On-Site Sewage Disposal System Environmental Risk Ranking Study for the The State of Hawaii

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2nd Annual Inter-Government Water Conference

Honolulu, Hawaii

August 12, 2014

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On-Site Sewage Disposal System

Formal Version

An on-site sewage system (OSDS) is a complete wastewater system installed on a parcel of land, under the control or ownership of any person, which accepts sewage for ultimate disposal under the surface of the ground of the parcel where the wastewater is generated. In a general sense this applies primarily to cesspools and septic systems but can also include small aerobic treatment systems.

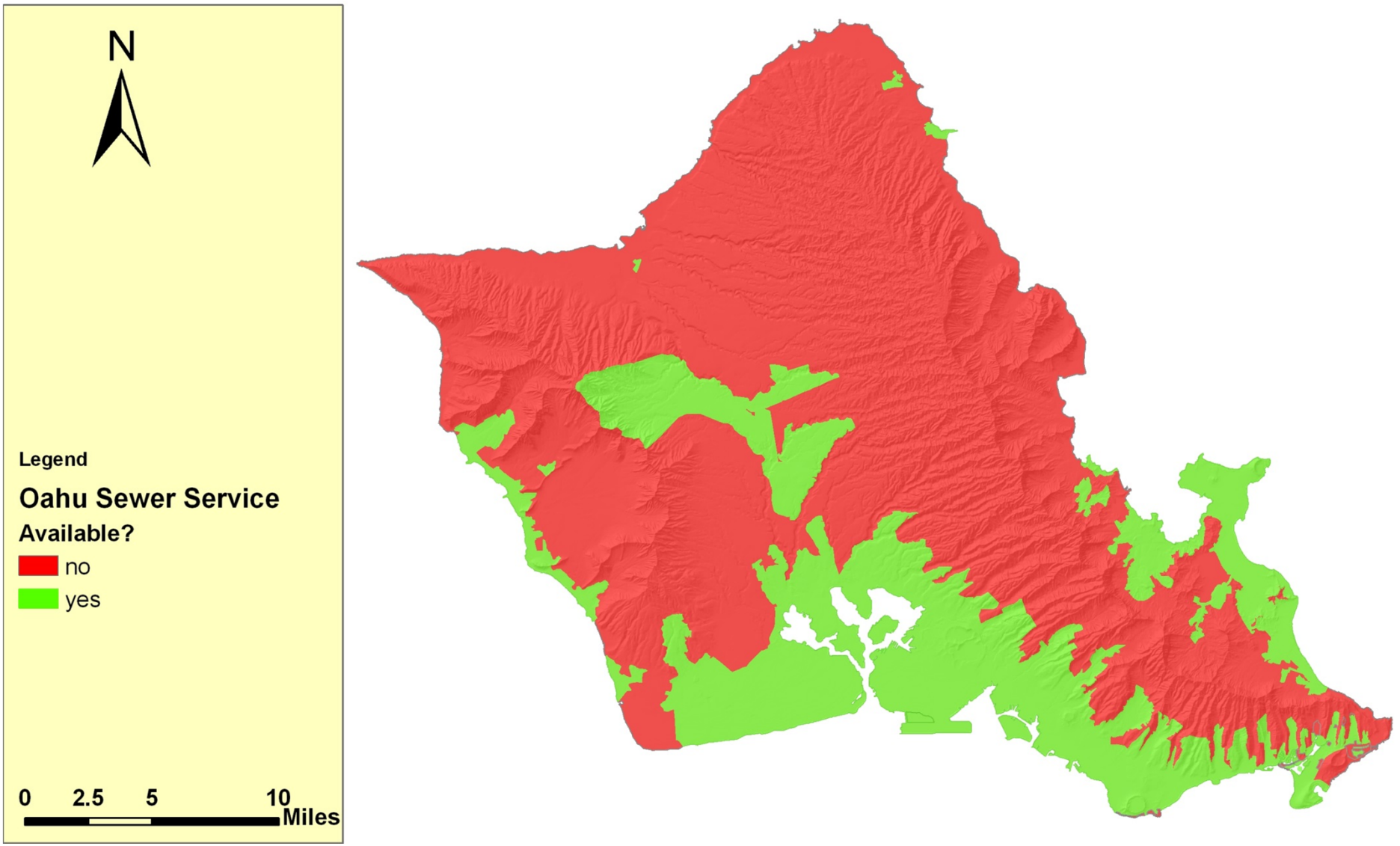
On-Site Sewage Disposal System

- Reader's Digest Version
  - Septic Systems
  - Small aerobic treatment units, and
  - Cesspools

Why We Did This Study

1. No reliable accounting of:
   - Number,
   - Location, or
   - Effluent load from OSDS
2. Increasing use of OSDS
   - Conversion of former ag. land to low density residential
3. Incomplete understanding of the health and environmental risks associated with OSDS
4. Large areas without a sewer service

Oahu has the most extensive sewer coverage, yet the majority of the area is not served



What This Study Accomplished

1. Provided the most comprehensive accounting of OSDS in Hawaii to date
2. Identified receptors that are most likely to be impacted by OSDS
3. Ranked the risk to those receptors most susceptible to adverse OSDS impact
4. Produced a detailed mapping of the limitations of various soils to properly remediate OSDS effluent
5. Established a tiered ranking of the health and environmental risk posed by individual OSDS

Introduction to OSDS and Associated Risk

OSDS Types and Effluent Quality

OSDS Type	OSDS Class	Nitrogen (mg/L)	Phosphorus (mg/L)	Fecal Coliform (CFU/100 ml)
All Systems Utilizing Soil Treatment	Class I	1	<2	13
Septic tanks discharging to a seepage pit	Class II	39-82	11-22	1,000,000-160,000,000
Aerobic units discharging to a seepage pit	Class III	7-60	2-18	1,000,000
Cesspools	Class IV	15-90	5-20	1,000,000 – 100,000,000

Data from WRRC and Engineering Solutions, 2008

The receptors that may be impacted

Drinking Water Sources

Streams

Nearshore Waters

Receptors of Concern (ROC)
Those ecosystems or facilities that may be adversely impacted by OSDS contaminated waters

What Factors Govern the OSDS Risk?

- Number, location, and Clustering of OSDS
- Hydrogeology
  - Magnitude of recharge
  - Dilution of the effluent by ambient grouindwater
  - Groundwater discharge points
  - Velocity of groundwater flow (time of travel considerations)
- Sensitive receptors within the OSDS effluent plume area
  - Particularly at points of groundwater discharge to surface waters
- Soil Characteristics
  - Ability of the soil to properly treat and drain the effluent

Tracking Down the Number and Location of OSDS

Lines of Evidence

- Where they are:
  - HDOH Waste Water Branch (WWB) databases
- Where they aren't:
  - County sewer GIS coverages
  - County Water/Sewer Billing Data
  - Interviews with water and wastewater service providers
- Where they might be:
  - Tax Map Key (TMK) GIS coverage & database
    - TMK number used as key field to link to other data
  - Dwelling information from real property tax databases

What We Assumed

- Any dwelling with a bathroom but not served by a sewer has an OSDS
- OSDS type is assumed to be a cesspool when no data to the contrary is available
- OSDS water quality characteristics (nitrogen, phosphorus, fecal coliform) are consistent with those detailed in WRRC and Engineering Solutions report (2008)
- OSDS effluent discharge is 200 gallons of per day per bedroom (Hawaii Revised Statutes - Title 11, Chapter 62)
- There is no remediation of wastewater after it leaves the zone of treatment

Can There Be Errors?

