Bitterroot Valley Groundwater Vulnerability Mapping Project

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Bitterroot Valley GW Vulnerability Project Purpose

- The project is intended to identify areas that are most vulnerable to impacts from septic system discharge.
- Provide a planning tool to be used to help prevent or reduce nutrient loading to groundwater
- Use DRASTIC methodology to identify areas of groundwater vulnerability
- Revise/Refine the map based on unique characteristics of the Bitterroot Valley

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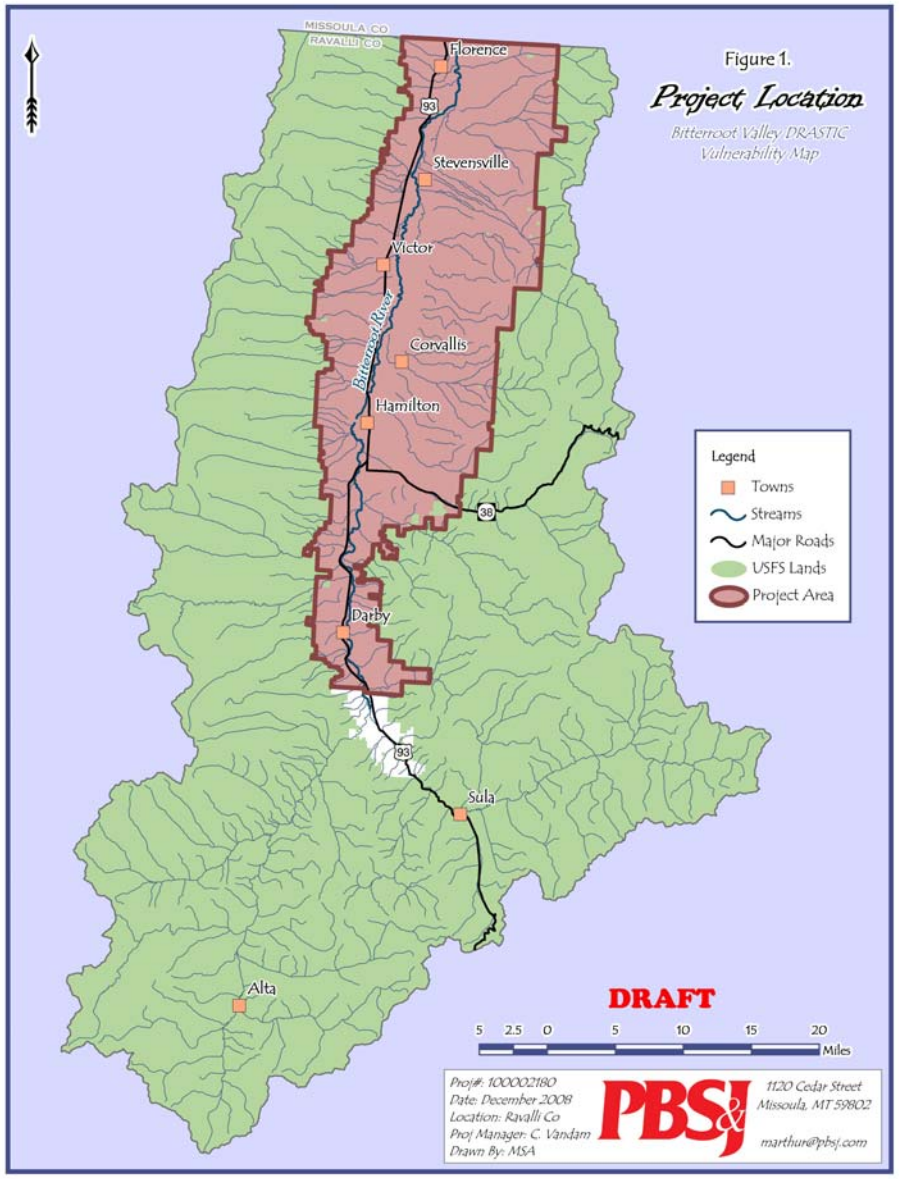

Phase 1 DRASTIC GW Vulnerability Map: Project Area

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DRASTIC Analysis

- Developed by the EPA in 1986
  - Important to remember that this is designed as a screening tool and not for site specific vulnerability analysis
- Numerical Equation
  - Assigns rank to each parameter
  - Weight factor assigned relative to pollution potential

$$\text{DRASTIC Index} = Dr(Dw) + Rr(Rw) + Ar(Aw) + Sr(Sw) + Tr(Tw) + Ir(Iw) + Cr(Cw)$$

- GIS-Raster Based Approach
- One Acre Grid
  - Consistent with Land Suitability Project Grid

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DRASTIC Analysis: Bitterroot Valley

- Complete in Two Phases
- Phase 1: Standard DRASTIC analysis
- Phase 2: Develop a Refined/Calibrated DRASTIC Analysis
  - Update the depth to groundwater map to reflect depth of water
  - Plot Water Quality (Nitrates) to Identify Impacted Areas
  - Correlation Analysis of DRASTIC Parameters to Nitrates
  - Adjust Parameters to Reflect Best Indicators of Nitrate in Groundwater

