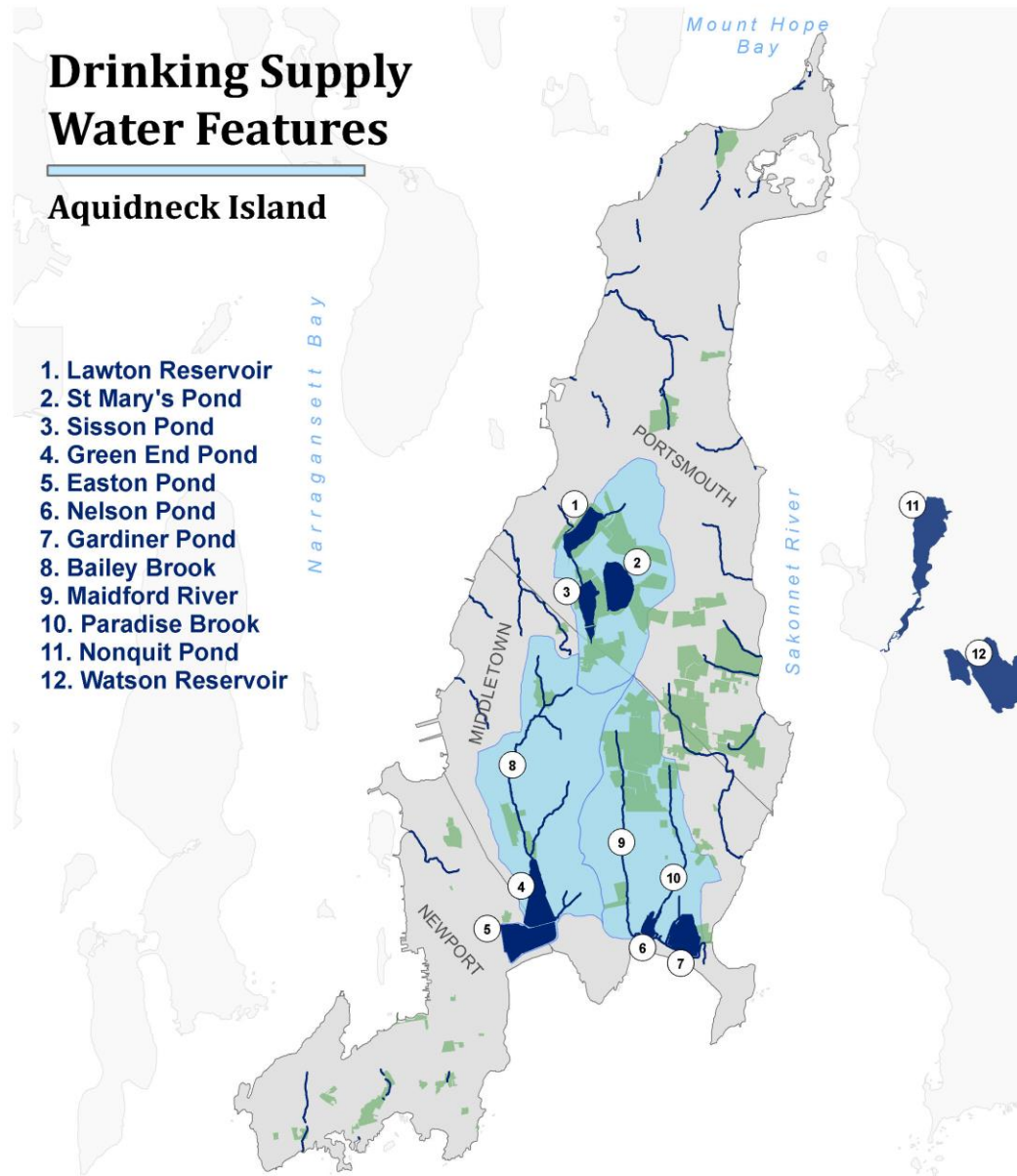
COMMERCIAL FULL BUILD RESULTS



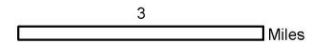
Drinking Supply Water Features

Aquidneck Island

1. Lawton Reservoir
2. St Mary's Pond
3. Sisson Pond
4. Green End Pond
5. Easton Pond
6. Nelson Pond
7. Gardiner Pond
8. Bailey Brook
9. Maidford River
10. Paradise Brook
11. Nonquit Pond
12. Watson Reservoir



- Streams
- Drinking Reservoirs
- Conserved by ALT



Sources: RIGIS Surface Water Protection Areas (edited), RIGIS 5K Streams, ALT Lands Database



SURFACE WATERSHEDS

Existing Impervious Coverage

<u>Watershed Name</u>	<u>HUC-12 Name</u>	<u>Area</u> (acres)	<u>Impervious Coverage</u> (%)
Upper East Passage	Upper East Passage	78	5.2%
Lower East Passage 1	Lower East Passage	1,455	20.1%
Sakonnet 2	Sakonnet River	2	7.7%
Sakonnet 1 (Little Creek)	Sakonnet River	880	7.9%
Lower East Passage 2	Lower East Passage	193	44.5%
Bailey (Brook)	Aquidneck Island – Frontal Atlantic Ocean	2,492	25.2%
Maidford (River)	Sakonnet River	1,498	9.2%
Paradise (Brook)	Sakonnet River	525	5.2%
Gardiner (Pond)	Sakonnet River	146	0.9%
Lower Maidford (River)	Sakonnet River	592	5.8%
Atlantic 1	Aquidneck Island – Frontal Atlantic Ocean	105	40.7%
Atlantic 2	Aquidneck Island – Frontal Atlantic Ocean	386	26.5%

SURFACE WATERSHEDS

Existing Water Quality Impairments

Waterbody

Little Creek ²

Enterococcus

Gardiner Pond (Paradise Brook; Maidford River)

Total Phosphorous (TP), Total Organic Carbon (TOC), Other flow regime alterations

Paradise Brook

Fecal Coliform (FC), Total Phosphorous, Turbidity

Nelson Pond (Paradise Brook; Maidford River)

Total Phosphorous, Total Organic Carbon, Other flow regime alterations

Maidord River, headwaters to water supply diversion

Benthic-Macroinvertebrate Bioassessments (MIB), Lead (Pb), Fecal Coliform, Total Phosphorus, Turbidity

Maidford River, water supply diversion to Hanging Rock Rd

Fecal Coliform

Baileys Brook and tributaries

Lead, Enterococcus, Total Phosphorus

North Easton Pond (Green End Pond) (Bailey's Brook)

Total Phosphorus, Chlorophyll-a (Chlor-A), Other flow regime alterations, Total Organic Carbon

South Easton Pond (Bailey's Brook)

Total Phosphorus, Total Organic Carbon

Sisson Pond (Portsmouth)

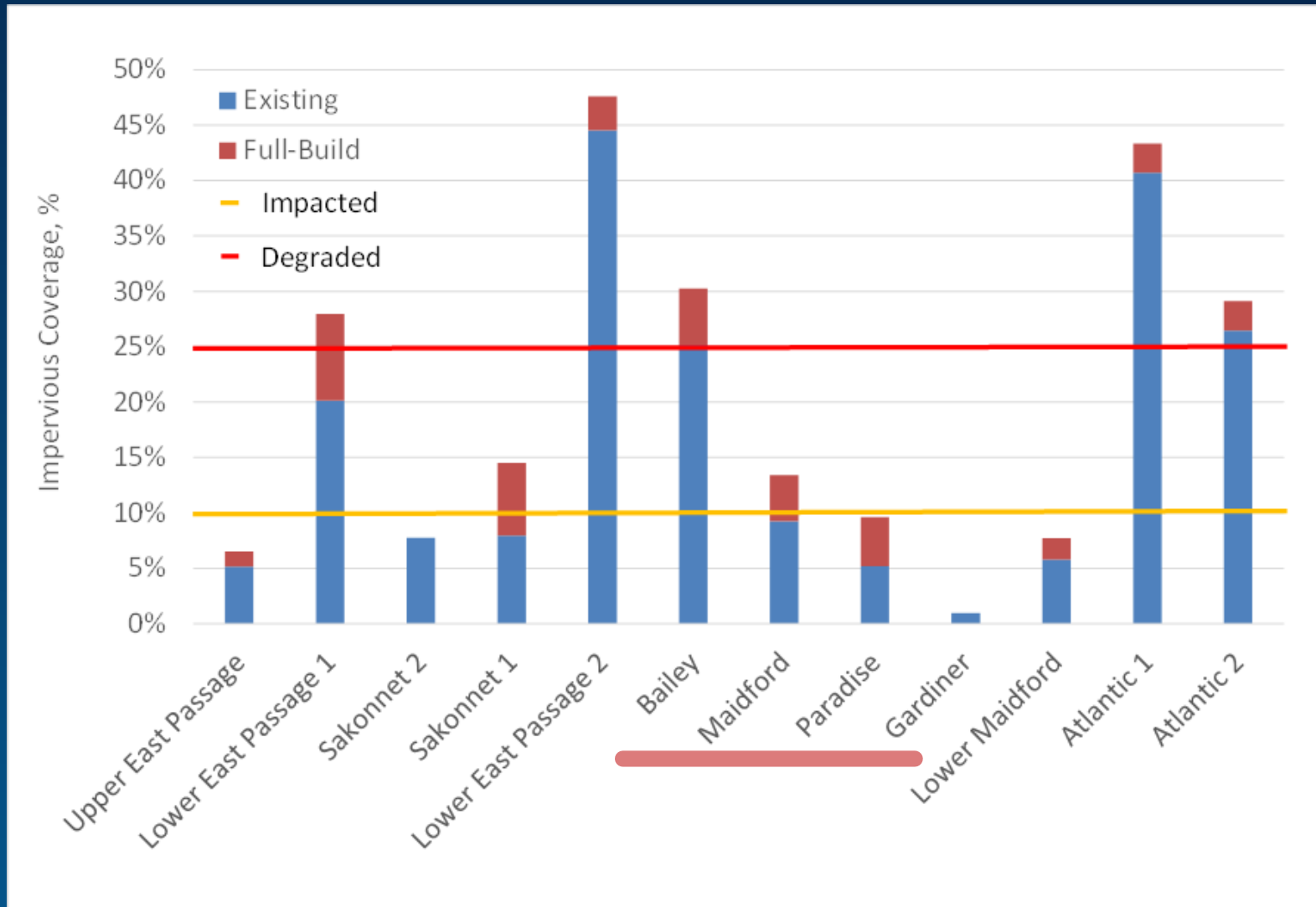
Total Phosphorus, Total Organic Carbon, Other flow regime alterations

Coddington Cove, breakwater to Coddington Point ³

Sediment Bioassays (SB) for Estuarine and Marine Waters

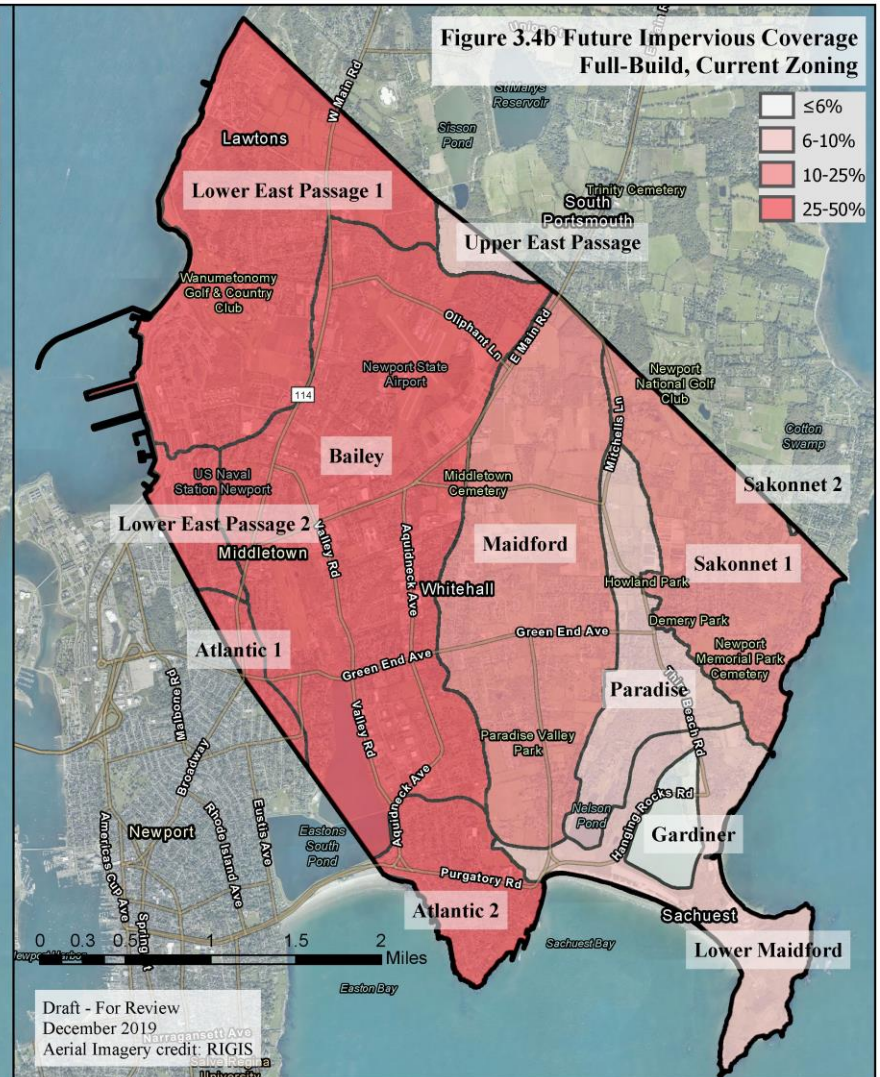
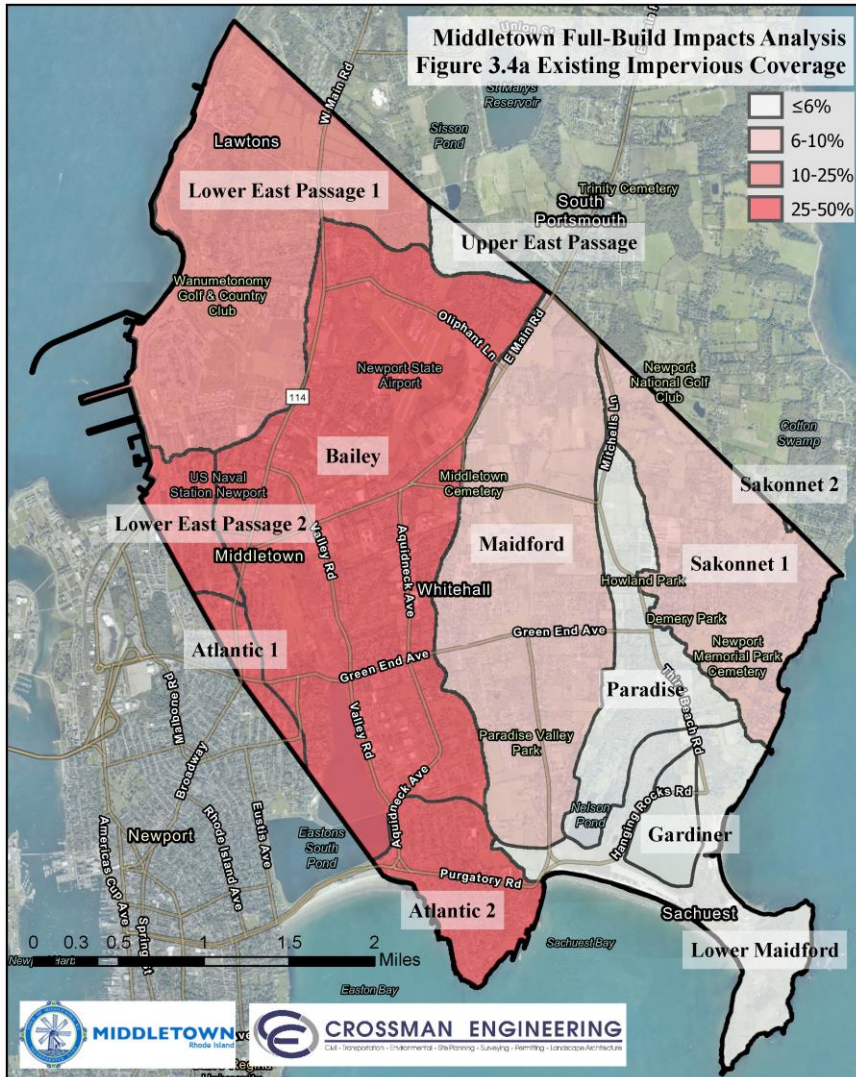
SURFACE WATER IMPACTS