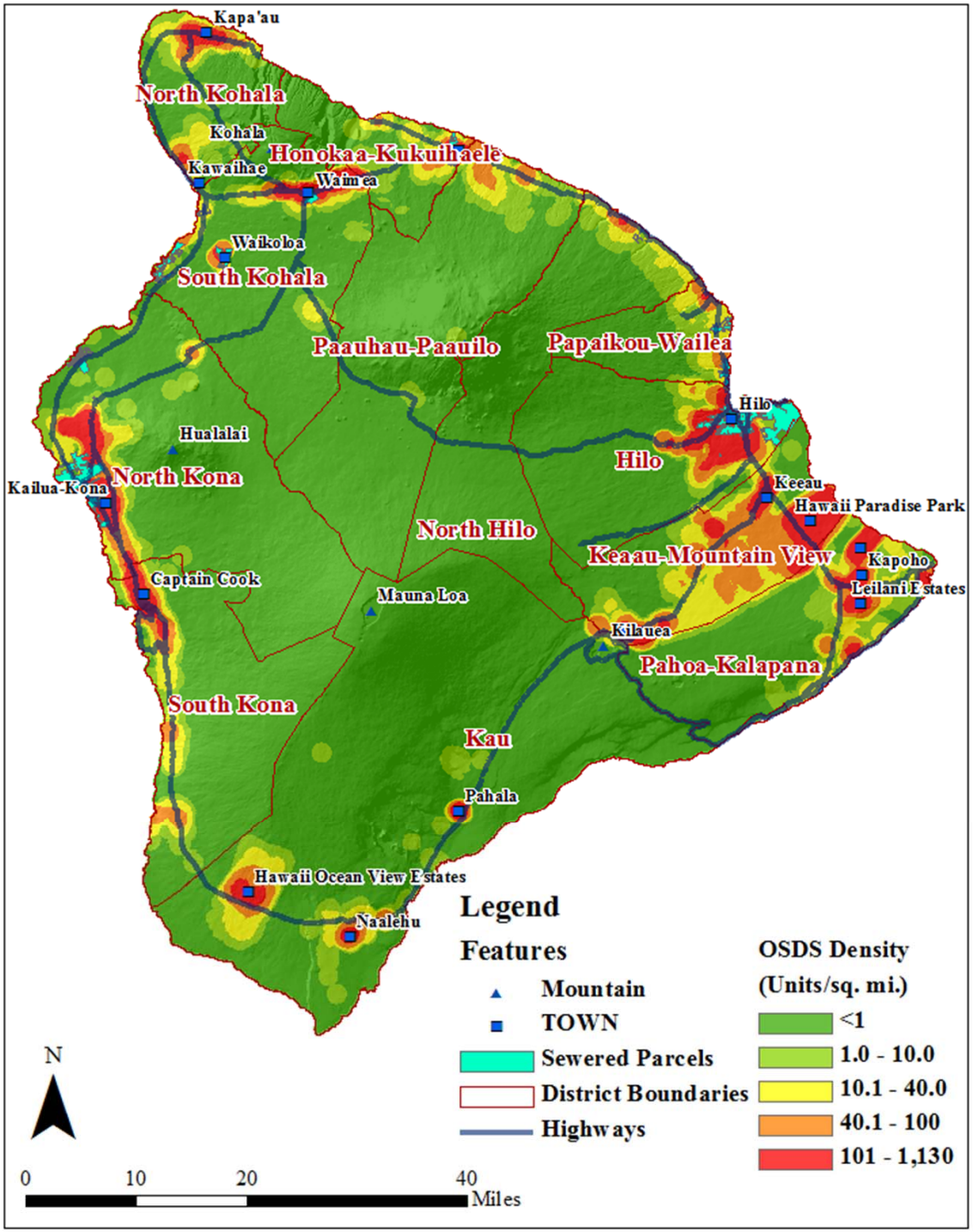
- Residences in sewered areas not connected to the system
- Incompleteness or duplication of IWS records
- Inaccuracies or misinterpretation of dwelling data
- OSDS status for commercial properties is difficult to assess
- Location not exact
- Effluent chemistry varies (incidental soil treatment)

Here Are the Numbers!

Island	Quantity	Class I	Class II	Class III	Class IV	Daily Effluent (mgd)	Daily N Flux (Kg/d)	Daily P Flux (Kg/d)
Hawaii	58,982	8,951	694	68	49,344	34.6	6,607	1,848
Kauai	18,011	3,107	910	304	13,688	12.5	2,115	607
Maui	16,883	4,105	559	75	12,242	11.6	1,869	554
Molokai	1,956	477	33	4	1,442	1.2	206	59
Oahu	14,606	2,620	534	199	11,253	9.7	1,732	500
Total	**111,438**	**19,170**	**2,730**	**650**	**87,969**	**69.6**	**12,529**	**3,568**

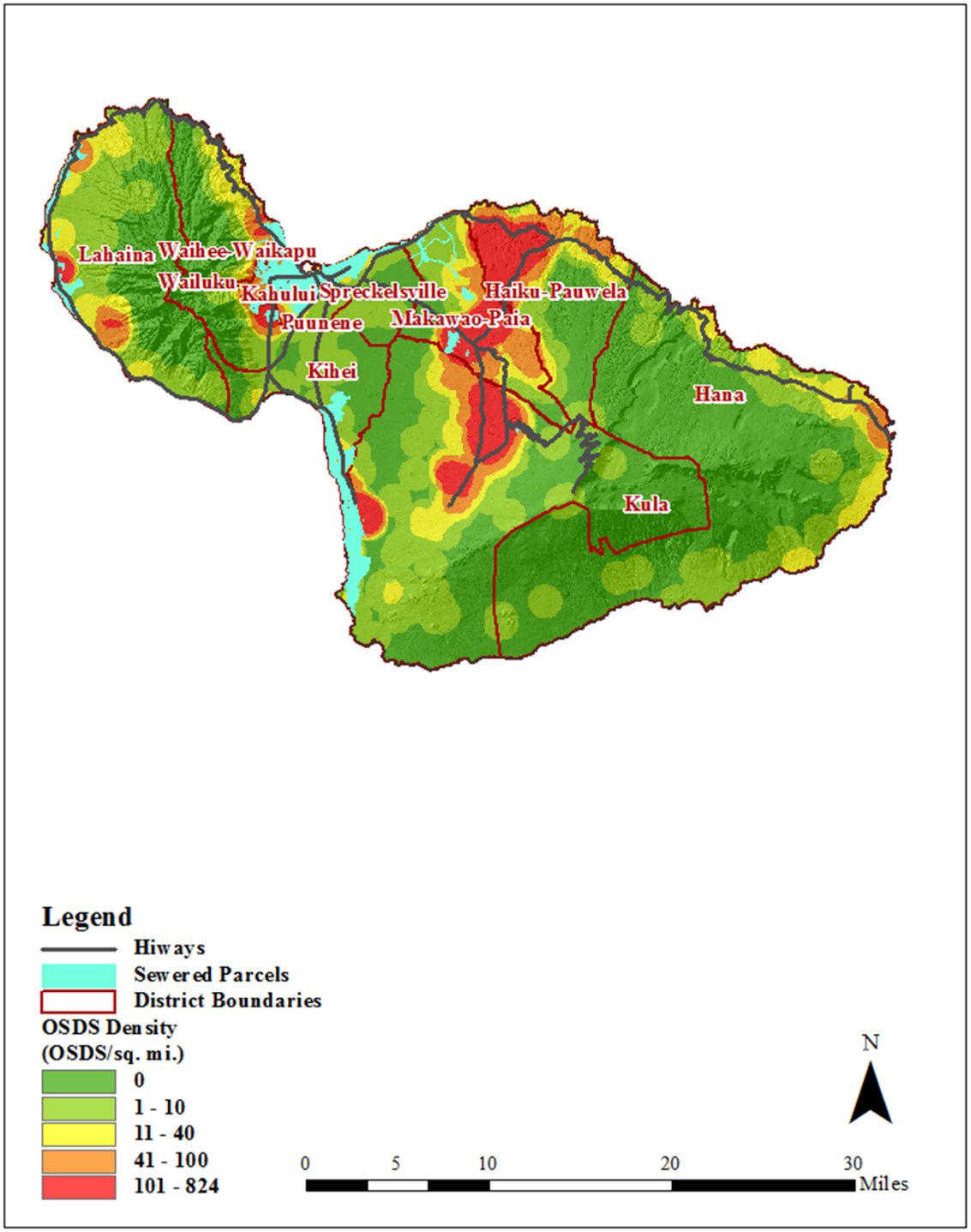
One OSDS Isn't a Problem, But a Herd of Them Are!