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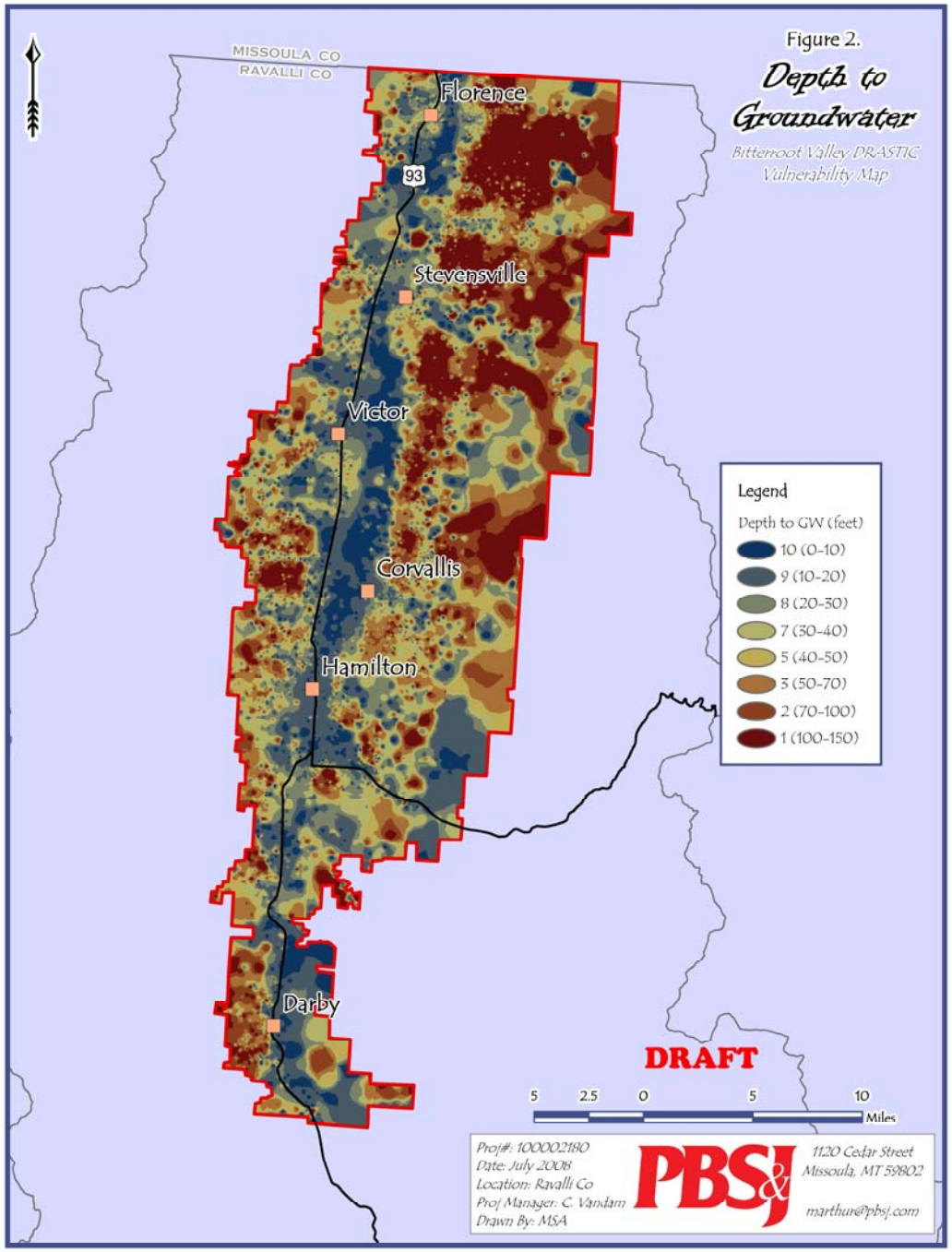
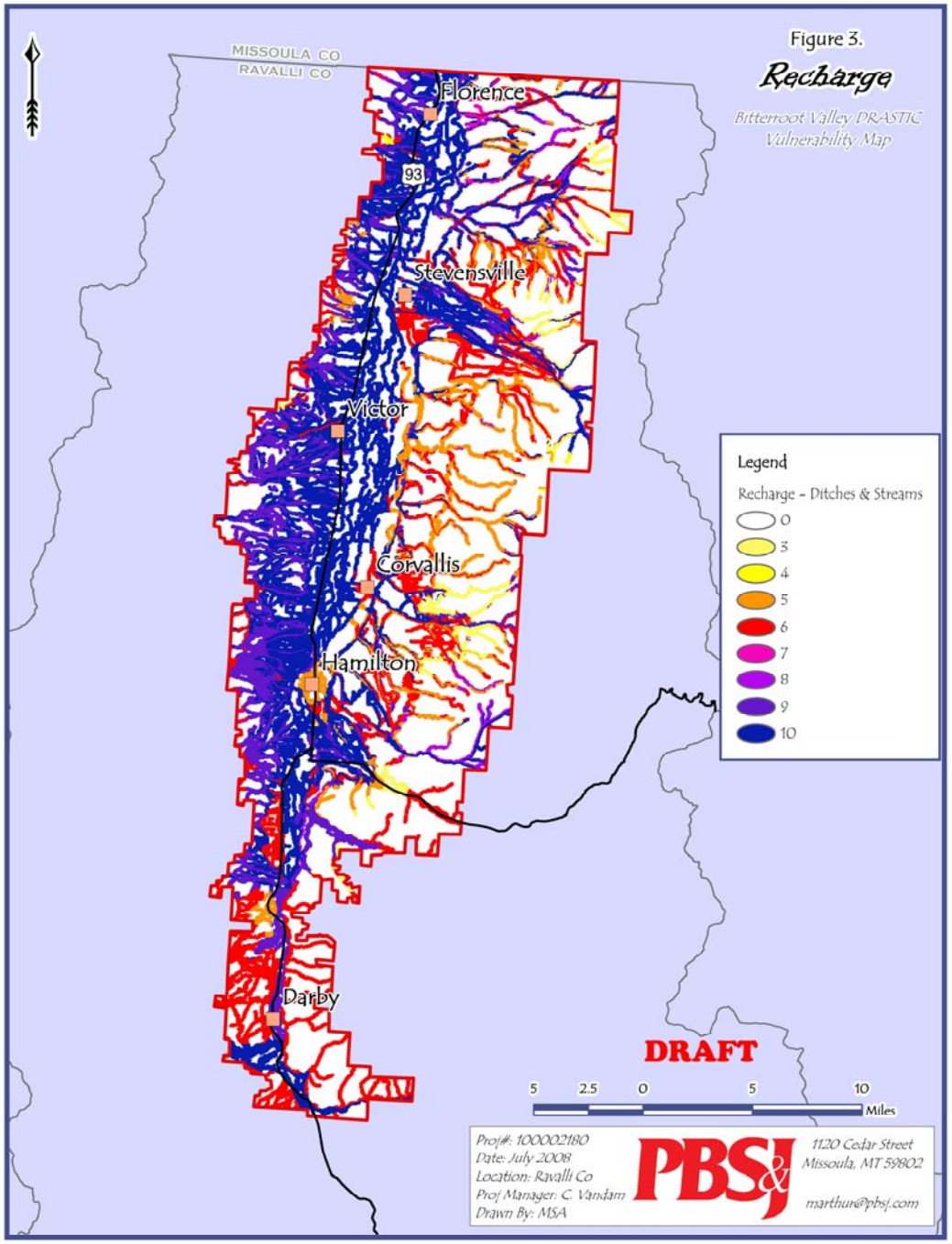