Impervious Coverage with Full Build



SURFACE WATER IMPACTS

Impervious Coverage Full Build



SURFACE WATER IMPACTS

Pollutant Loading Factors

	Total Nitrogen	Total Phosphorus ²	Total Suspended Solids	Fecal Coliform	Lead	Copper
Residential	2.1 ¹	0.30	100	7,000	0.012	0.005
Commercial	2.1	0.20	75	4,600	0.018	0.096
Industrial	2.1	0.25	75	2,400	0.026	0.002
Transportation	2.3	0.25	150	1,700	0.035	0.001
Agricultural	2.85 ³	0.50	100	300 ⁴	0	0
Mining	2.1	0.25	150 ⁵	2,400 ⁶	0.035 ⁷	0.096 ⁷
Undeveloped	1.7	0.10	50	300	0	0

1 Values for all parameters in mg/L except Fecal Coliform (colonies / 100 mL);

2 Values for phosphorus from RIDEM (2015) and from EPA (2014) for Charles River TMDL study, Massachusetts;

3 Nitrate value for agricultural land use estimated from general literature review

4 Fecal Coliform value for agricultural land use based on agricultural study in Texas; value reflects crop agriculture use

5 Value estimated for mining land use based on assumption of moderate losses from exposed soils.

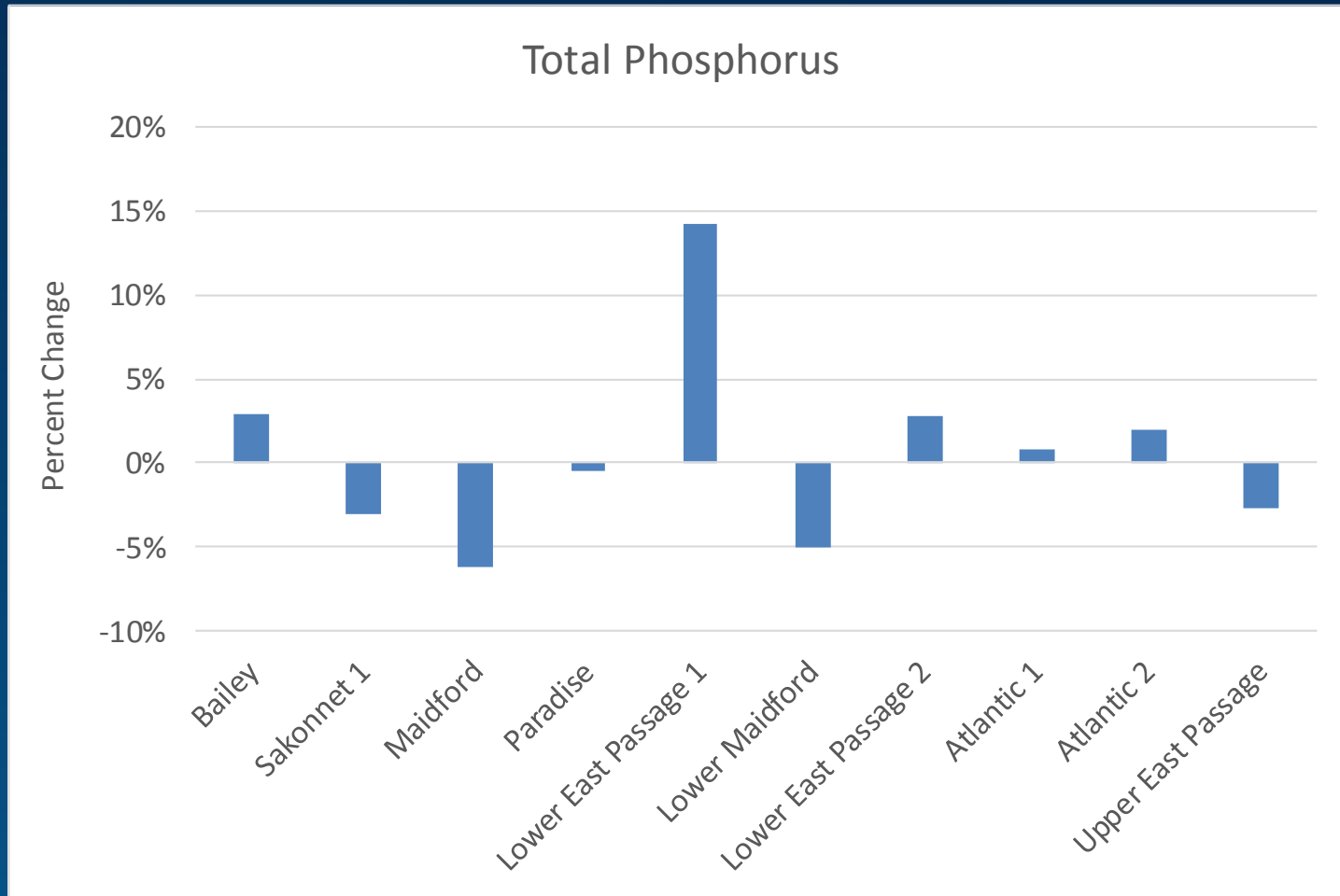
6 Fecal Coliform value for mining land use assumed equivalent to industrial land use;

7 Lead and Copper values for mining land use assumed equivalent to highest value for other land uses assuming exposure of metals in mined material.