- Groundwater risk varies by OSDS density (Yates, 1985)
  - < 10 units/mi^2 – low density
  - 10 to 40 units/mi^2 – medium density with potential for groundwater contamination **(1 unit per 16-64 acres)**
  - > 40 units/mi^2 – high density **(1 unit per 16 acres)**
  - **Ag. Lots commonly 1 acre or 640 lots/sq. mile**

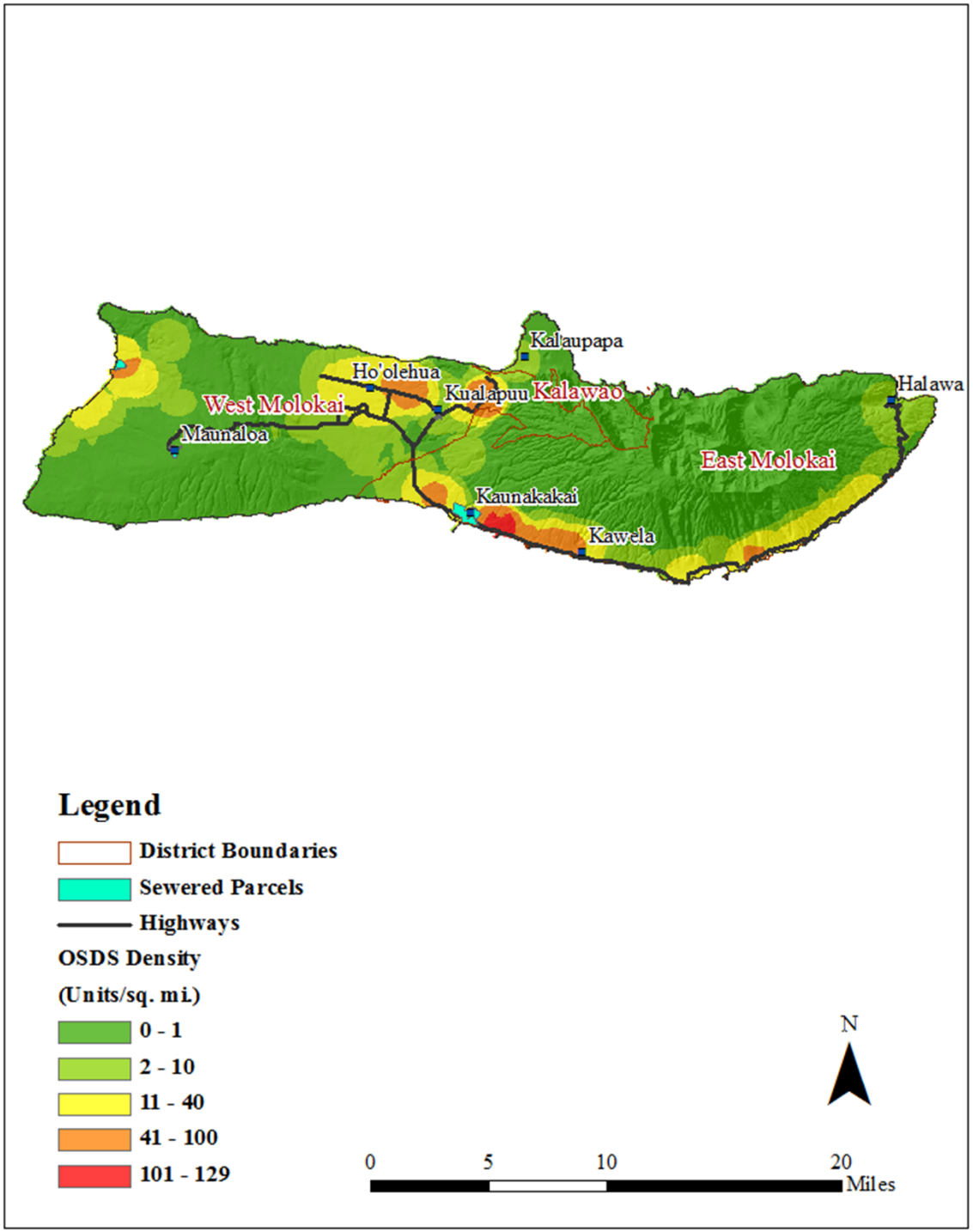


The OSDS Density on Hawaii