Depth to Groundwater

Weight Factor =5

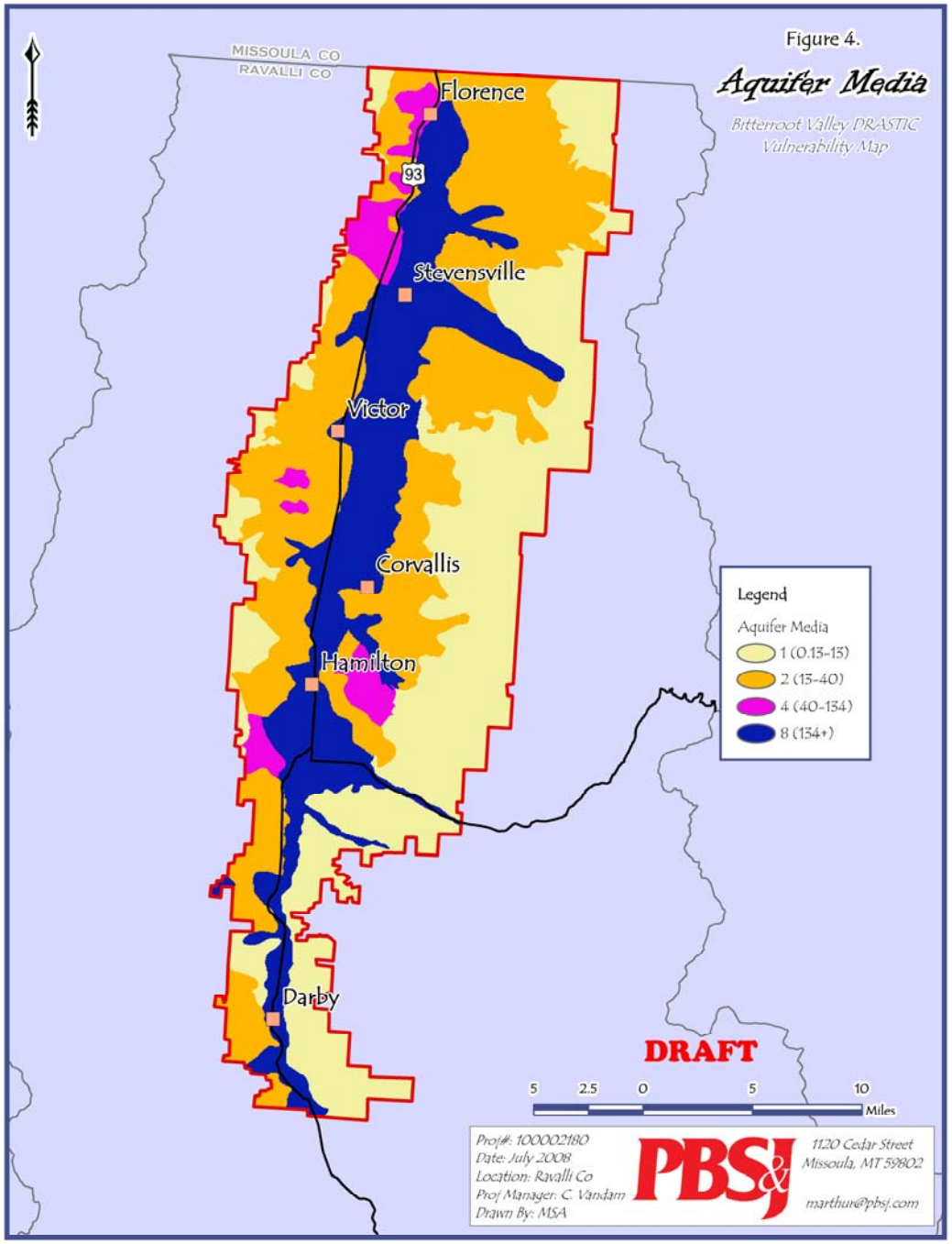
Source: Well Logs



Recharge

Weight =1

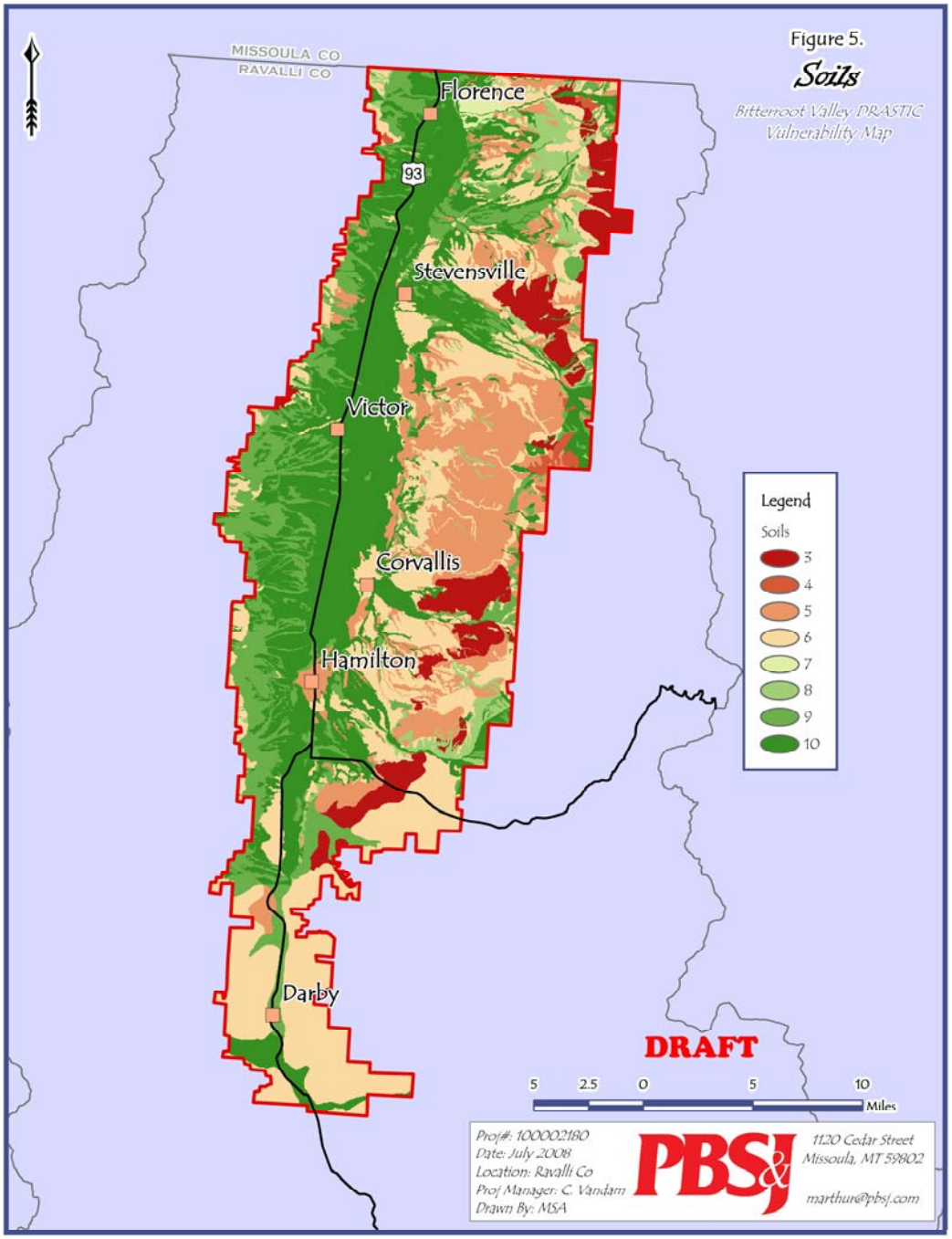
Source: USGS Hydrography & DNRC WRS



Aquifer Media

Weight=3