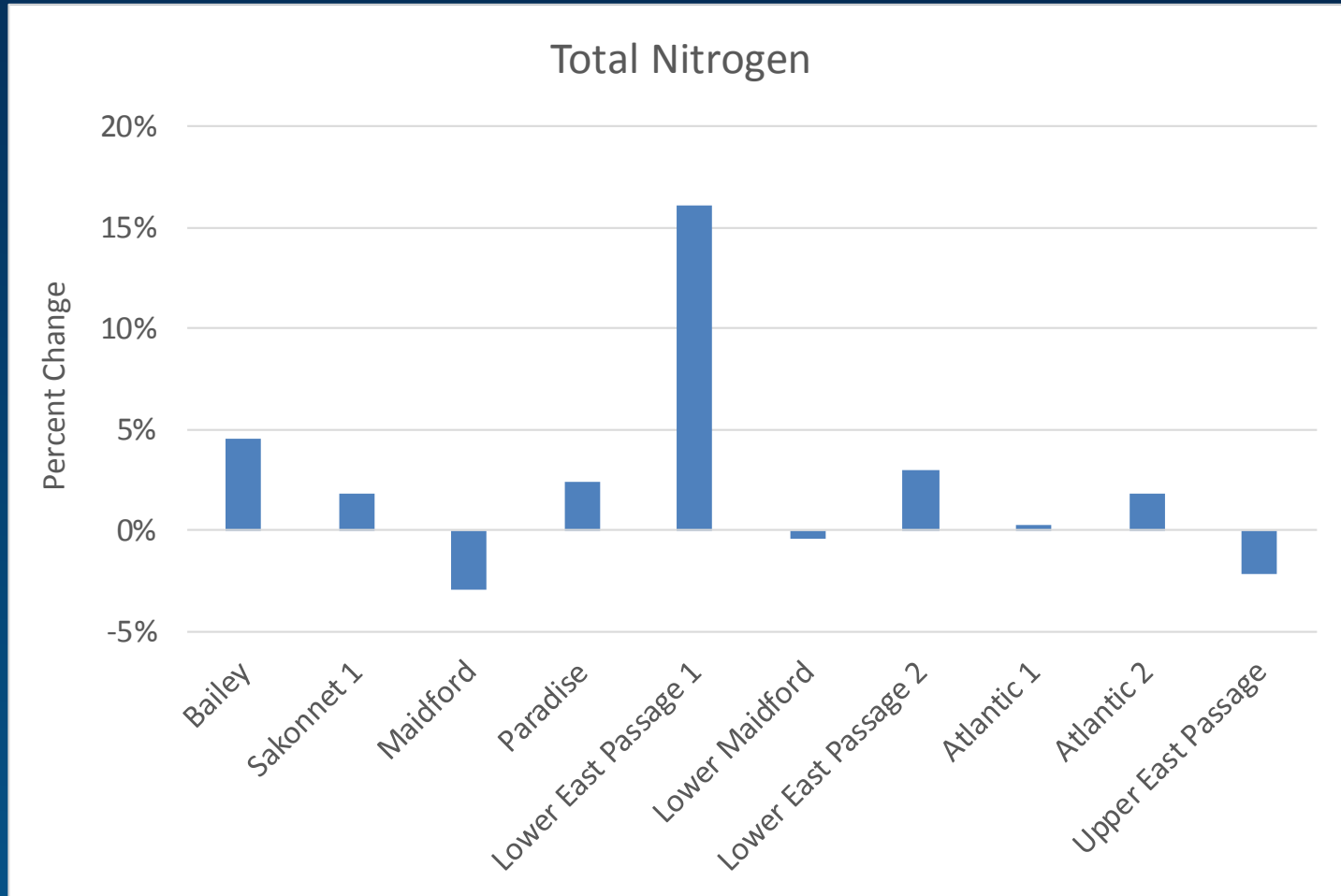
SURFACE WATER IMPACTS

Pollutant Loading Impacts



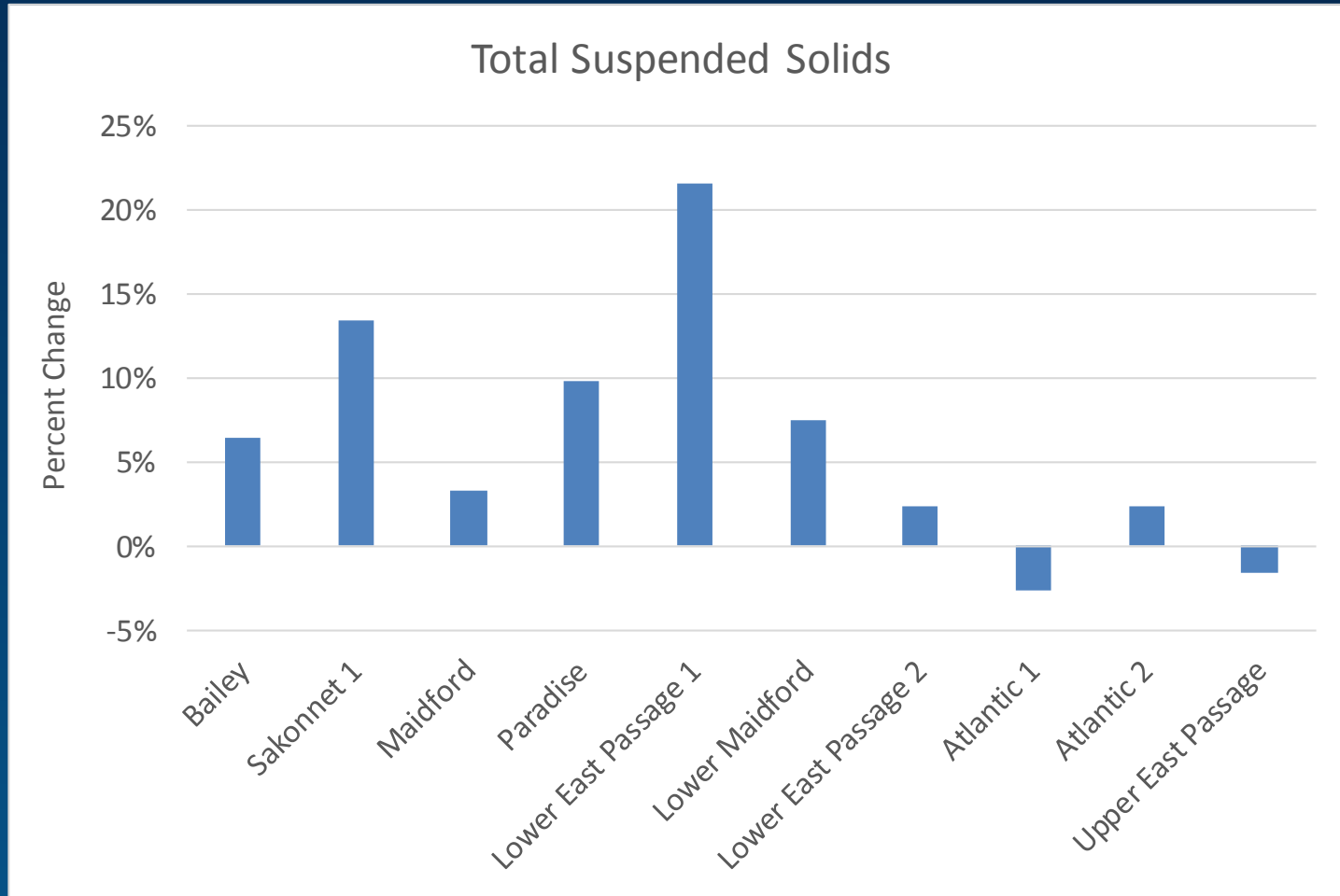
SURFACE WATER IMPACTS

Pollutant Loading Impacts



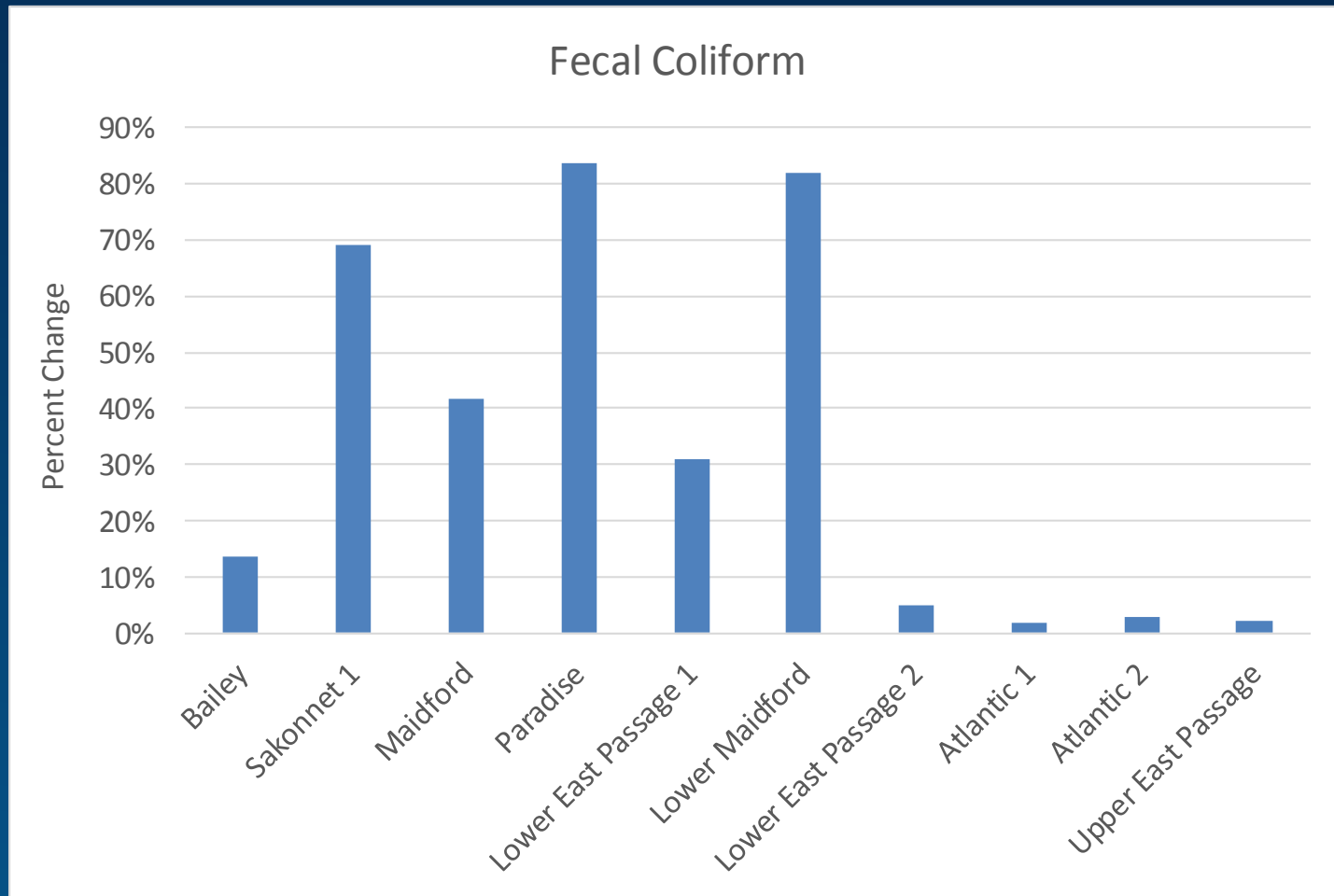
SURFACE WATER IMPACTS

Pollutant Loading Impacts



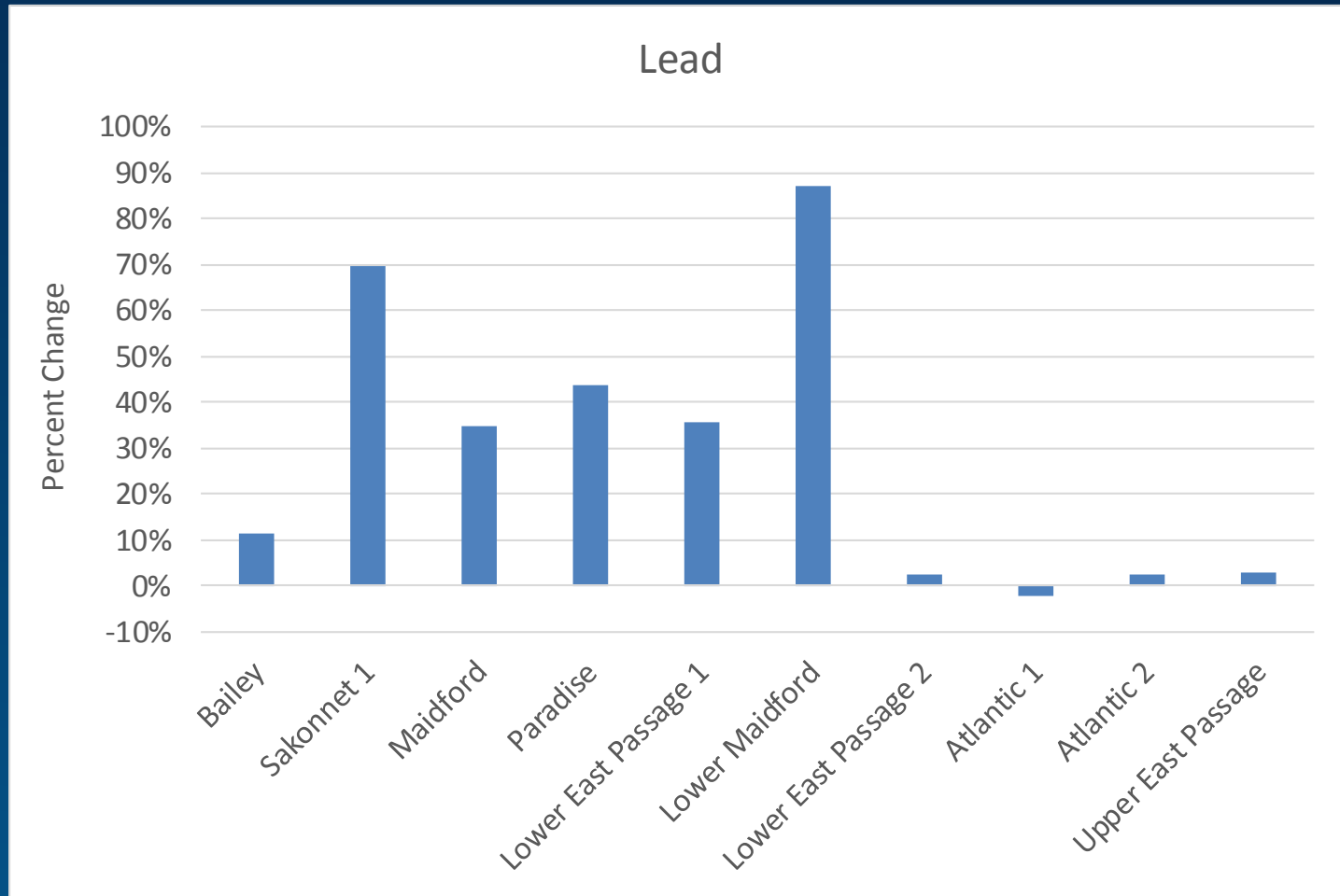
SURFACE WATER IMPACTS

Pollutant Loading Impacts



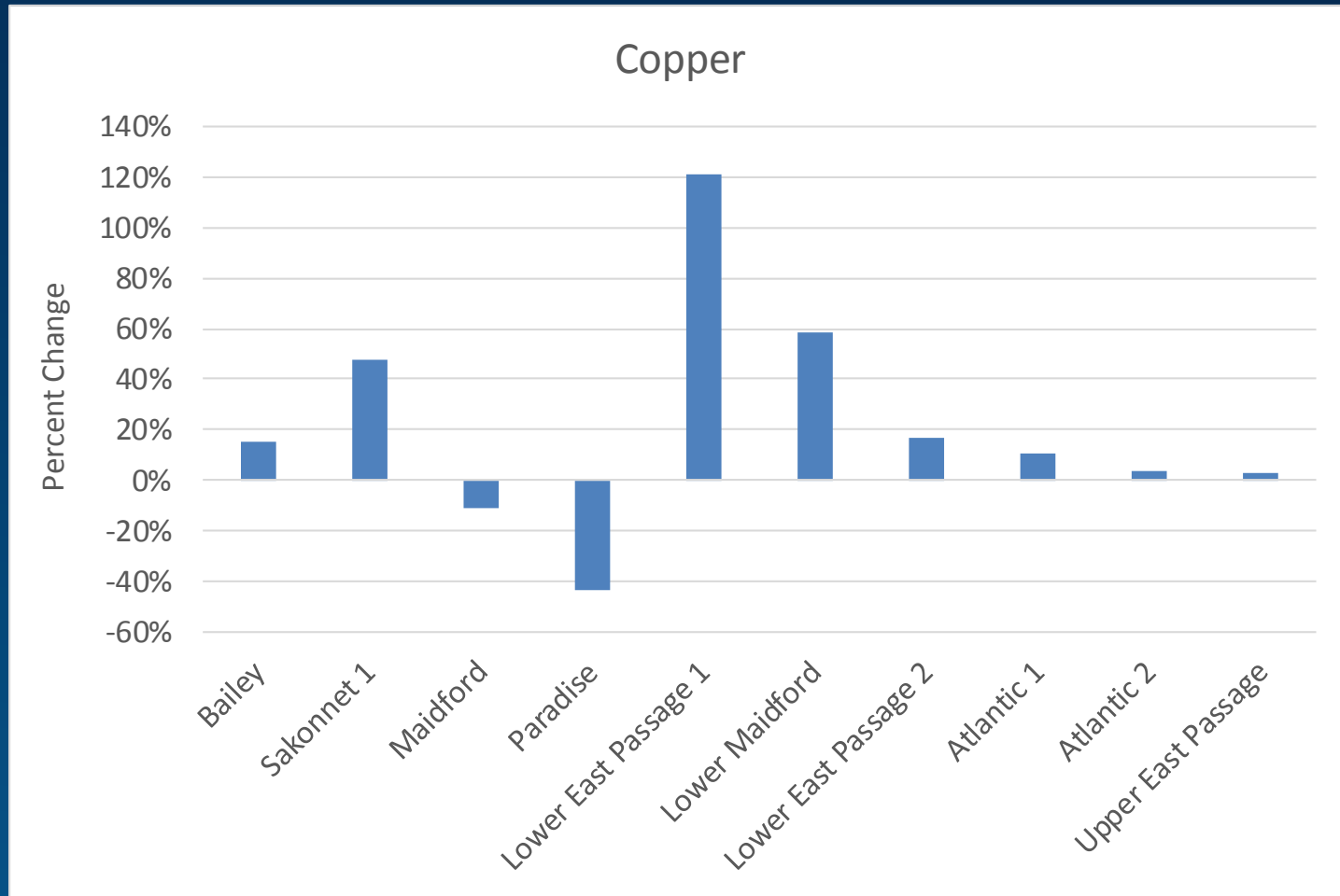
SURFACE WATER IMPACTS

Pollutant Loading Impacts



SURFACE WATER IMPACTS

Pollutant Loading Impacts



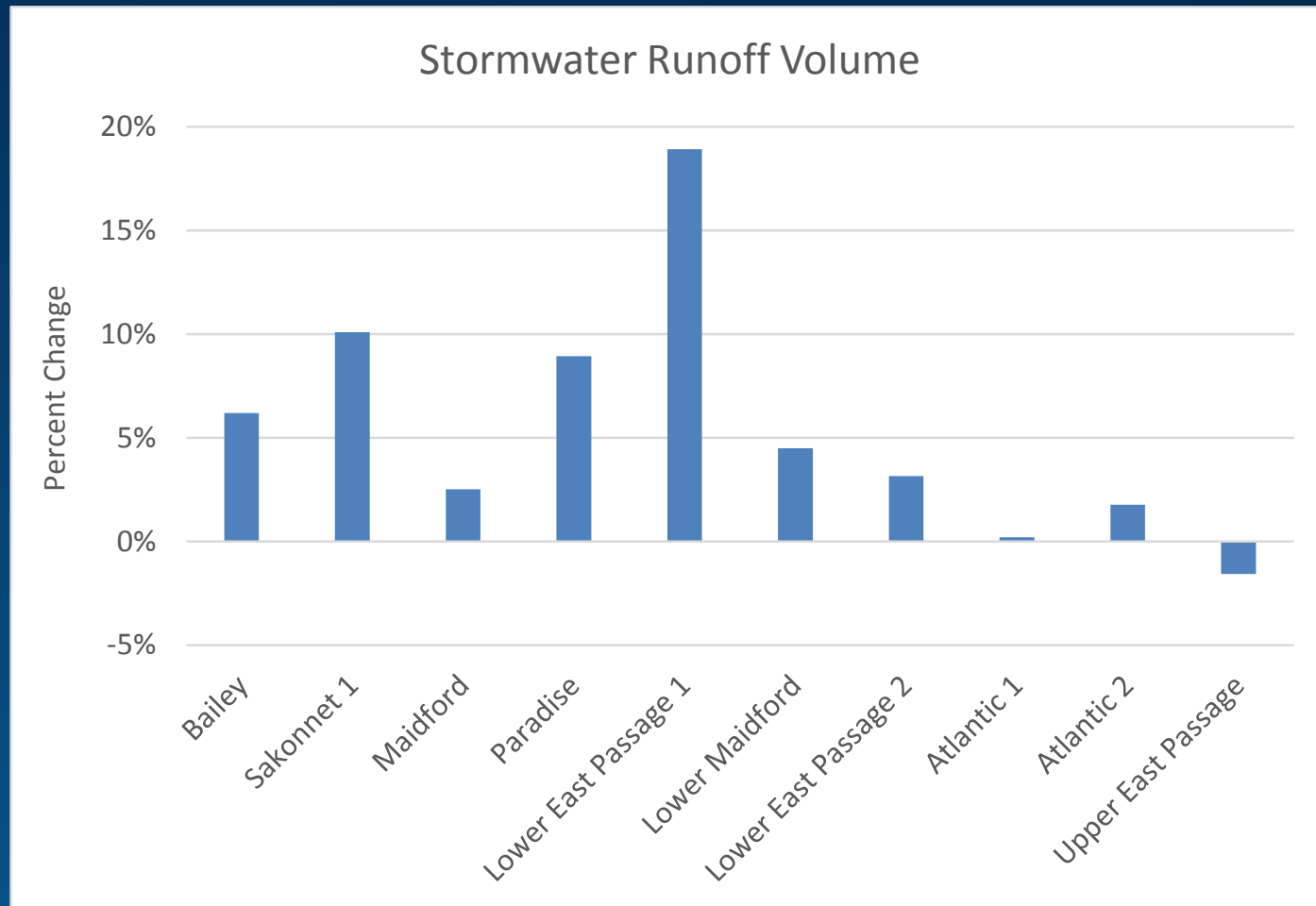
SURFACE WATER IMPACTS

RI Stormwater Manual Standard Treatment Performance

- Treatment of first 1 inch of runoff from new impervious areas
- Standard Treatment Goals of RISDISM
 - 85% removal for Total Suspended Solids
 - 30% removal for Nitrogen or Phosphorus
 - 60% removal for pathogens (e.g., fecal coliform)

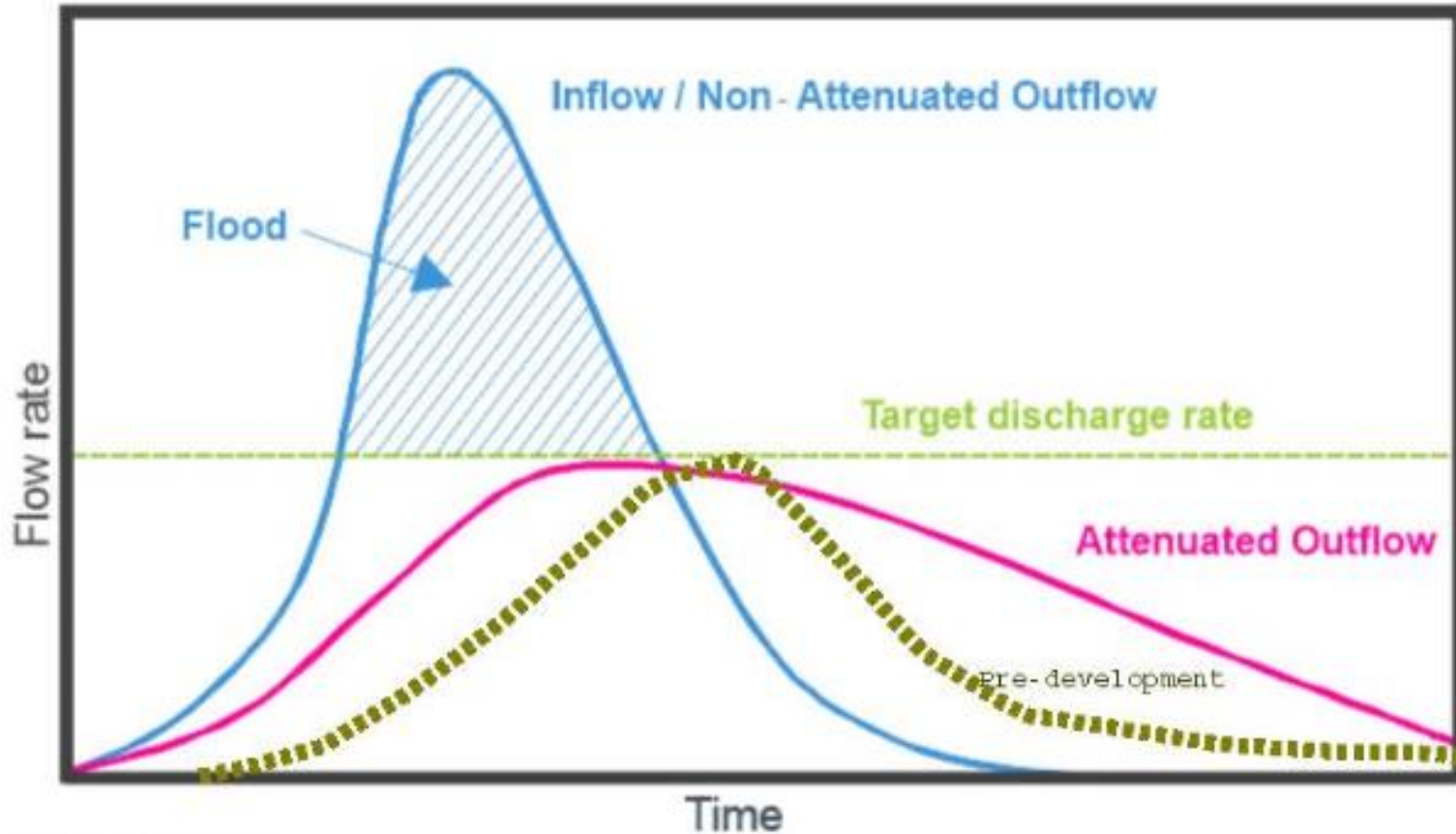
SURFACE WATER IMPACTS

Pollutant Loading Impacts – Change in Runoff



SURFACE WATER IMPACTS

Storm Event - Change in Runoff Pattern



Simple Hydrograph

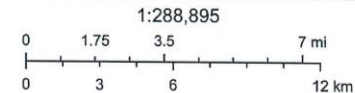
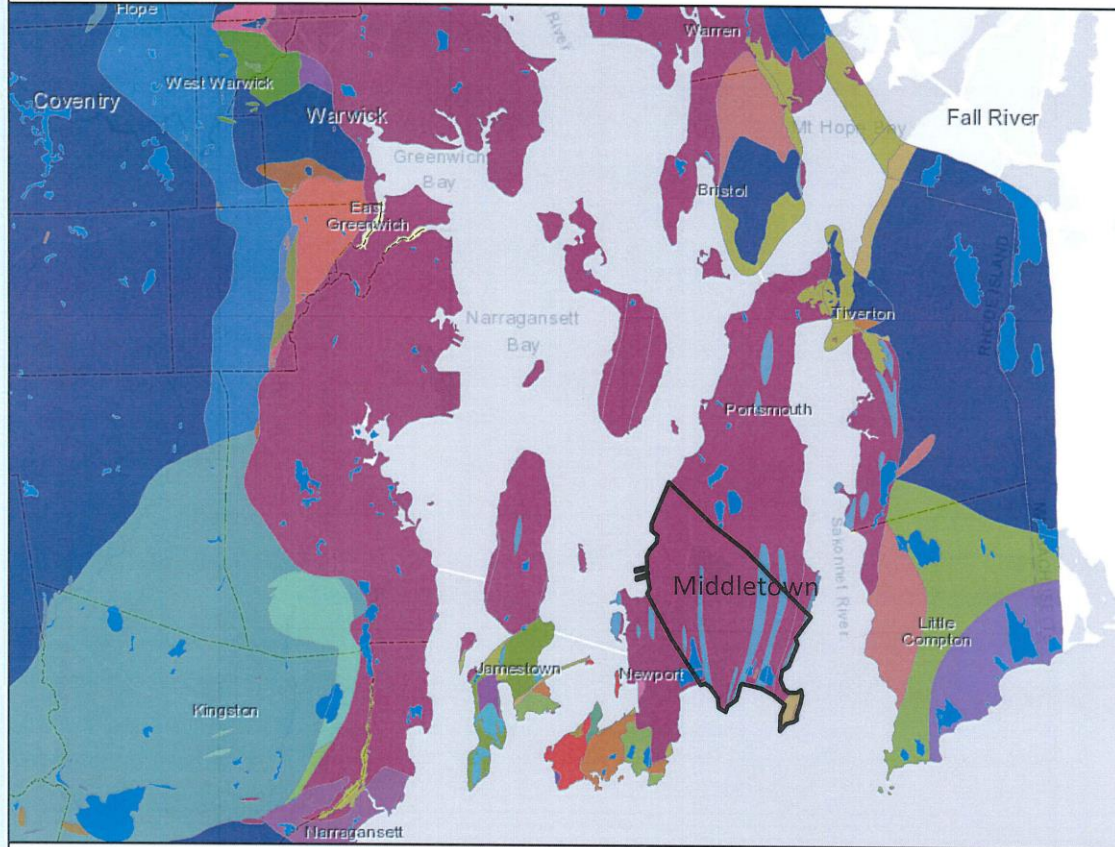
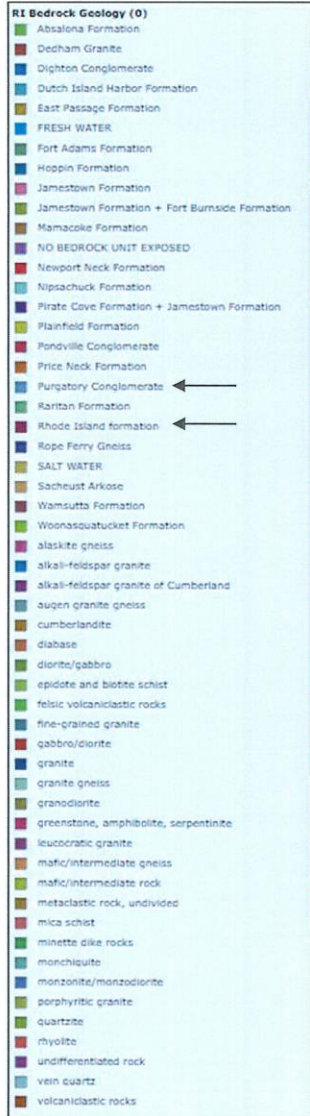
SURFACE WATER IMPACTS

Recommendations

1. Continue to encourage low impact development (LID) development strategies that minimize impervious area creation.
2. Recognize that designs based upon current standards do not fully remove pollutants of concern and identify specific stormwater treatment systems and pollutant removal efficiencies that should be required to mitigate pollutants of concern for each watershed for new development and redevelopment. Update the Town Stormwater Ordinance accordingly.
3. Promote source reduction (stormwater recharge/infiltration) strategies to reduce stormwater discharge from new development.
4. Establish a Fertilizer Nutrient Control Ordinance to minimize excess nitrogen and phosphorous loadings from existing and new development.
5. Establish routine water quality testing of Town stormwater systems to assist in the identification of existing pollutant sources. Identify significant pollutant sources and work towards implementation of improvements.
6. Identify streams and waterways that experience erosion (sediment transport) for permanent stabilization projects.
7. Identify opportunities to improve discharge of existing development through retrofit of existing stormwater systems.
8. Expand public educational measures to improve awareness of consequences of actions on water quality.
9. Evaluate the feasibility of establishing a Town Stormwater Utility for improved operations, maintenance and performance of current and future stormwater systems.