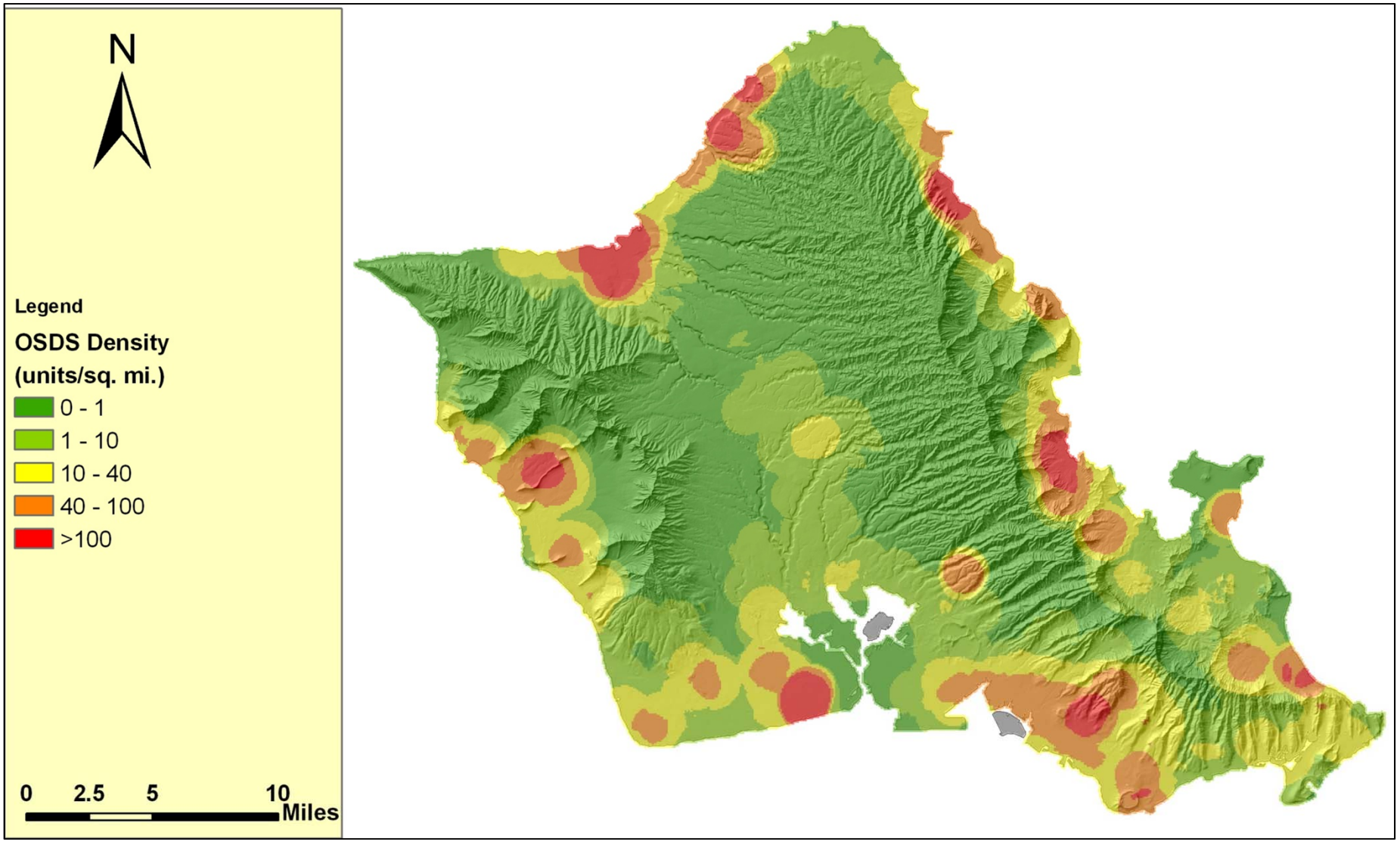
The OSDS Density on Maui

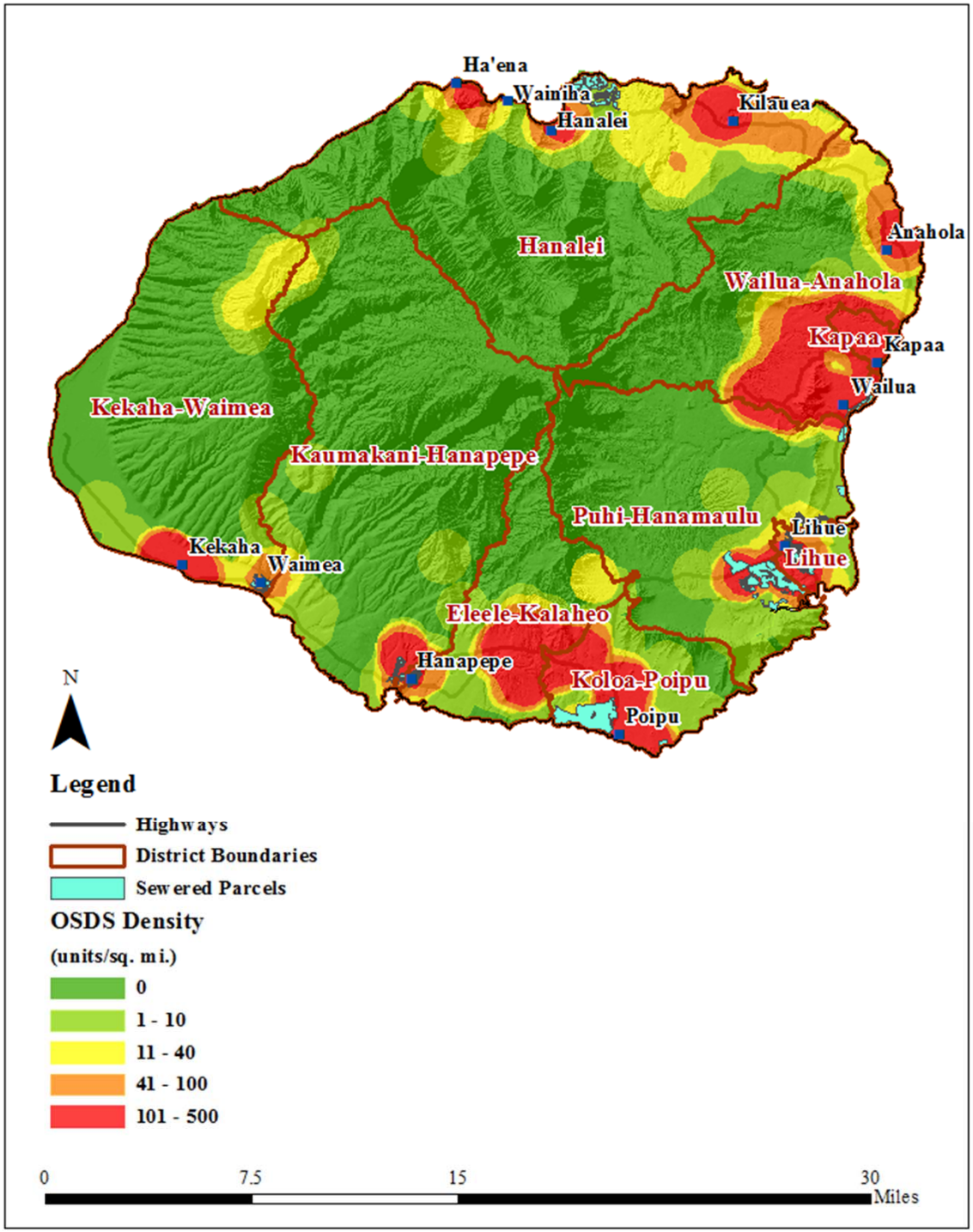


The OSDS Density on Molokai

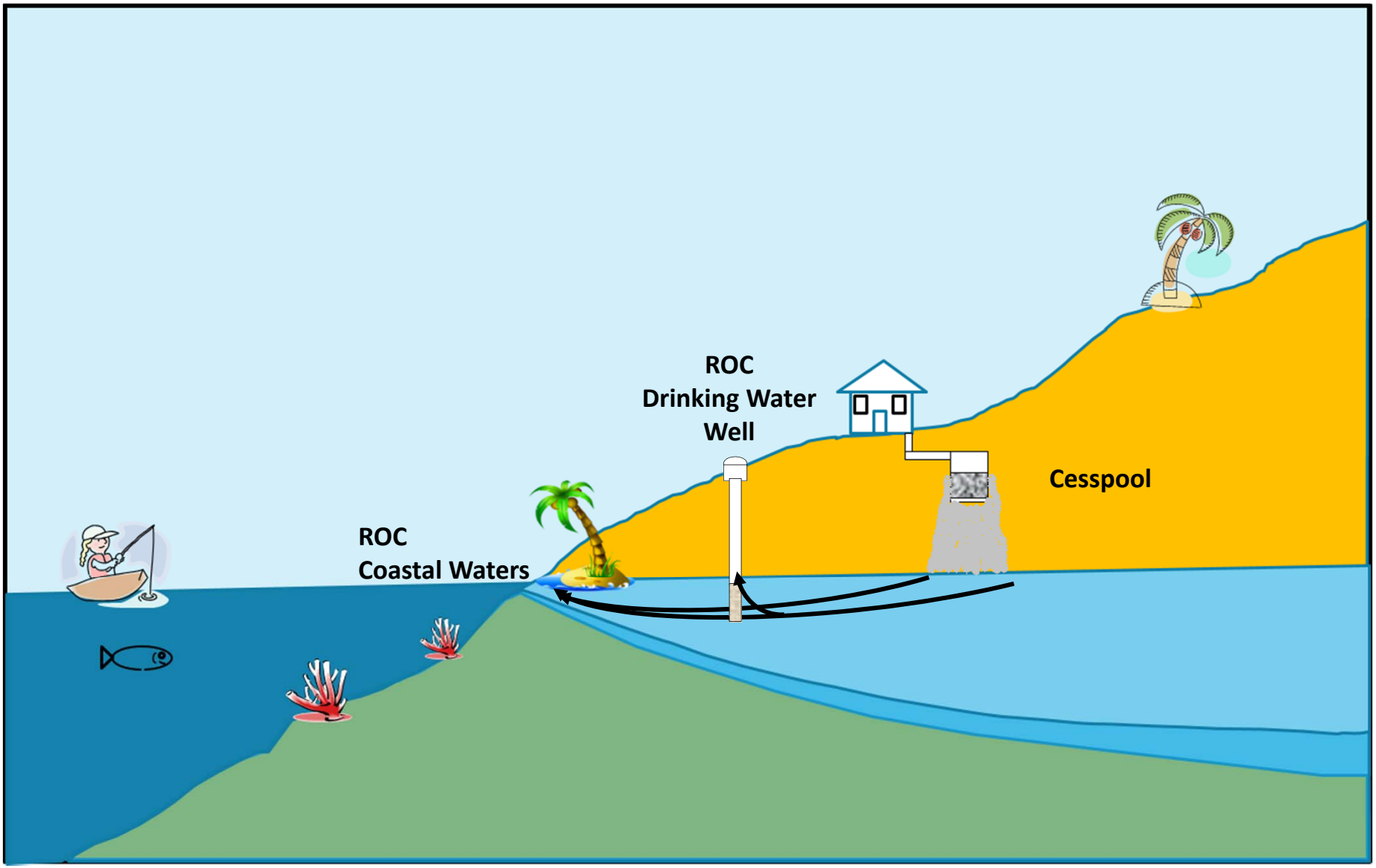


The OSDS Density on Oahu





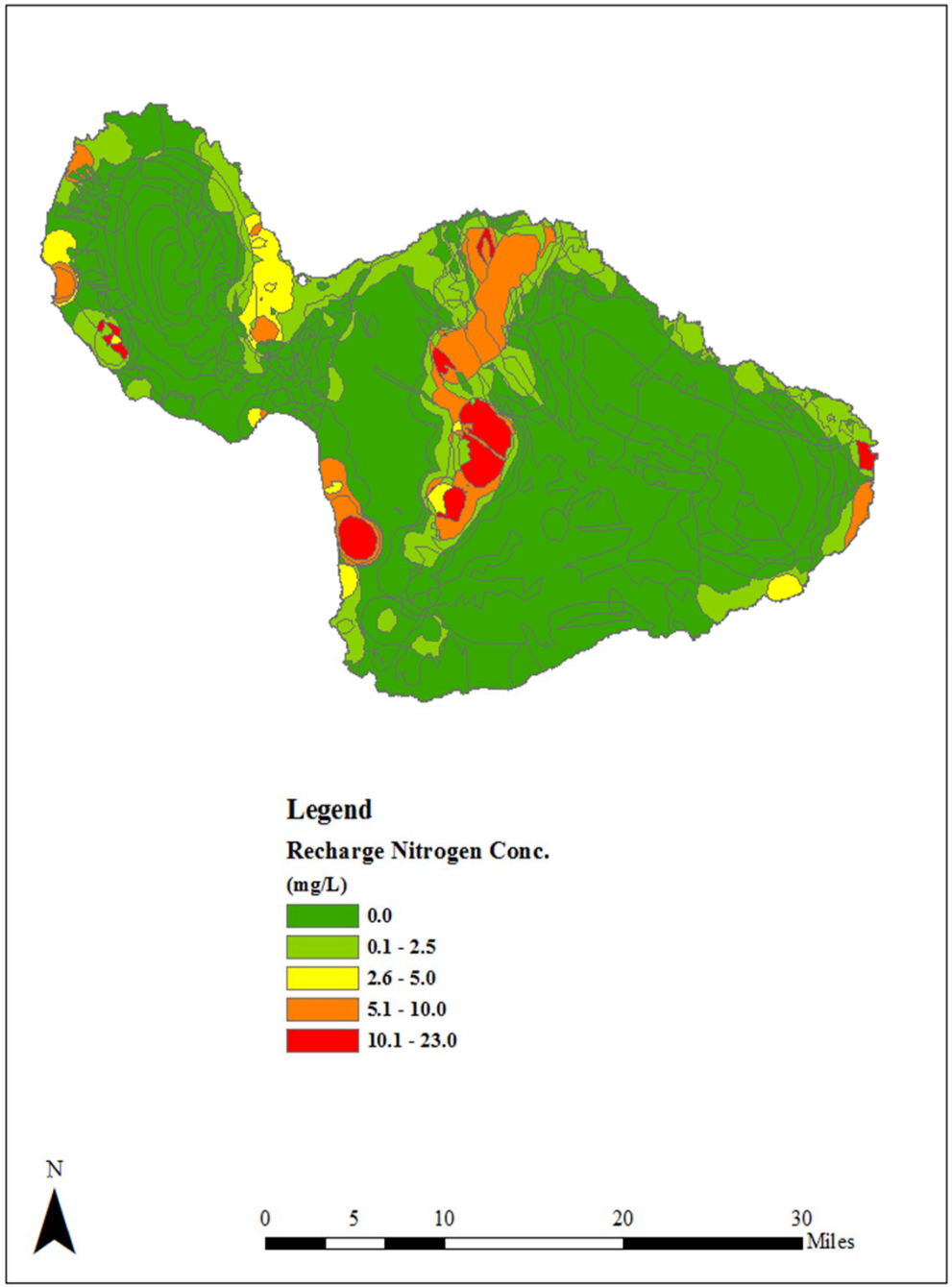
The OSDS Density on Kauai



Groundwater is the pathway between point of effluent discharge and Receptors of Concern

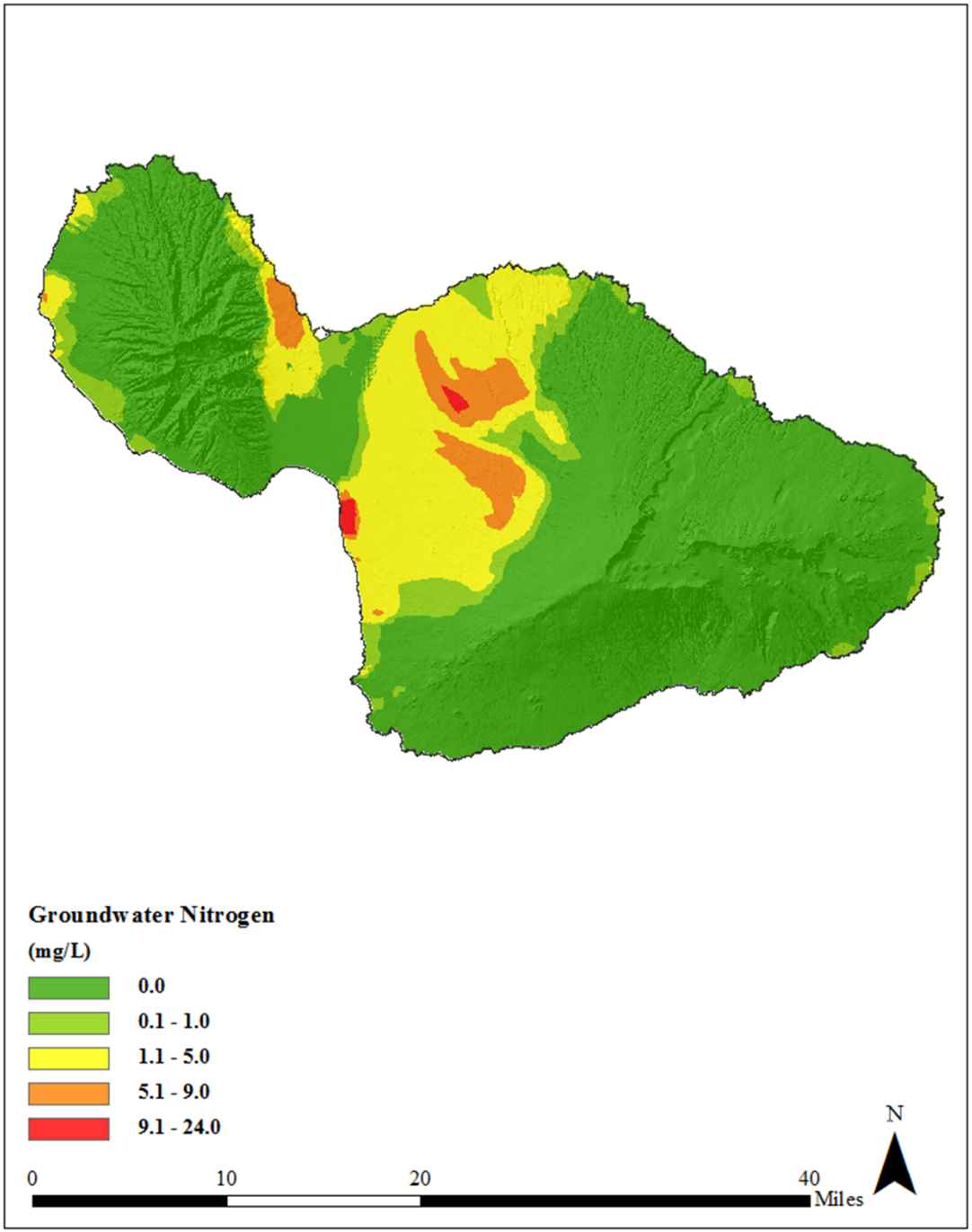
Evaluating Footprint of OSDS Impact

- Groundwater flow and transport modeling can synthesize that pathway
- Modeling Accounts for hydrologic processes:
  - Dilution by recharge
  - Dilution by upgradient groundwater
  - Shows severity and distribution of OSDS effluent in the groundwater (i.e. plume footprint)
  - Identifies those ROCs most at risk
- Nitrogen from the OSDS effluent is the tracer