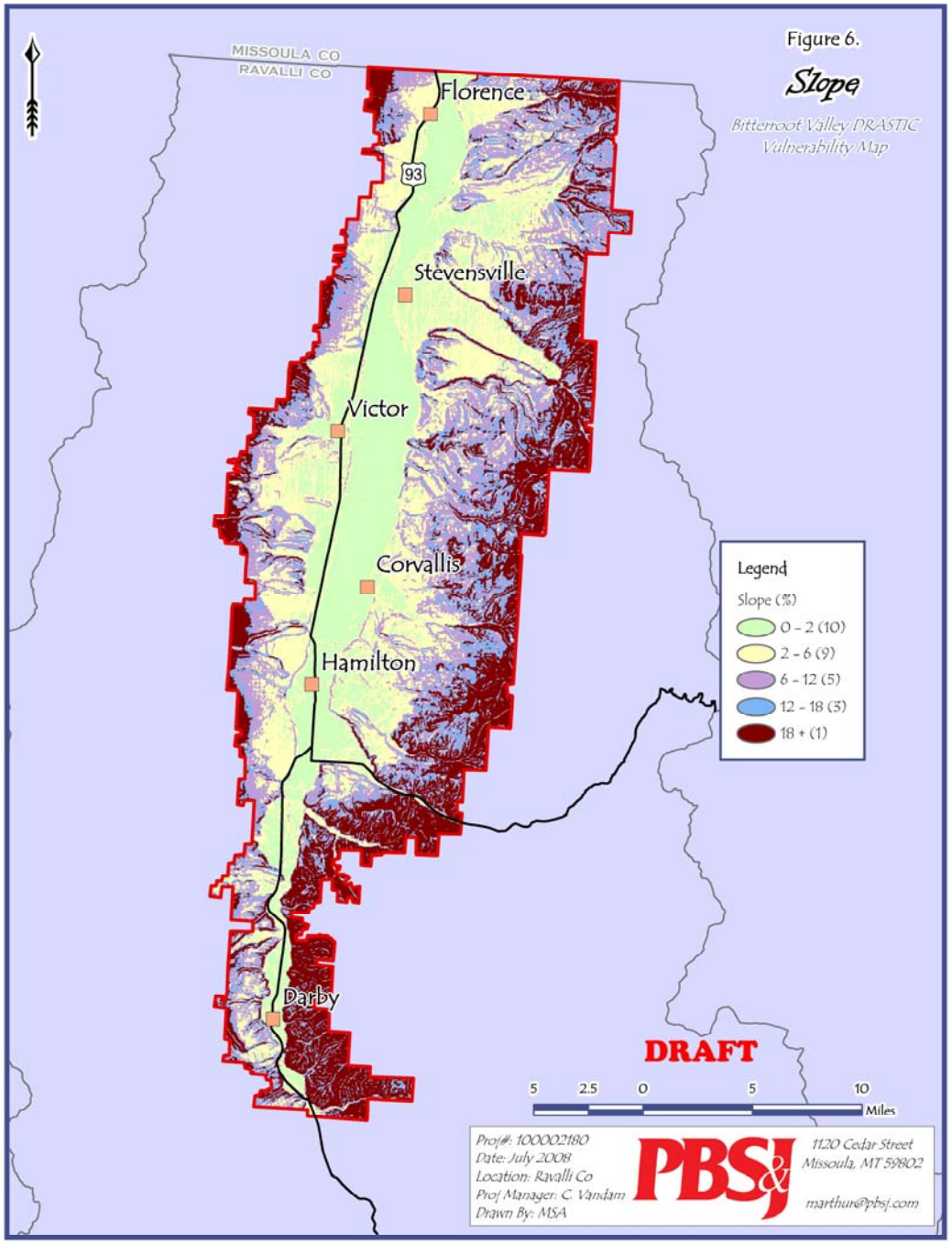
Source: Well Logs



SOILS

Weight=2

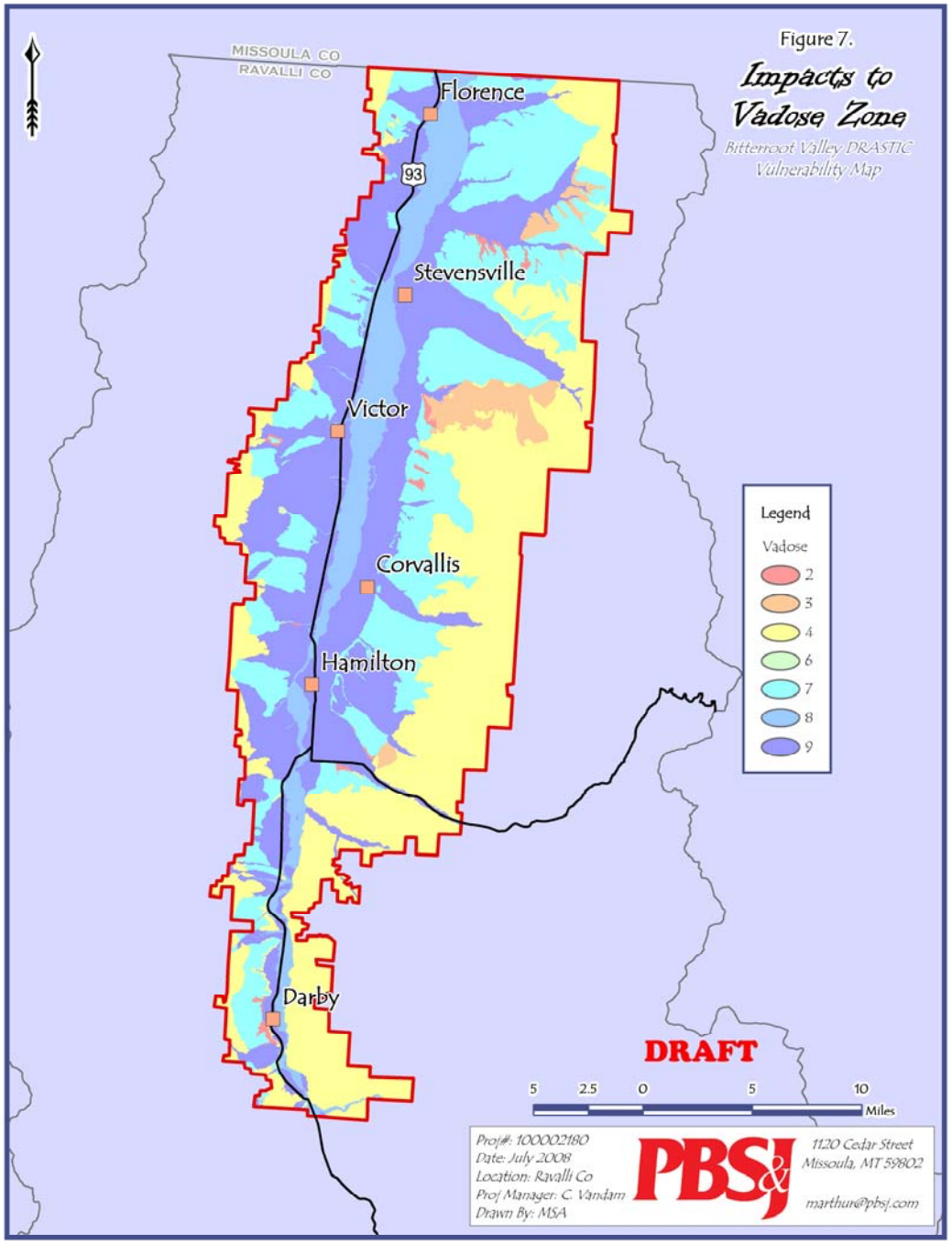
Source: SSURGO & STATSGO



SLOPE

Weight=1

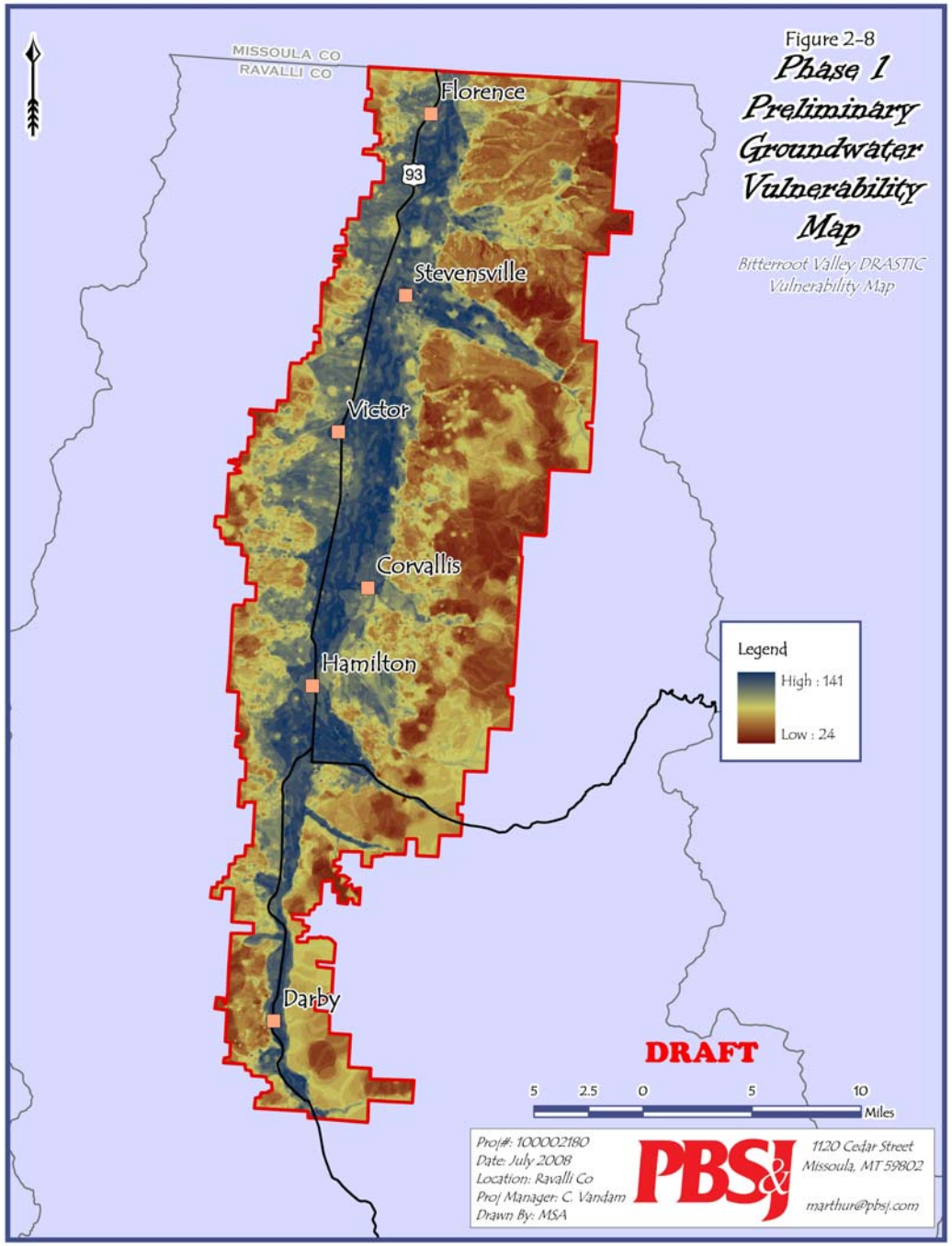
Source: USGS DEM (30m)