GROUNDWATER RESOURCES

Figure 4.1 Bedrock Geology for eastern Rhode Island



Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user

GROUNDWATER RESOURCES

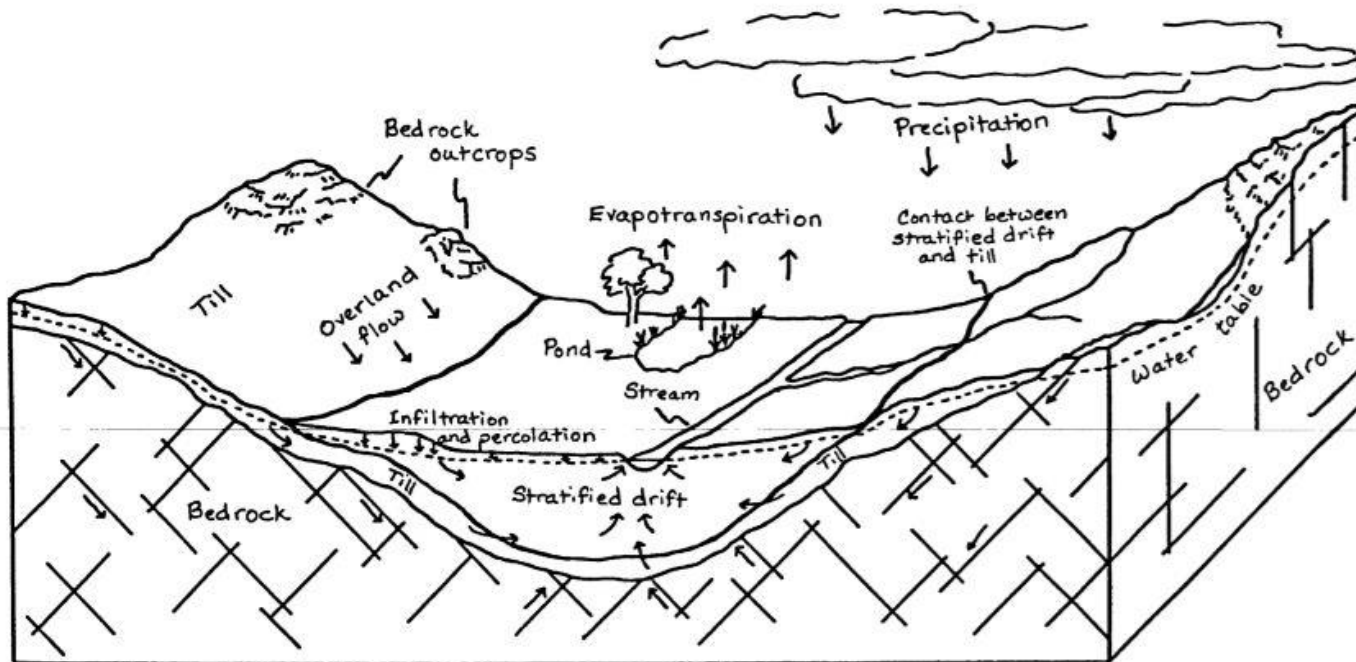
RIDOH Well Data



- 100 records for wells installed between 1972 to 2018
- Average depth to bedrock is 18 feet (range 4 feet to 60 feet)
- The 90th percentile is 522 feet
- Average well depth 340 feet
- Well Yield varied: 7.8 average gpm

GROUNDWATER RESOURCES

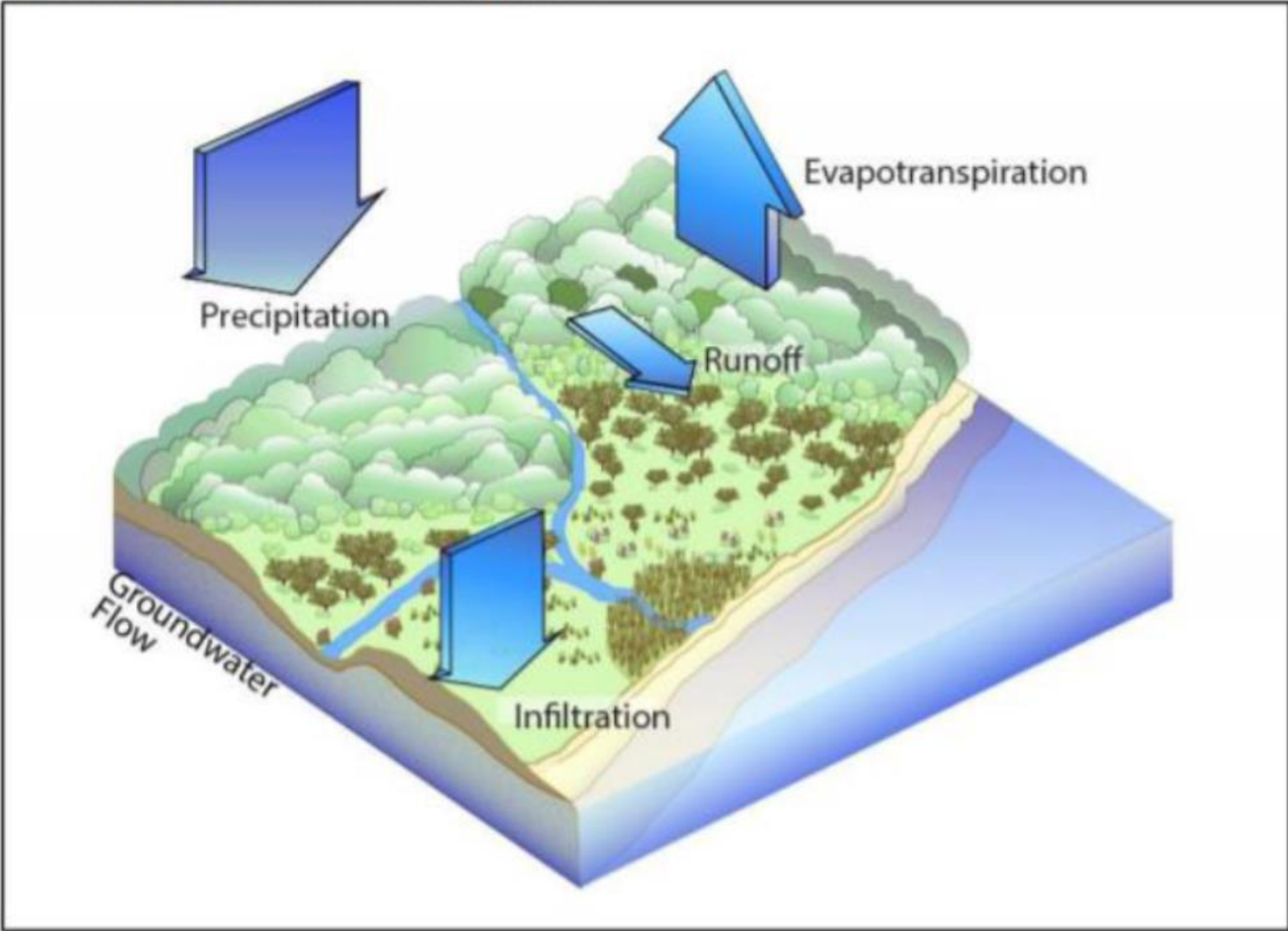
Groundwater behavior in glaciated terrain



Not to scale

Figure 9.--Typical hydrogeologic setting in glaciated terrain. Unconsolidated glacial deposits overlie fractured bedrock. Till blankets the bedrock surface and is exposed at the land surface in upland areas. Till generally underlies the stratified drift that fills bedrock valleys. Arrows indicate directions of flow or movement of water and water vapor. (Source: Modified from Trench and Morrissey, 1985, p. 4, fig. 1.)

Hydrologic Cycle – Pre-development



GROUNDWATER RESOURCES

Groundwater recharge and use

$$P = Q + ET + R + \Delta S$$

P = Annual Precipitation = 46 inches

Q = Surface Discharge from Watershed

ET = Annual Evapotranspiration = 20.5 inches

R = Recharge = 9 to 12 inches into till (Trench, 1991)