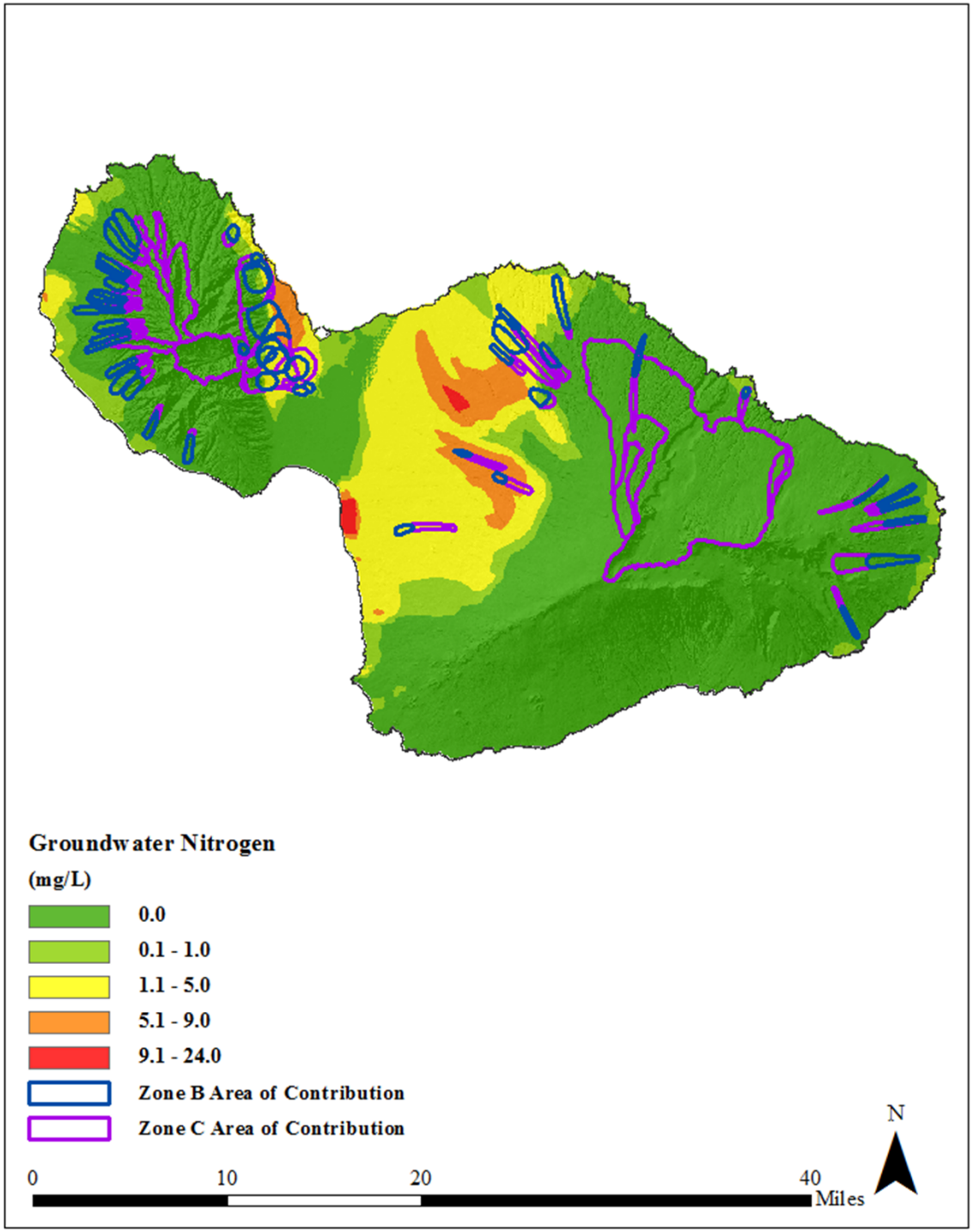
Merging OSDS Data With Recharge:

- Accounts for dilution by recharge
- Estimates N concentration right above the water table
- Does not:
  - Account for dilution by GW Flow; or
  - Model where the effluent may migrate to



OSDS Nitrogen Transport Modeling

- Accounts for dilution by groundwater flow
- Estimates the:
  - Magnitude,
  - Plume footprint, and
  - ROCs that may be impacted.
- Nitrogen assumed to be conservative



Overlay Nitrogen GW Plume with ROC Zones

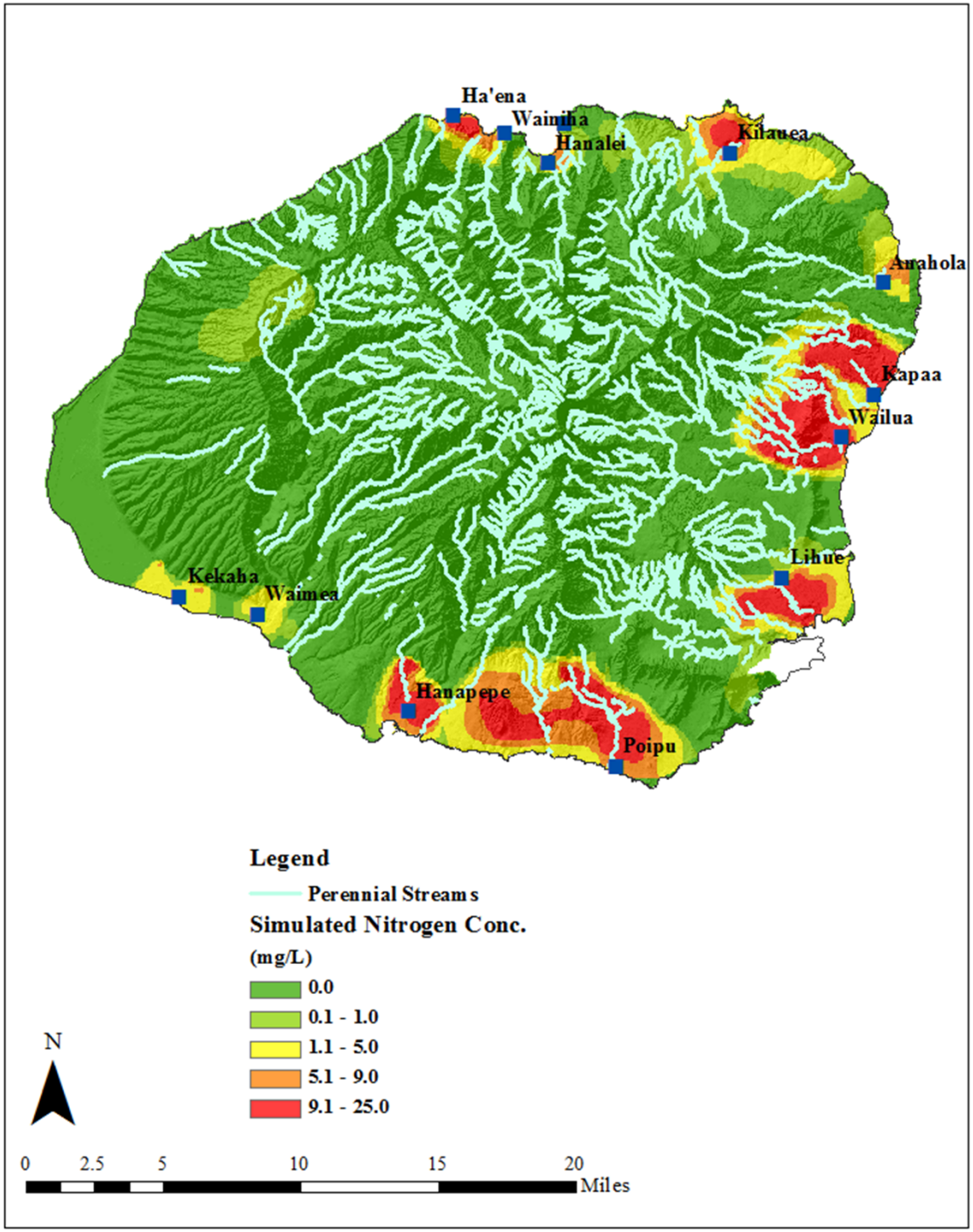
- Capture zones for drinking water wells

OSDS Inventory – Drinking Water Capture Zone B

		Hawaii	Kauai	Maui	Molokai
OSDS		992	730	1,004	52
Class I		198	147	330	27
Class II		8	46	26	13
Class III		2	20	10	0
Class IV		787	517	638	12
Effluent	(mgd)	0.61	0.50	0.68	0.030
Nitrogen Flux	(kg/d)	106.7	82	96	2.66
Phosphorus Flux	(kg/d)	30.2	24	28	0.91

OSDS Inventory – Drinking Water Capture Zone C

		Hawaii	Kauai	Maui	Molokai
OSDS		525	1,277	1,128	52
Class I		81	268	262	9
Class II		2	68	29	4
Class III		0	0	0	0
Class IV		523	941	845	39
Effluent	(mgd)	0.34	0.90	0.70	0.032
Nitrogen Flux	(kg/d)	67.6	147	115	5.84
Phosphorus Flux	(kg/d)	18.8	42	34	1.65