Impact to Vadose Zone

Weight=3

Source: Valley Surface Geology (Lonn & Sears)



Phase 1 DRASTIC Index Map

Areas of Vulnerability:

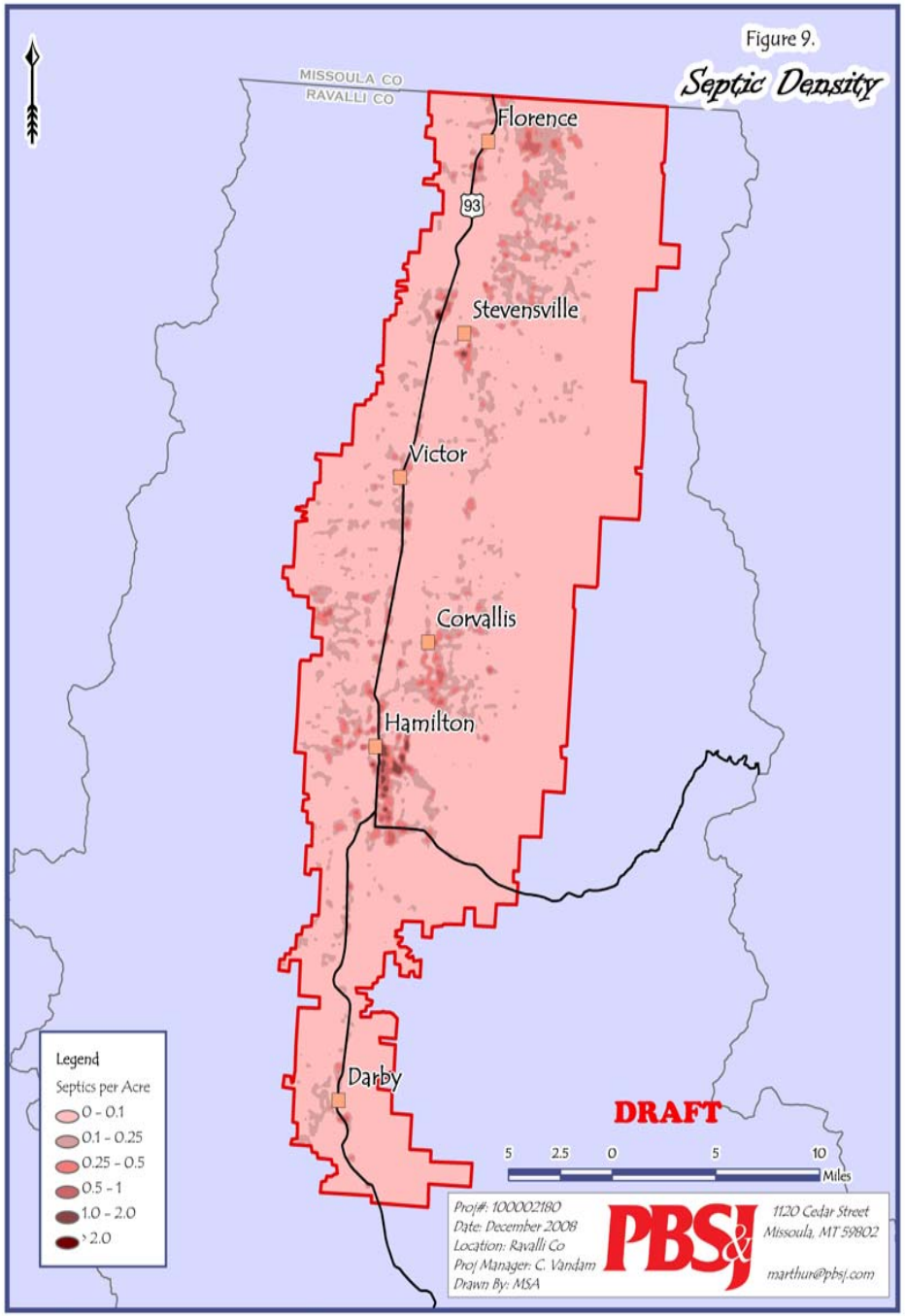
- Alluvial Valleys
- West Side Terraces

Phase 2 Revised DRASTIC Groundwater Vulnerability Map

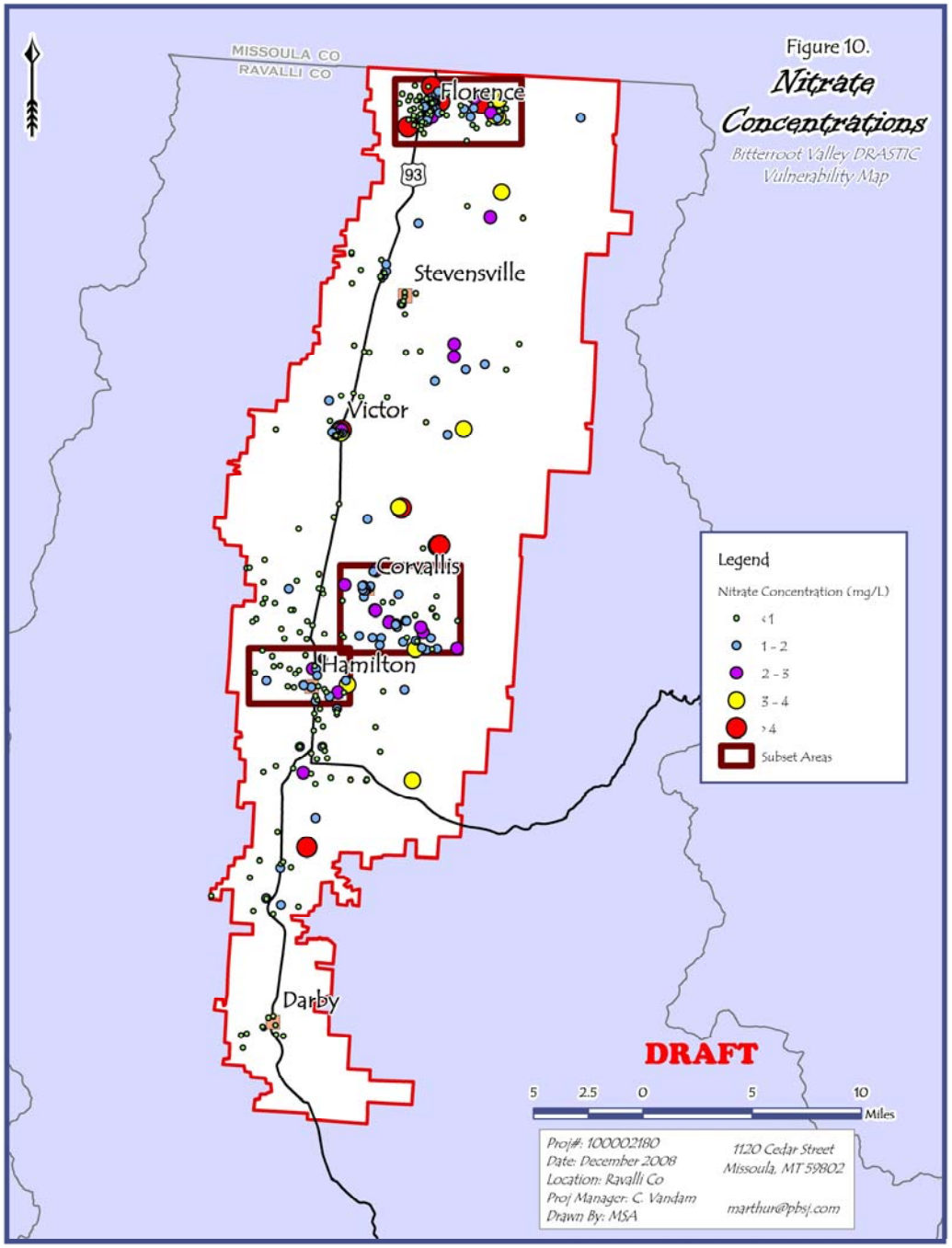
- Goal: Adjust DRASTIC to Reflect Actual Conditions
  - Develop an Environmental Model that Can Predict Nitrate Impacts
- Developed Septic Density Maps
- Prepared Nitrate Concentration Maps
- Statistical Correlations of DRASTIC Inputs to Nitrate Concentration
- Revised Groundwater Vulnerability Map

New Data: Septic Density & Nitrate

- Ravalli County Structure Data
  - Assigned septic for each identified structure
  - Use to adjust nitrate data
- Existing Nitrate Analytical Data
- GWIC and Public Water System Data