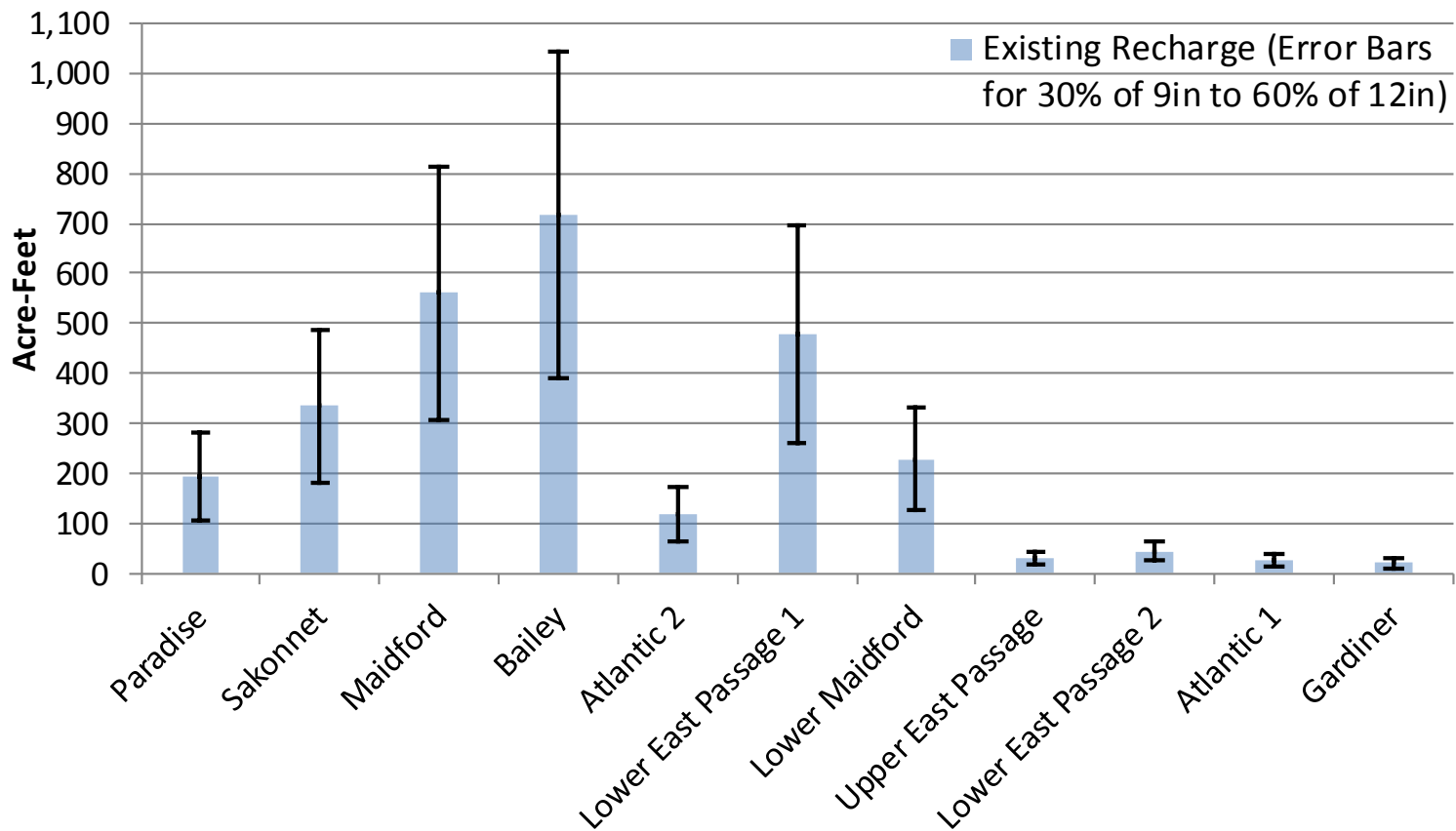
ΔS = Change in Storage volume

Low annual bedrock recharge = 30% x 9 inches = 3 inches

High annual bedrock recharge = 60% x 12 inches = 7 inches

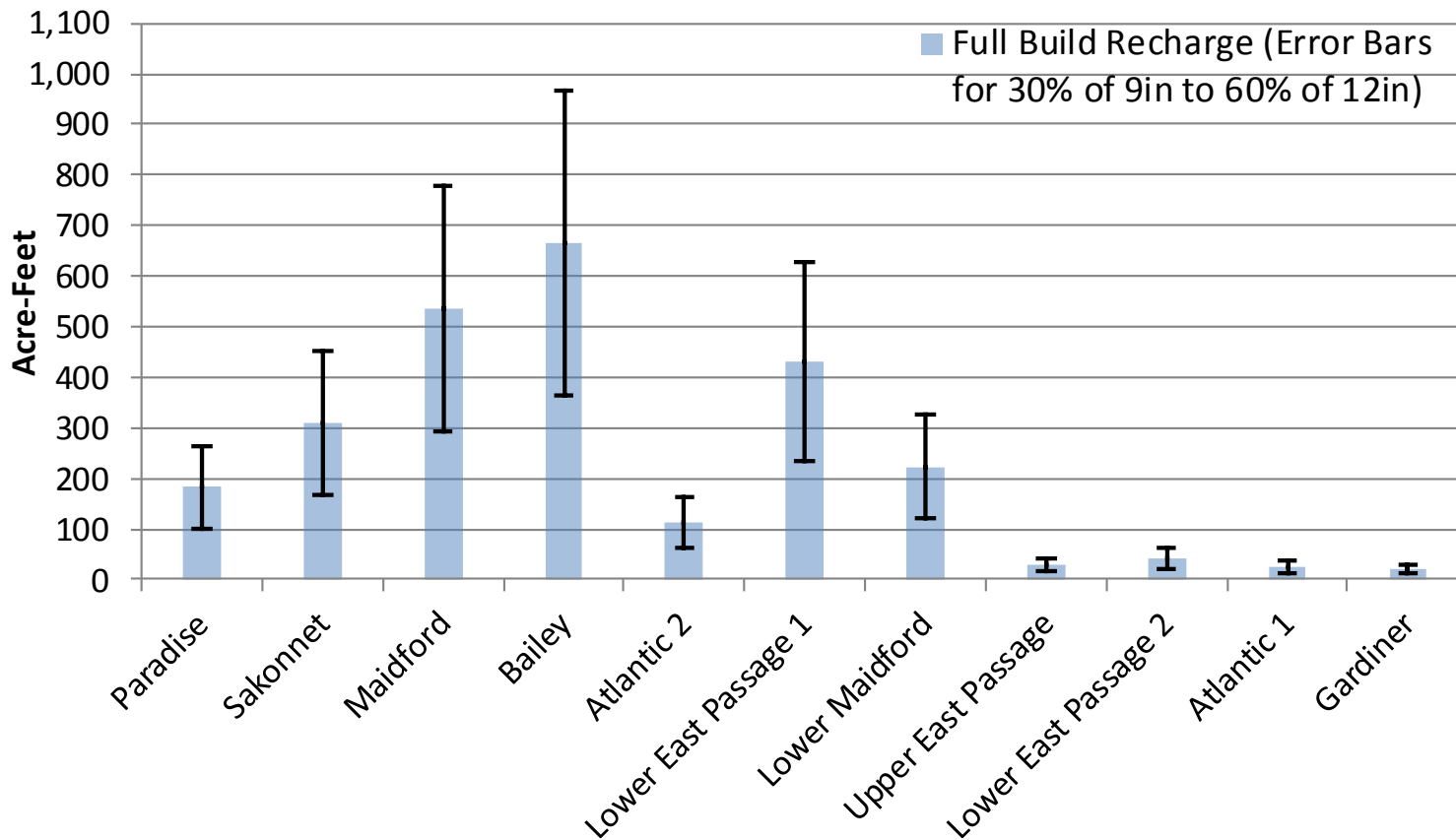
GROUNDWATER RESOURCES

Bedrock Annual Recharge (Existing)

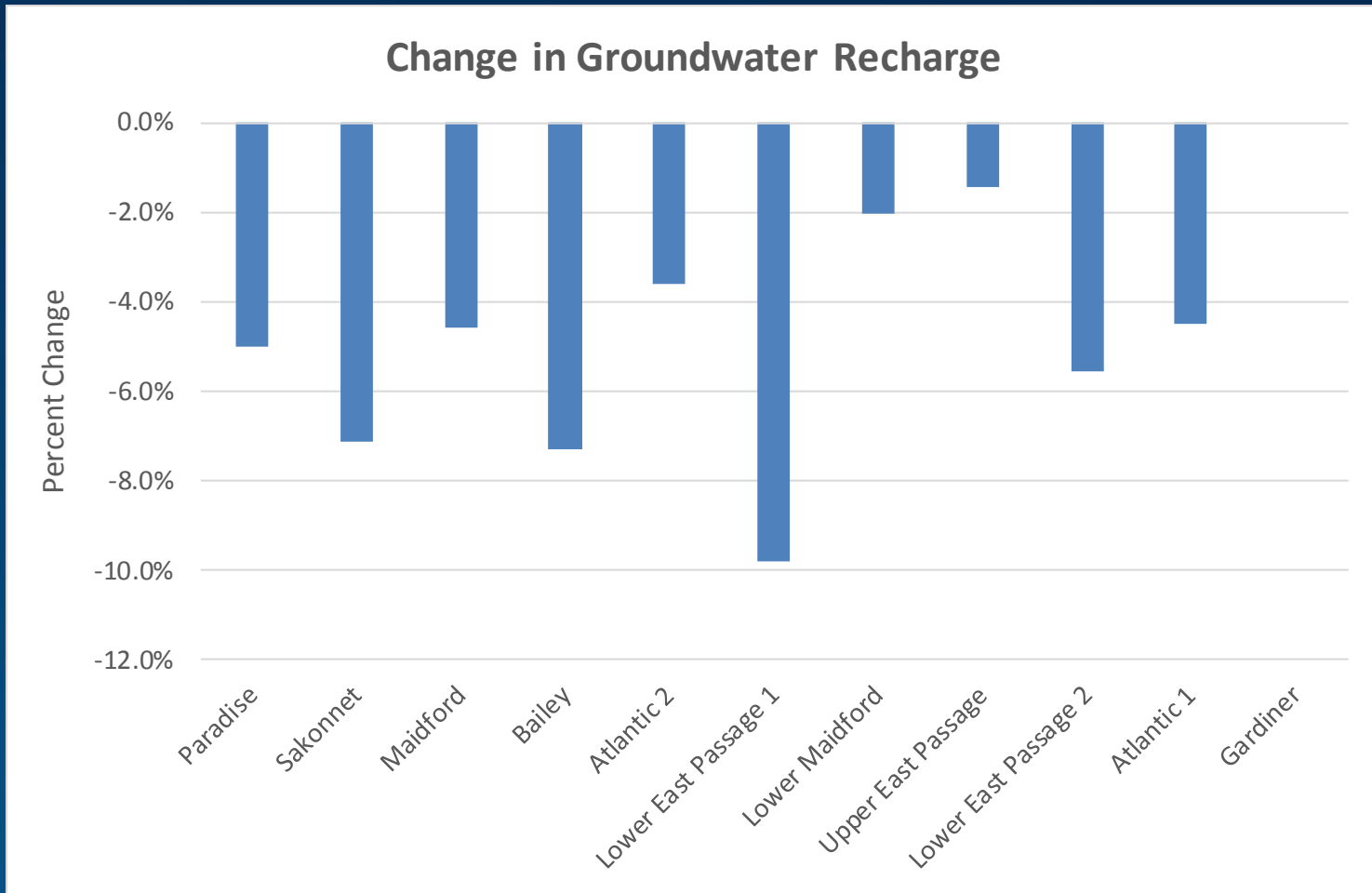


GROUNDWATER IMPACTS

Bedrock Annual Recharge (Full-Build, Current Zoning)



GROUNDWATER IMPACTS



GROUNDWATER RESOURCES

RI Stormwater Manual Recharge Standard (RIDEM, 2015)

$$Re = (1 \text{ inch} \times F \times I) / 12$$

Re = Required Recharge Volume (acre-feet)

F = Recharge factor based on soils

I = New Impervious Surface Area (acres)

Soil Type	F
A	0.60
B	0.35
C	0.25
D	0.10

Value of one (1) refers to the runoff from impervious area in inches from a storm with 1.2 inches of precipitation, referred to as the Water Quality storm

GROUNDWATER IMPACTS

Groundwater Domestic Use

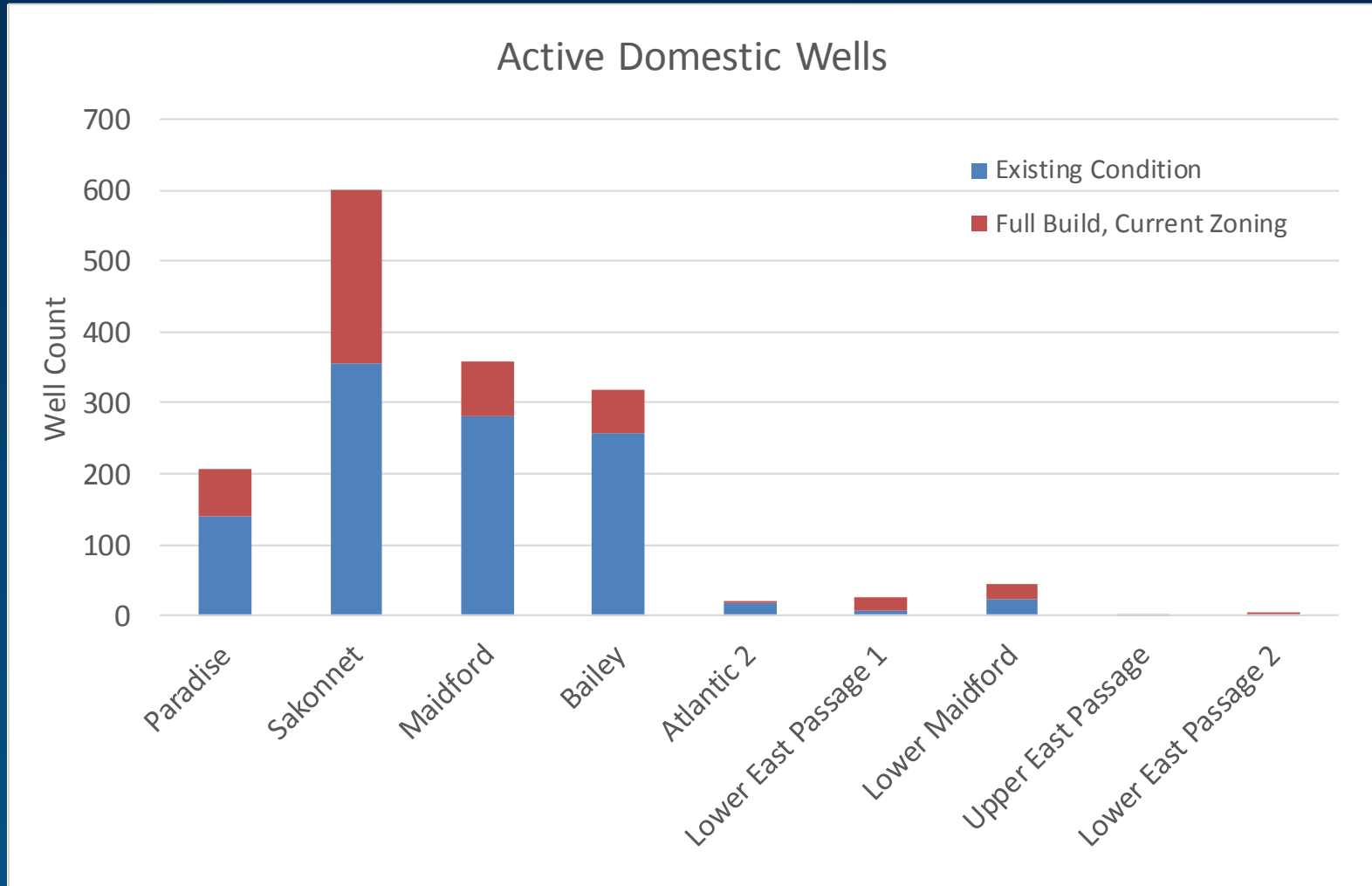
Low annual water use =

$$\begin{aligned} & 2.5 \text{ persons} \times 42 \text{ GPCD} \times 365 \text{ days per year} \\ & = 38,325 \text{ gallons/residence} \end{aligned}$$

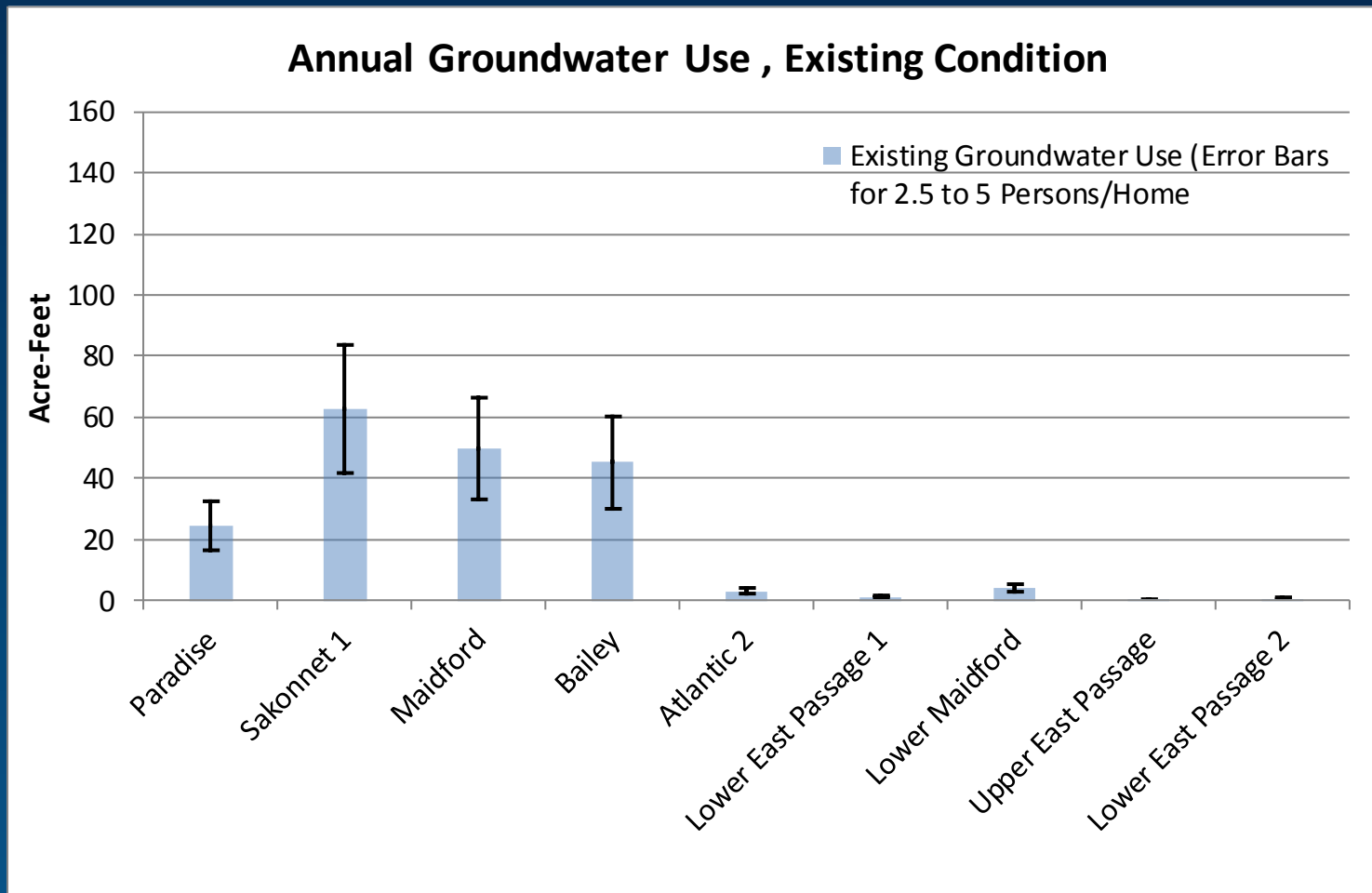
High annual water use =

$$\begin{aligned} & 5 \text{ persons} \times 42 \text{ GPCD} \times 365 \text{ days per year} \\ & = 76,650 \text{ gallons/residence} \end{aligned}$$