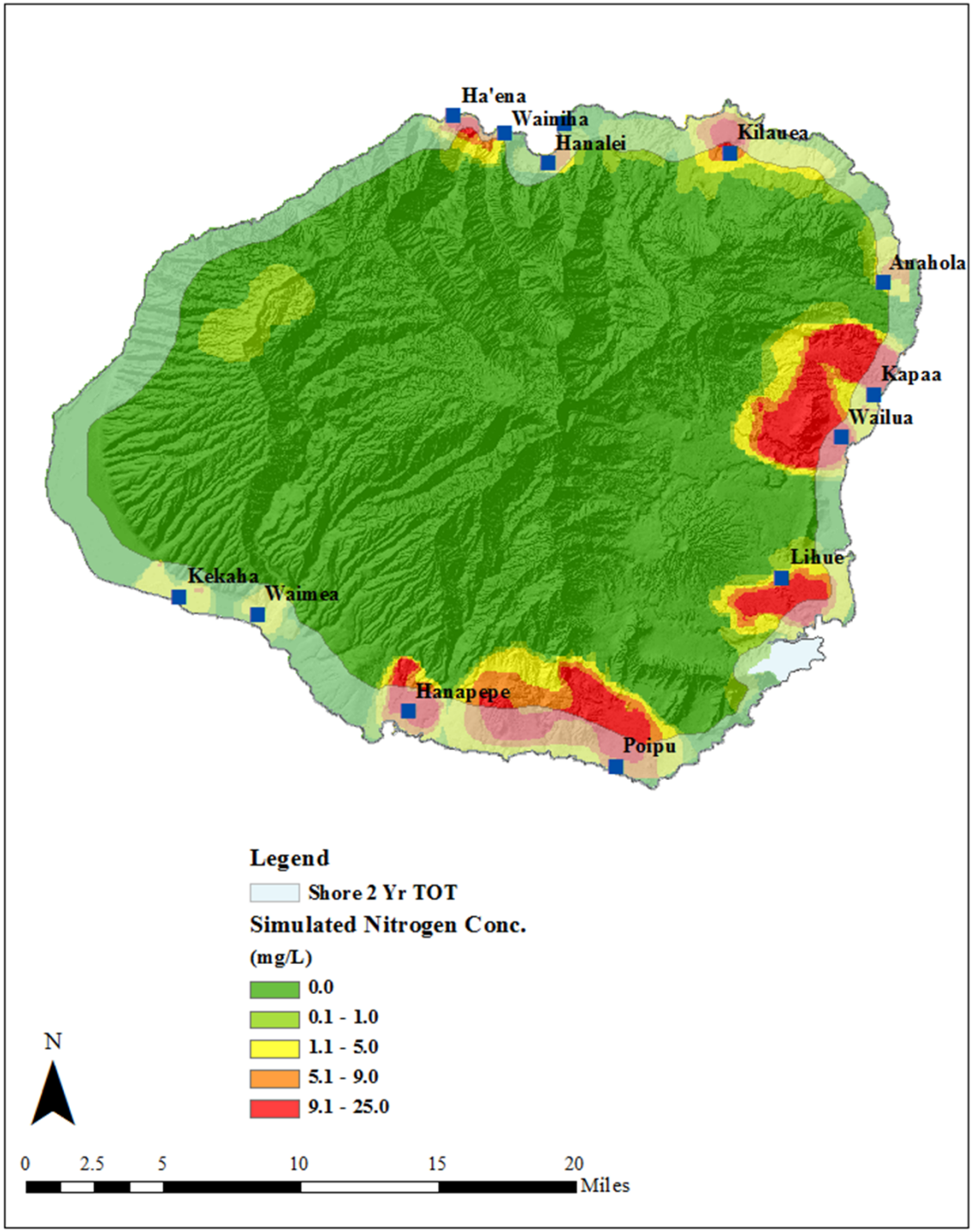


Overlay Nitrogen GW Plume with ROC Zones

- Capture zones for drinking water wells
- Perennial Streams and associated watersheds

OSDS Estimates – Perennial Watersheds

		Hawaii	Kauai	Maui	Molokai
OSDS		19,766	13,406	4,593	80
Class I		2,138	1,736	1,313	17
Class II		316	743	153	2
Class III		13	264	16	0
Class IV		17,326	10,663	3,119	61
Effluent	(mgd)	12.3	9	3.28	0.05
Nitrogen Flux	(kg/d)	2,473	1,656	512	8.39
Phosphorus Flux	(kg/d)	688	472	154	2.36



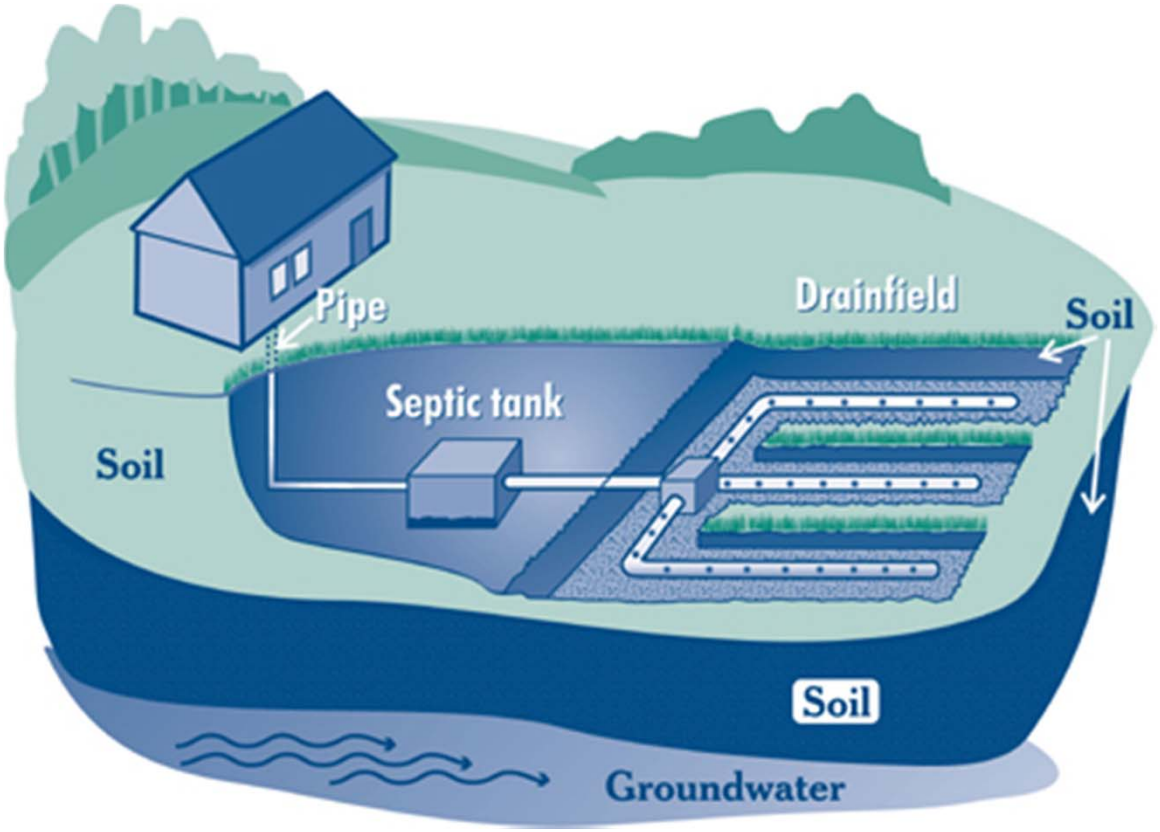
Overlay Nitrogen GW Plume with ROC Zones

- Capture zones for drinking water wells
- Perennial Streams
- Nearshore Waters

OSDS Estimates – Shoreline 2 Yr TOT

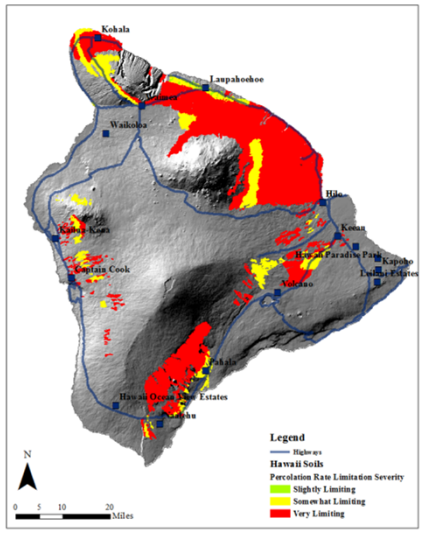
		Hawaii	Kauai	Maui	Molokai
OSDS		27,639	7,438	5,401	1,308
Class I		3,398	1,355	1,373	391
Class II		293	323	194	31
Class III		49	235	39	3
Class IV		23,928	5,525	3,795	883
Effluent	(mgd)	16.6	5.2	3.85	0.83
Nitrogen Flux	(kg/d)	3,276	848	618	123
Phosphorus Flux	(kg/d)	913	244	187	35.9

OSDS Siting – Soil Suitability Assessment



Soil is the primary mode of OSDS effluent treatment

- By design (leach fields) or incidental (seepage pits)
- Factors
  - Flooding frequency Filtration ability
  - Depth to rock or cemented pan
  - Slow water movement (low permeability)
  - Other factors
    - Excessive slope
    - Large stone content
    - Seepage out of the bottom layer