  - Rely upon data with known coordinates
- 343 Well Locations/Data Points



Septic Density Map

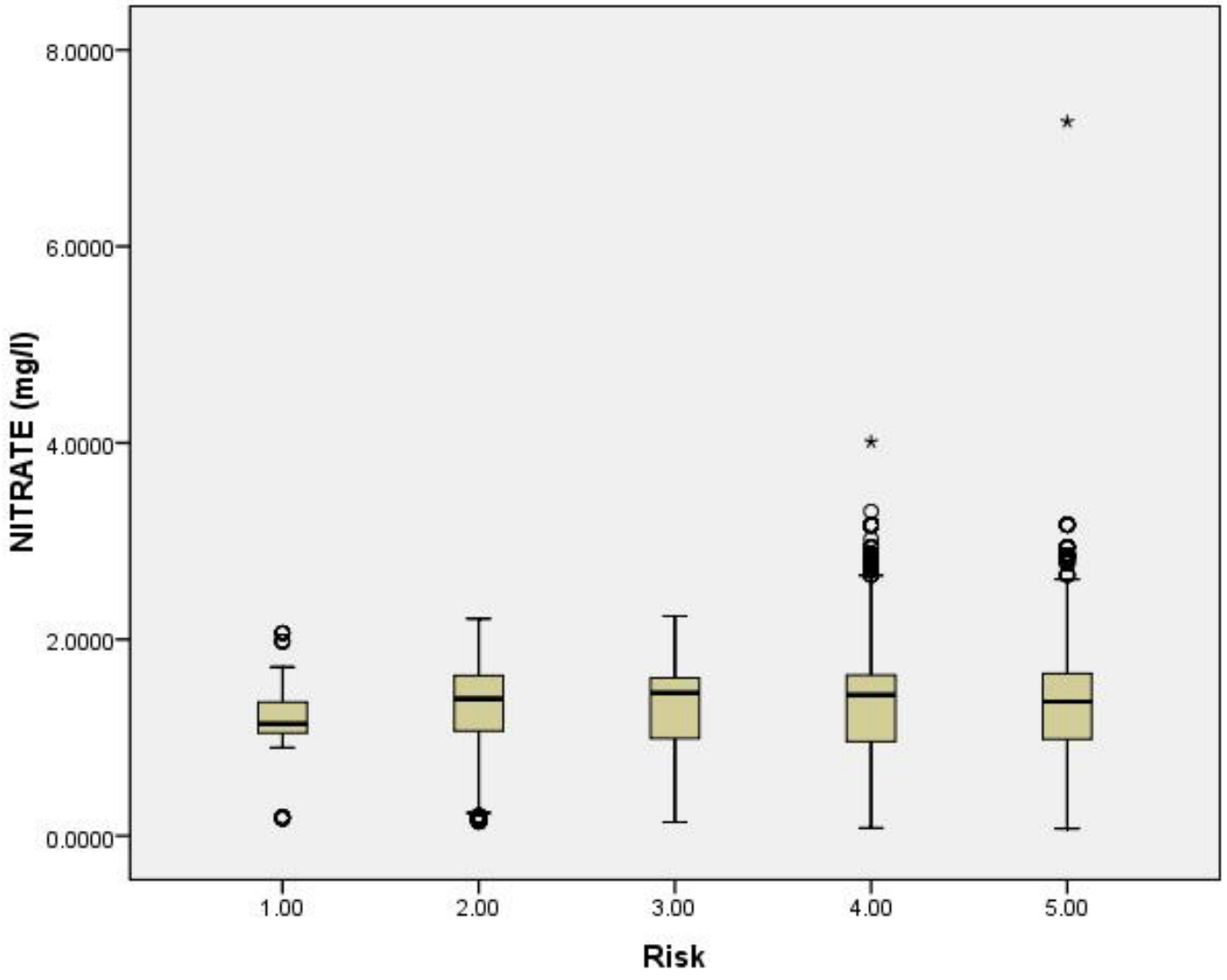


Nitrate Point Data Map

Statistical Correlations

- Bivariate correlation, ANOVA, multiple regression techniques
- Analyzed 343 data points with known nitrates
- Compared to Phase 1 vulnerability results
- Compared to individual parameters
- Adjusted parameter weighting and scale dependent on correlation results
- Tested adjusted results in three smaller areas within the valley

Statistical Correlations-Phase 1 Map 343 Nitrate Points (Risk vs. Nitrate)



Phase 1 DRASTIC
Pearson Correlation Parameters vs. Nitrate

Parameter	Nitrate
Recharge	-0.201*
Soils	-0.136*
Vadose	0.084
Slope	-0.005
Aquifer	-0.088
Septic Density	-0.05
Total Depth	-0.058
Static Water Level	0.045