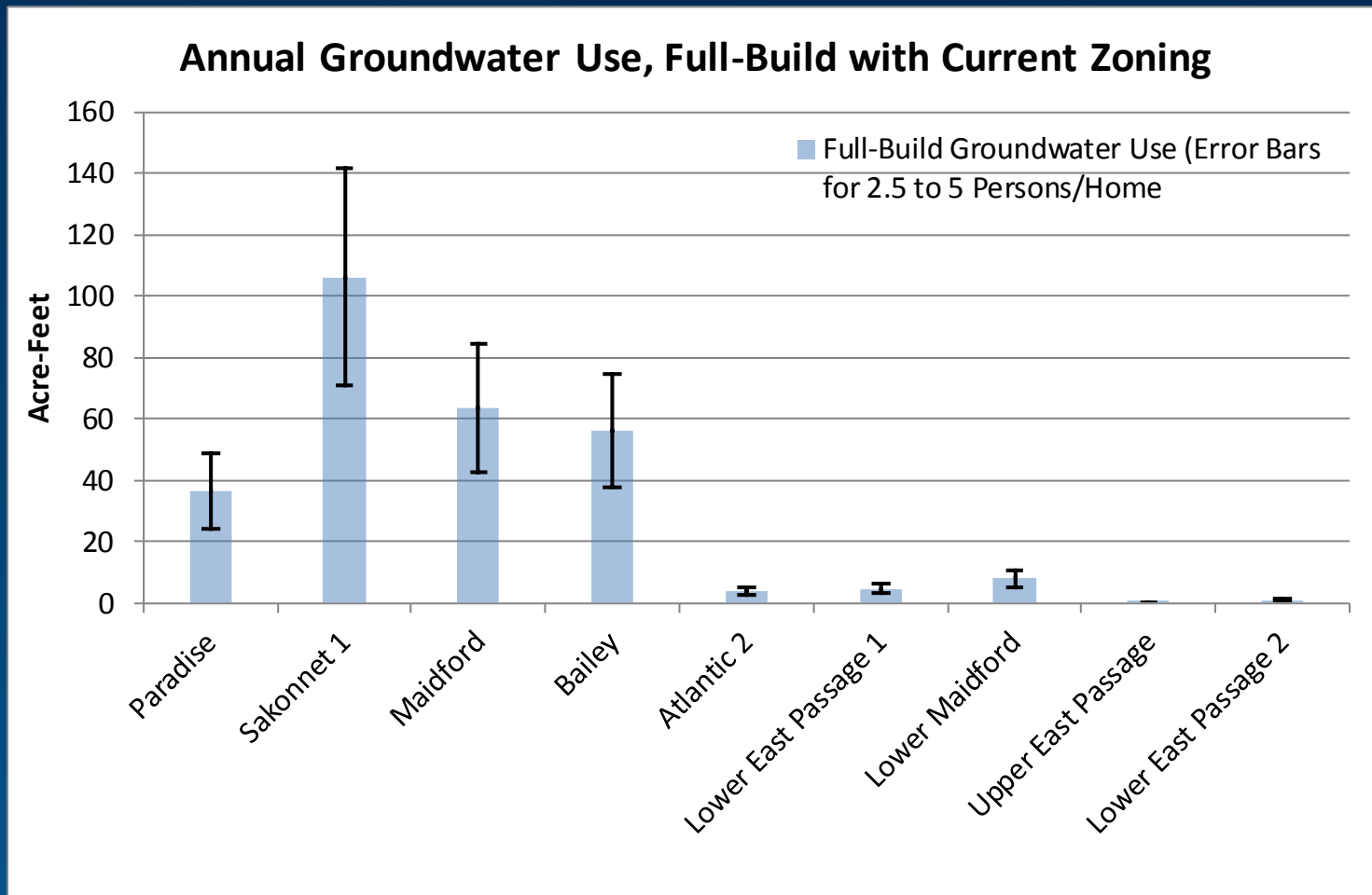
GROUNDWATER IMPACTS



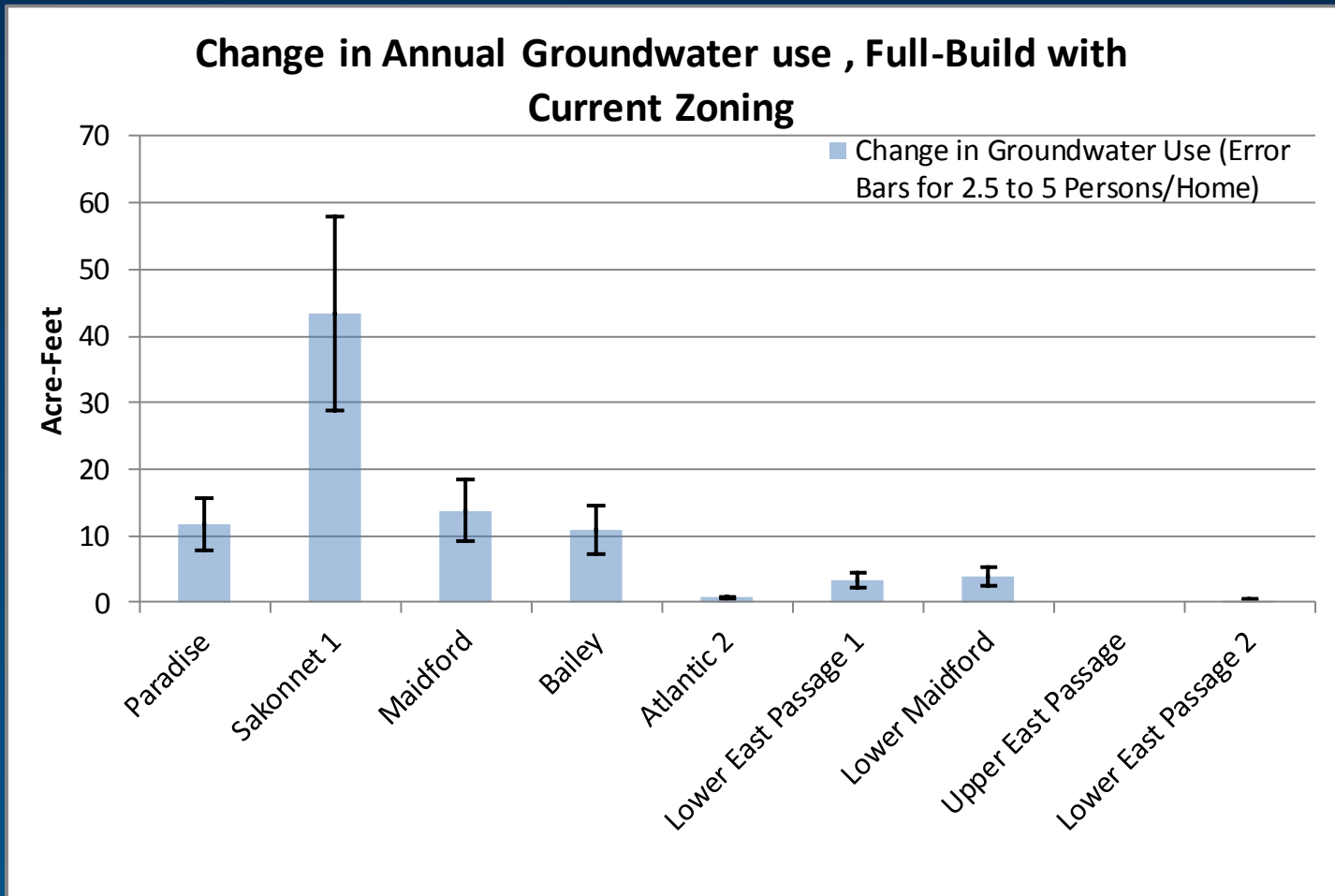
GROUNDWATER IMPACTS



GROUNDWATER IMPACTS



GROUNDWATER IMPACTS



GROUNDWATER IMPACTS

Groundwater Budget

Future estimated recharge 1,400 to 3,740 acre-feet

Future estimated domestic well water use 190 to 370 acre-feet

Note: Not all recharge is available due to fissure network.

*Excludes Irrigation and other non-domestic water uses

*Seasonal variability in water table may create temporal shortfalls in water supply

GROUNDWATER IMPACTS

Conceptual Lot Size Requirements, Domestic Water Supply



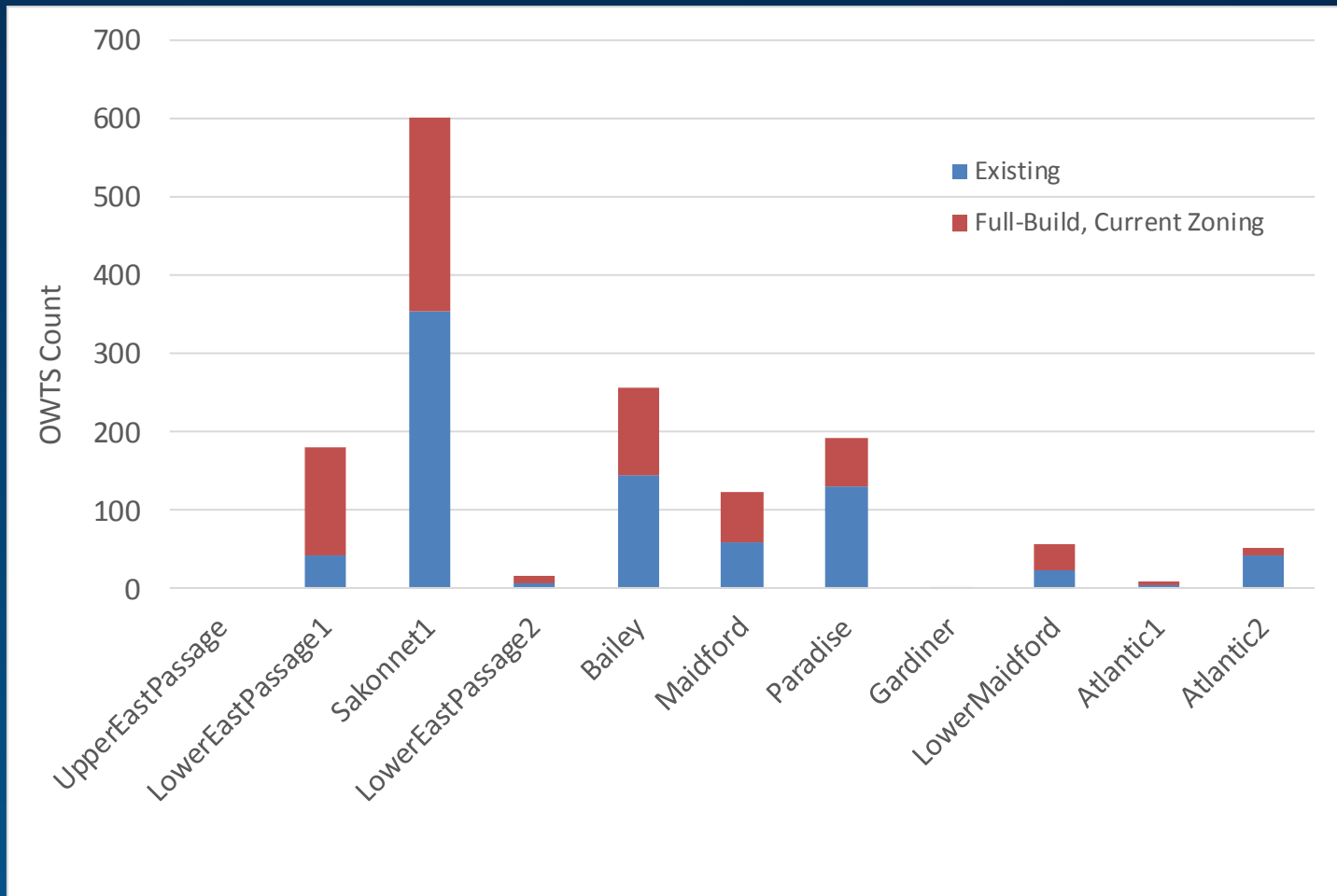
House Size	Annual Water Demand (acre-feet)	Lot size (square feet)	
		60% of 12" Till Recharge	30% of 9" Till Recharge
2 Persons/Home ¹	0.09	10,000	20,000
5 Persons/Home ¹	0.24	20,000	60,000
3-Bedroom Home ²	0.39	40,000	90,000
4-Bedroom Home ²	0.52	50,000	110,000

¹ Water use modeled at 42 gallons per person per day (GPCD) (low estimate)

² Water use modeled at 115 gallons per bedroom per day (high estimate)