Slow Water

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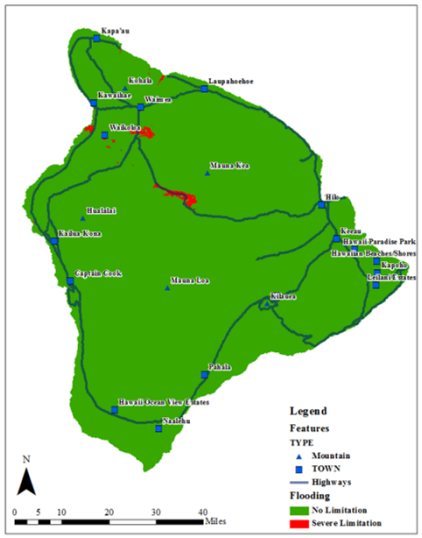

Flooding

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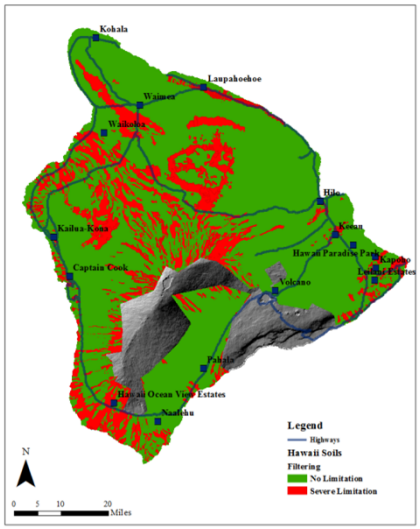
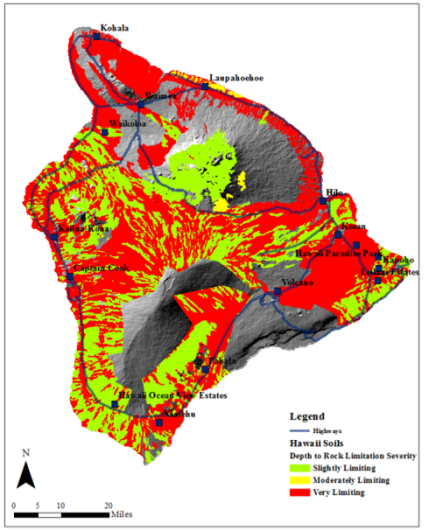


Insufficient Filtration



Depth to Rock

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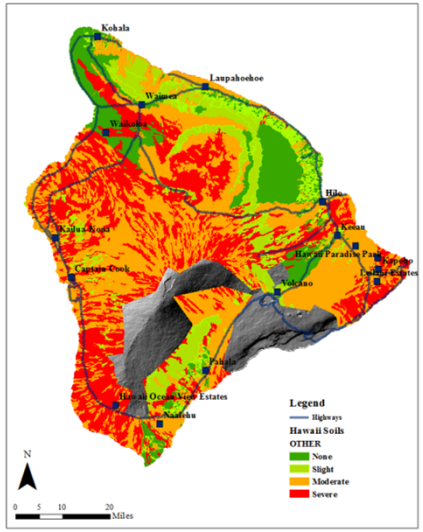

Other

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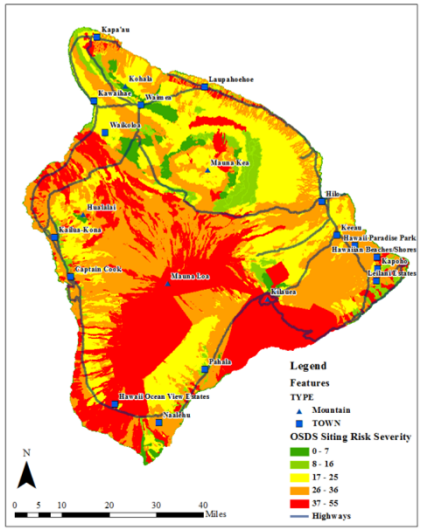
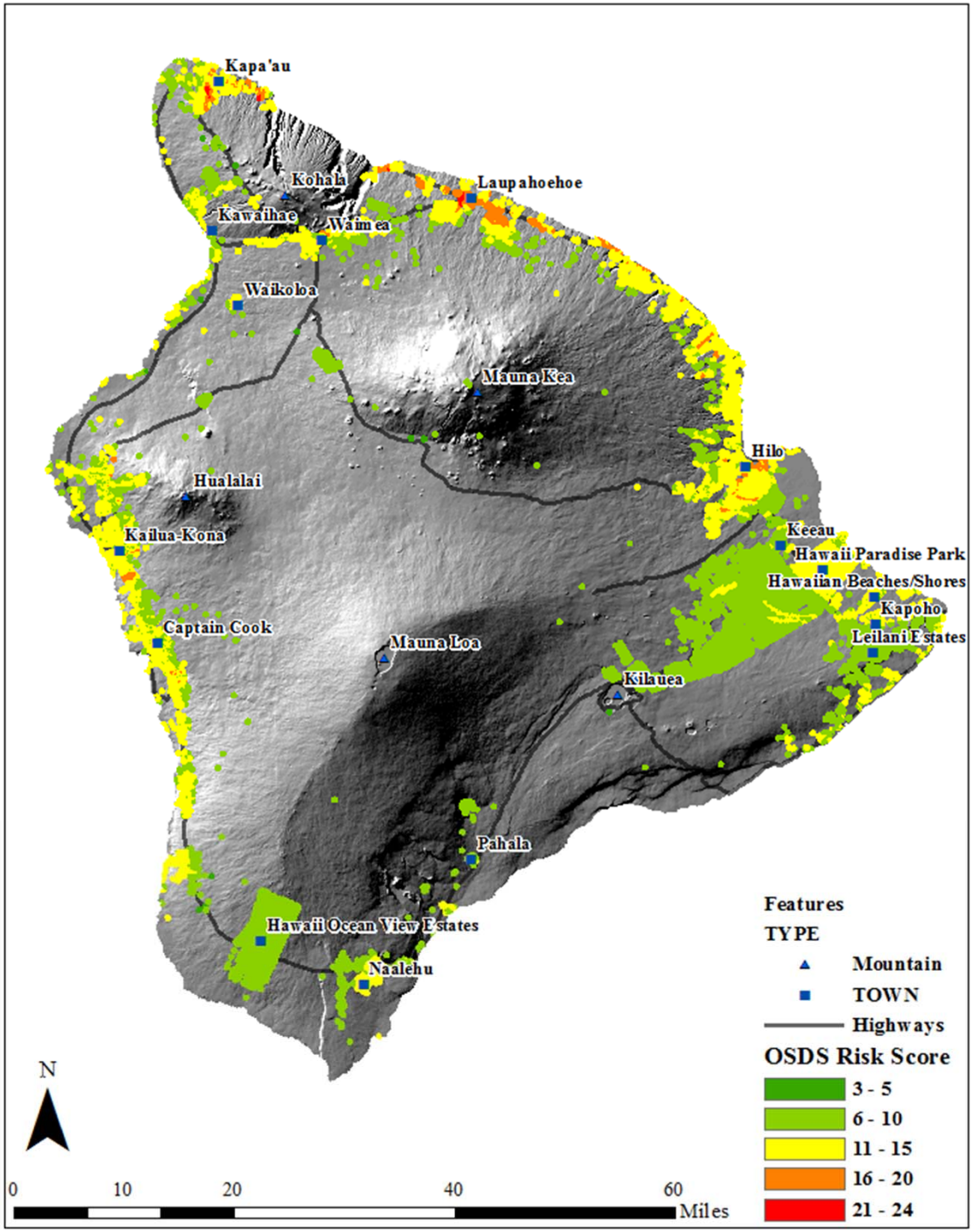


Soil Risk Score

The Cumulative Risk



Example - Distribution of OSDS Risk Severity Scores for Hawaii

- Individual OSDS risk scores averaged over areas of highest risk
- Areas of primary concern
  - Lapahoehoe/Honokaa
  - North Hilo
  - West Hawaii

In Summary

Summary

- The population of OSDS in the state of Hawaii is estimated to be approximately 111,000 units
  - The Hawaii Island has over half (~59,000 units)
- Approximately 70 mgd of minimally treated wastewater are eventually discharged to the ocean

Summary (Cont.)

- The potential exists for negative impact to receptors of concern
  - OSDS effluent may increase groundwater nitrate concentrations to values that exceed drinking water limits
  - These areas of increased nitrate include drinking water well zones of contribution
  - Increased nutrient loading of streams and coastal waters may result
- Study estimates the POTENTIAL Risk
  - Assessing Actual impact will require good scientific field work and further analysis

Thank You!