*Pearson correlations significant at 1% level

Environmental Models should have correlations >0.5

Parameter Weighting Changes Based on Strong Correlations

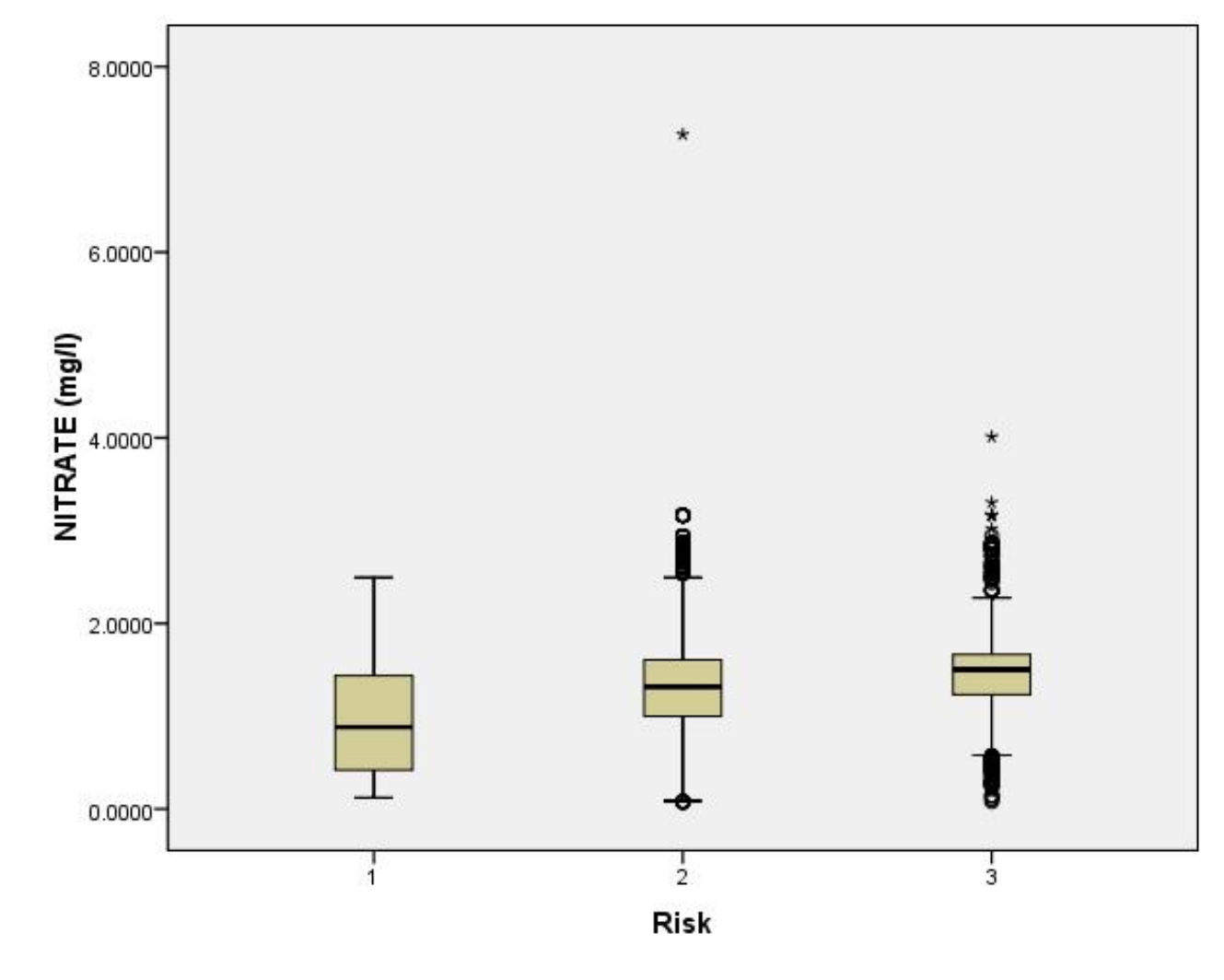
Parameter	Original Weight	Revised Weight
Recharge	1	3
Soils	2	2
Vadose	3	1
Slope	1	2
Aquifer	3	1
Depth to Water	5	1

Statistical Correlations After Revising Ranges/Weighting

Parameter	Nitrate
Recharge	0.285*
Soils	0.134*
Vadose	0.081*
Slope	0.149*
Aquifer	-0.01
Septic Density	0.038*
Depth to Water	0.118*

*Pearson correlations significant at 1% level

Statistical Correlations-Revised Phase 2 Map



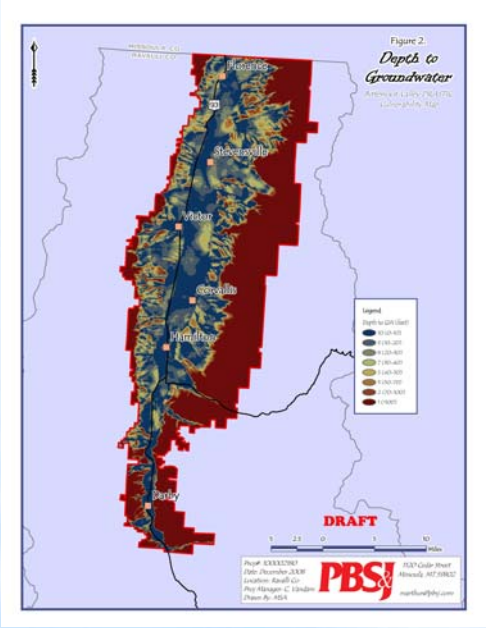


Figure 2.
Depth to Groundwater
Florence
Stevensville
Victor
Corvallis
Hamilton
Darby
Legend
DRAFT
PBSJ

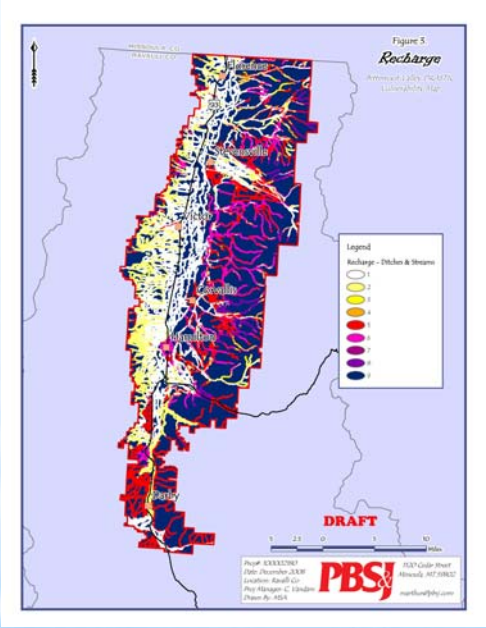


Figure 3
Recharge
Florence
Stevensville
Victor
Corvallis
Hamilton
Darby
Legend
DRAFT
PBSJ

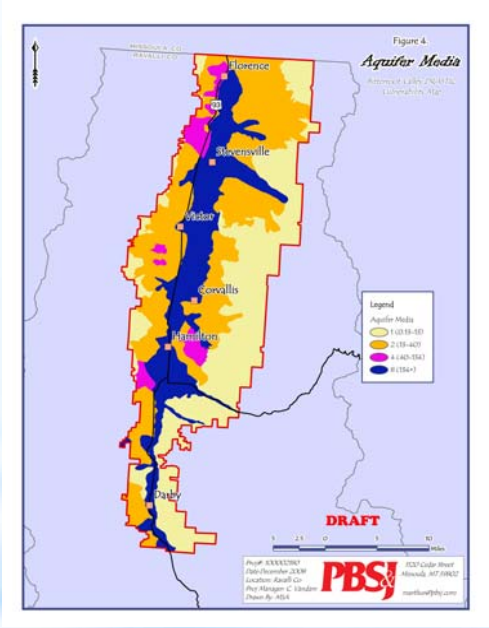


Figure 4
Aquifer Media
Florence
Stevensville
Victor
Corvallis
Hamilton
Darby
Legend
DRAFT
PBSJ