GROUNDWATER IMPACTS

Groundwater Quality – On-site Wastewater Treatment Systems

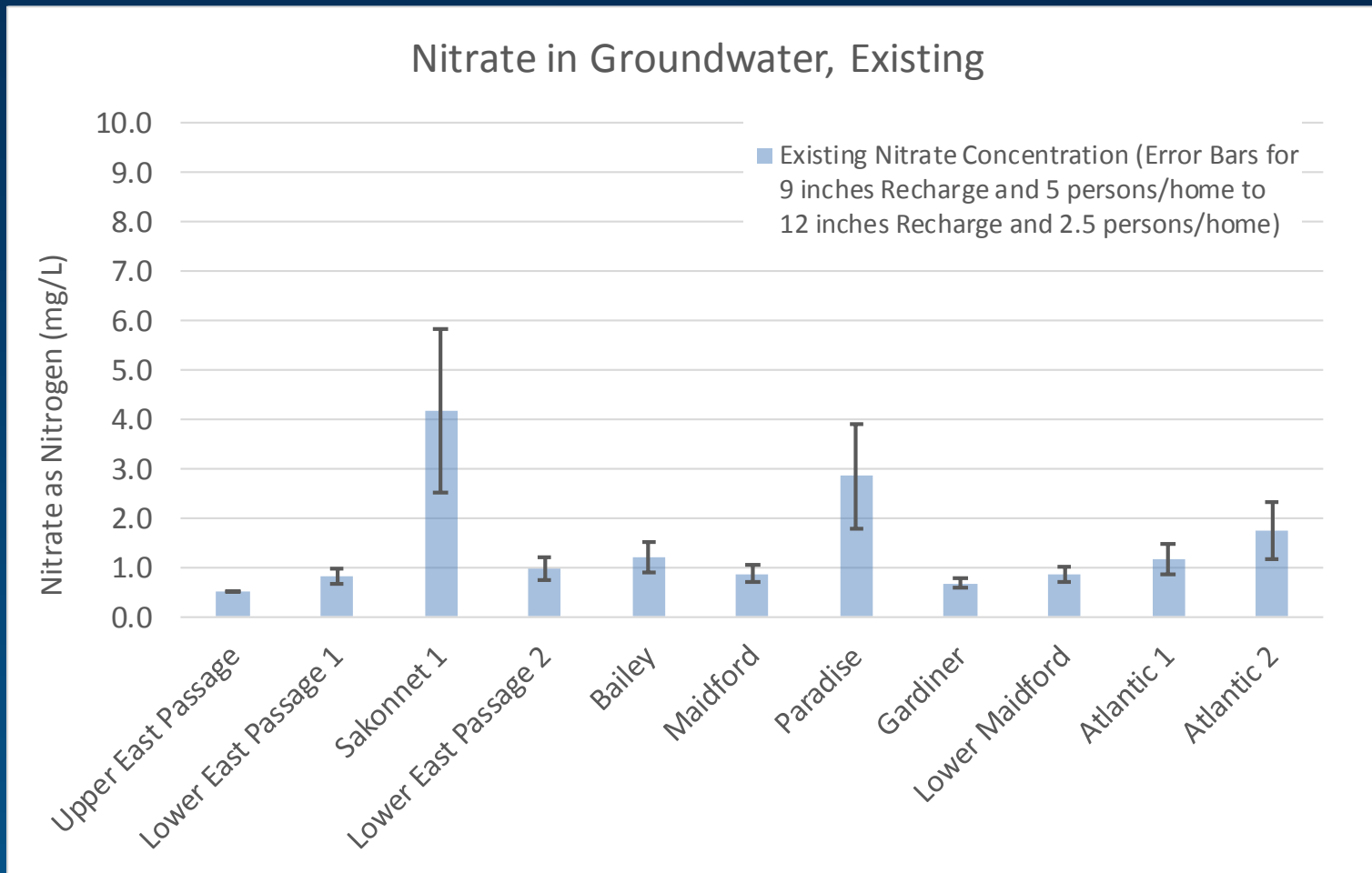


Groundwater Impacts – Nitrate Budget

<u>Nitrate (mg/L)</u>	<u>Category</u>
1	Elevated
5	RI Preventative Action Limit
10	Federal Drinking Water Standard

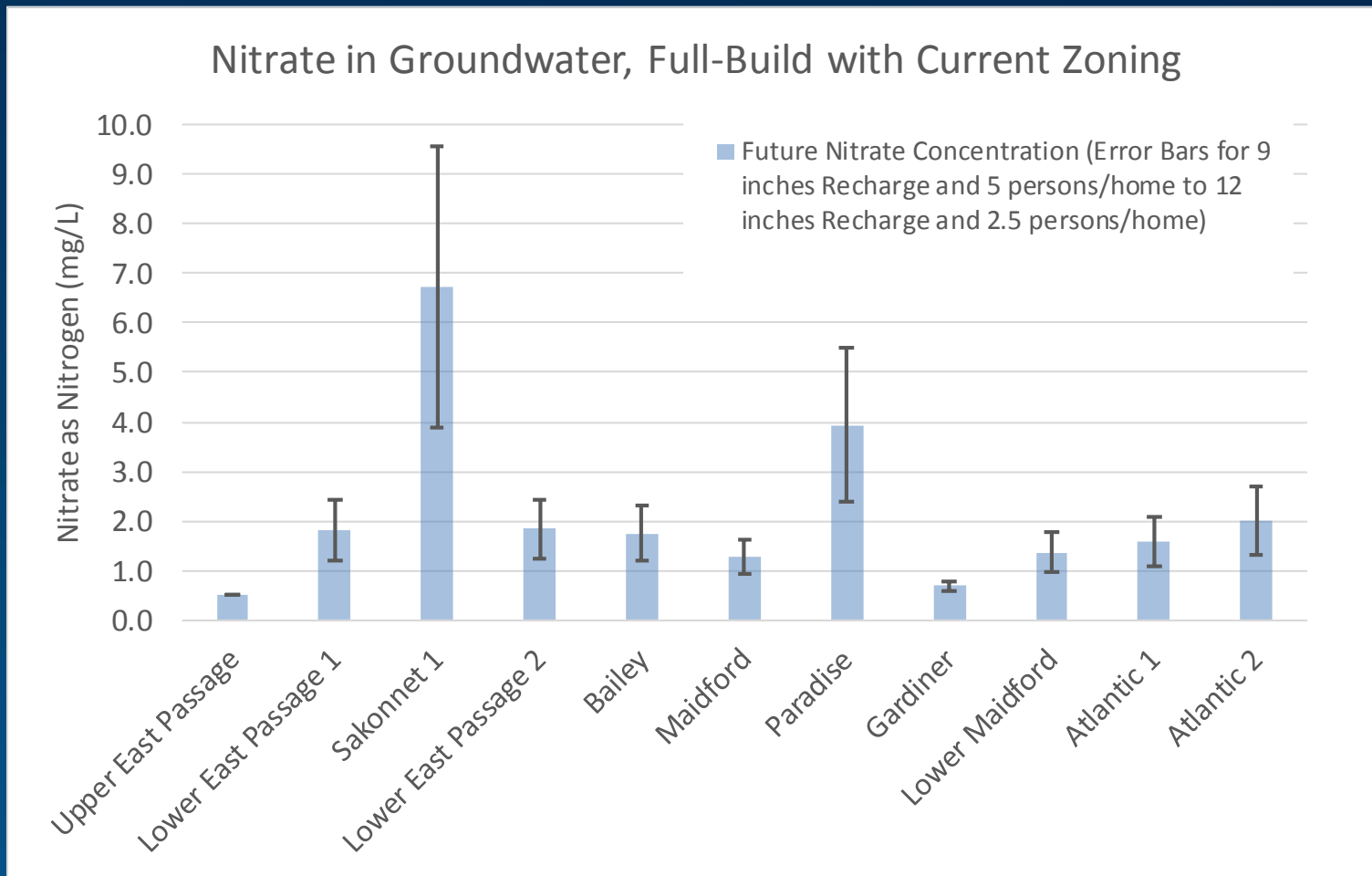
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Groundwater Quality



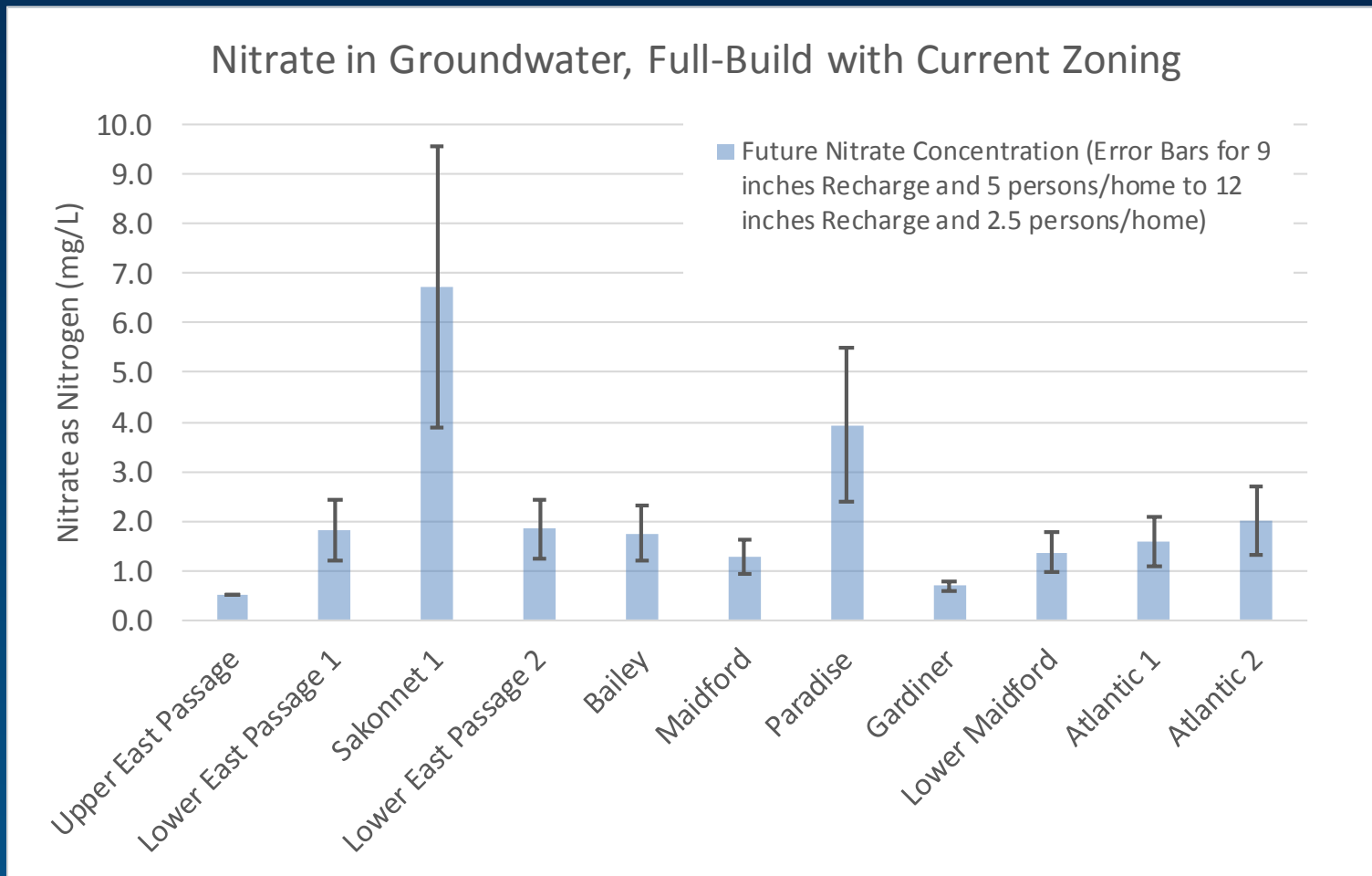
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Recommendations

1. Avoid or minimize the granting of waivers to the Town's Stormwater Standards, especially in public water supply watersheds.
2. The conceptual groundwater water budget suggests that for an average year and an operating mitigation system, the RI Stormwater Manual's Recharge Standard is adequate but the standard will need to increase if climate trends toward fewer storm events with higher storm severity. Otherwise, a net decrease in recharge will result. A single, stagnant recharge standard that is effective today can become be ineffective for the long term and diminish the effectiveness of mitigation measures built today.
3. The Recharge Standard is currently satisfied with a system that is sized to capture and recharge a specific volume of rainfall at the time of its installation but the Standard does not address the decrease in performance following initial installation. Performance can be significantly reduced in advance of the currently required threshold for maintenance. The Recharge Standard should be increased to address diminished performance.
4. Consider the installation of a series of groundwater monitoring wells throughout the Town to allow for long term seasonal collection of groundwater levels, quality and trends.
5. Surveys of homes with on-site wells should be taken to document private well data and the occurrence of well water supply issues and identify a point of contact for residents to inform of future well related issues.
6. Encourage testing of private wells by homeowners through an educational awareness program and retain data in a Town database for future groundwater evaluations.
7. Develop an OWTS educational program for residents to ensure that the State required maintenance standards are being performed and consider enacting an Onsite Wastewater Management Ordinance with a goal of ensuring proper maintenance to elongate a system's life, minimize system failure and provide proper treatment to protect groundwater resources.
8. Evaluate the allowed lot size for new parcels with OWTS or wells based upon number of bedrooms, water use, soil conditions and daily sanitary flow rate. This evaluation should also address the minimum lot sizes for Conservation style developments to prevent localized exceedances.
9. Consider Dimensional Zoning Requirements that address the differing needs for lots with and without public water, public sewer and both public water and sewer.
10. Perform town-wide groundwater quality testing to document conditions and needs for public water extensions.
11. Review historical records of OWTS failures or need for repair to assess future needs for public sewer extensions.