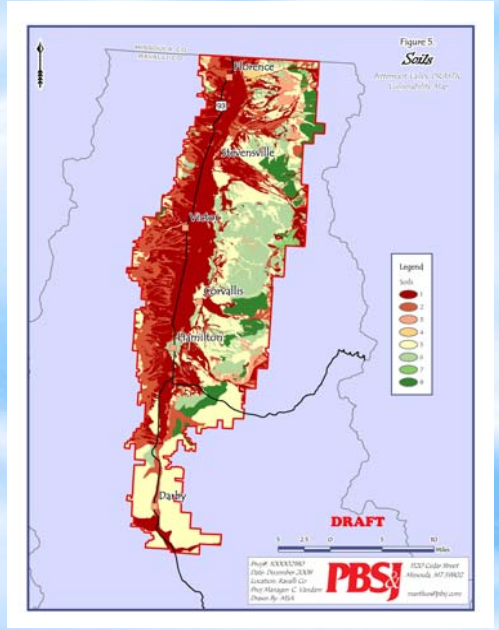


Figure 5
Soils
Florence
Stevensville
Victor
Corvallis
Hamilton
Darby
Legend
DRAFT
PBSJ

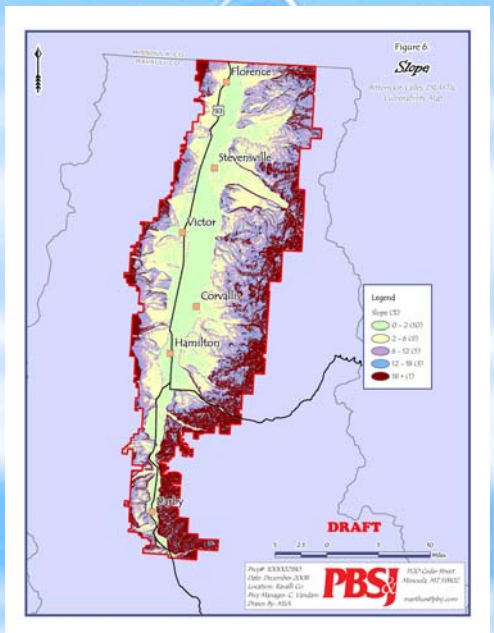


Figure 6
Slope
Florence
Stevensville
Victor
Corvallis
Hamilton
Darby
Legend
DRAFT
PBSJ

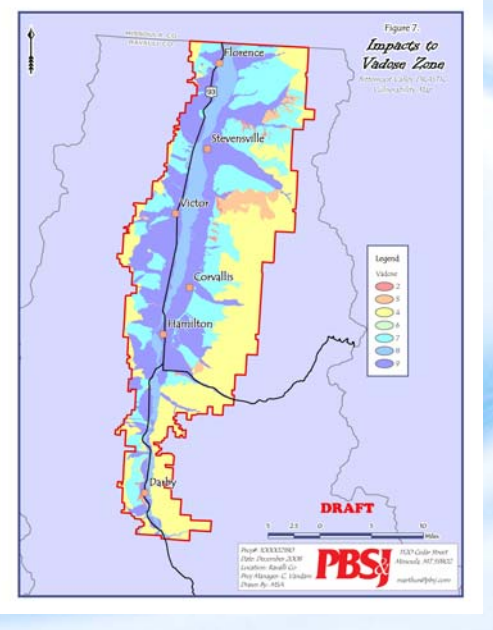


Figure 7
Impacts to Vadose Zone
Florence
Stevensville
Victor
Corvallis
Hamilton
Darby
Legend
DRAFT
PBSJ

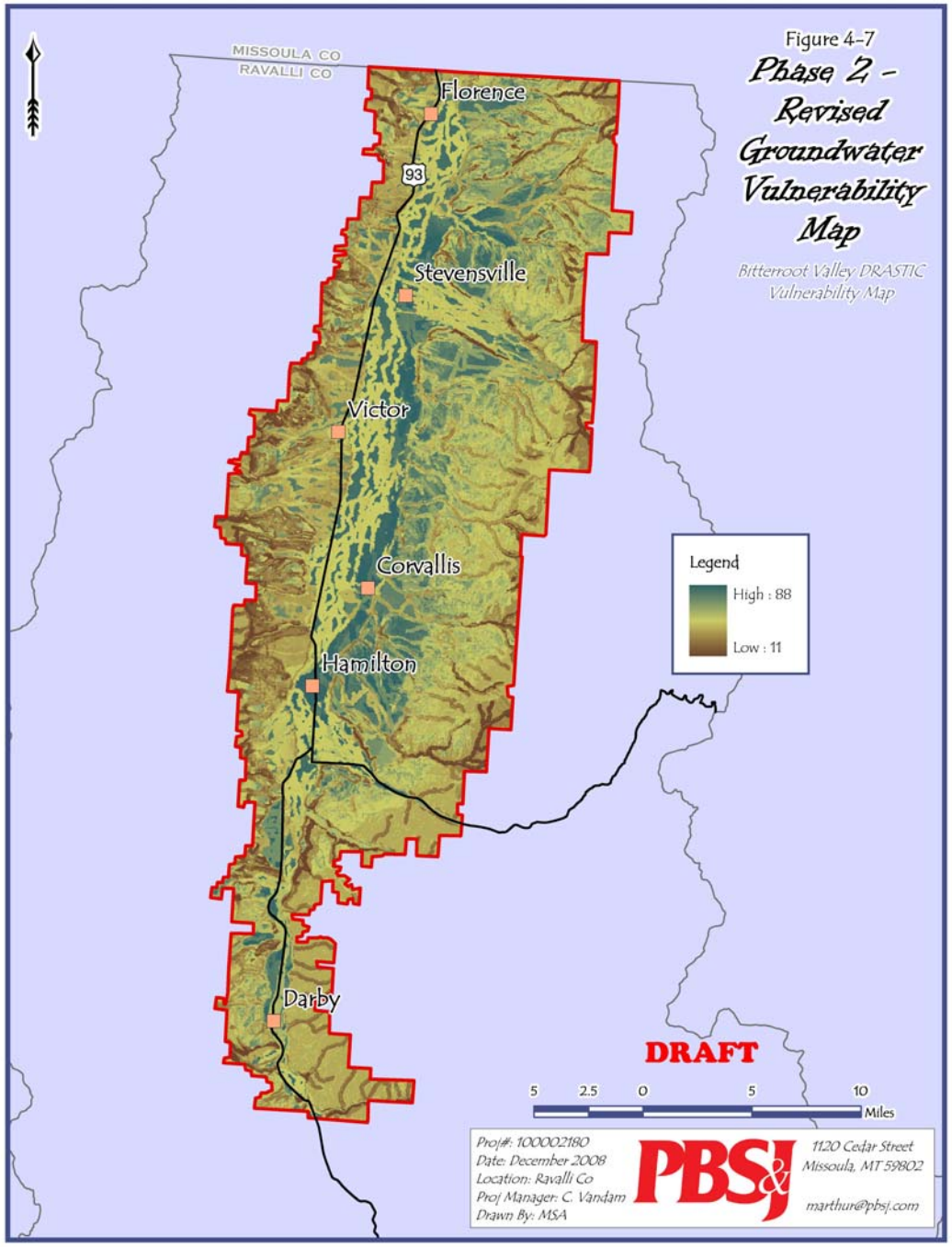


Figure 4-7
Phase 2 - Revised Groundwater Vulnerability Map
Bitterroot Valley DRASTIC Vulnerability Map
MISSOULA CO
RAVALLI CO
Florence
93
Stevensville
Victor
Corvallis
Hamilton
Darby
Legend
High : 88
Low : 11
DRAFT
5 2.5 0 5 10
Miles
Proj#: 100002180
Date: December 2008
Location: Ravalli Co
Proj Manager: C. Vandam
Drawn By: MSA
PBSJ
1120 Cedar Street
Missoula, MT 59802
marthur@pbsj.com

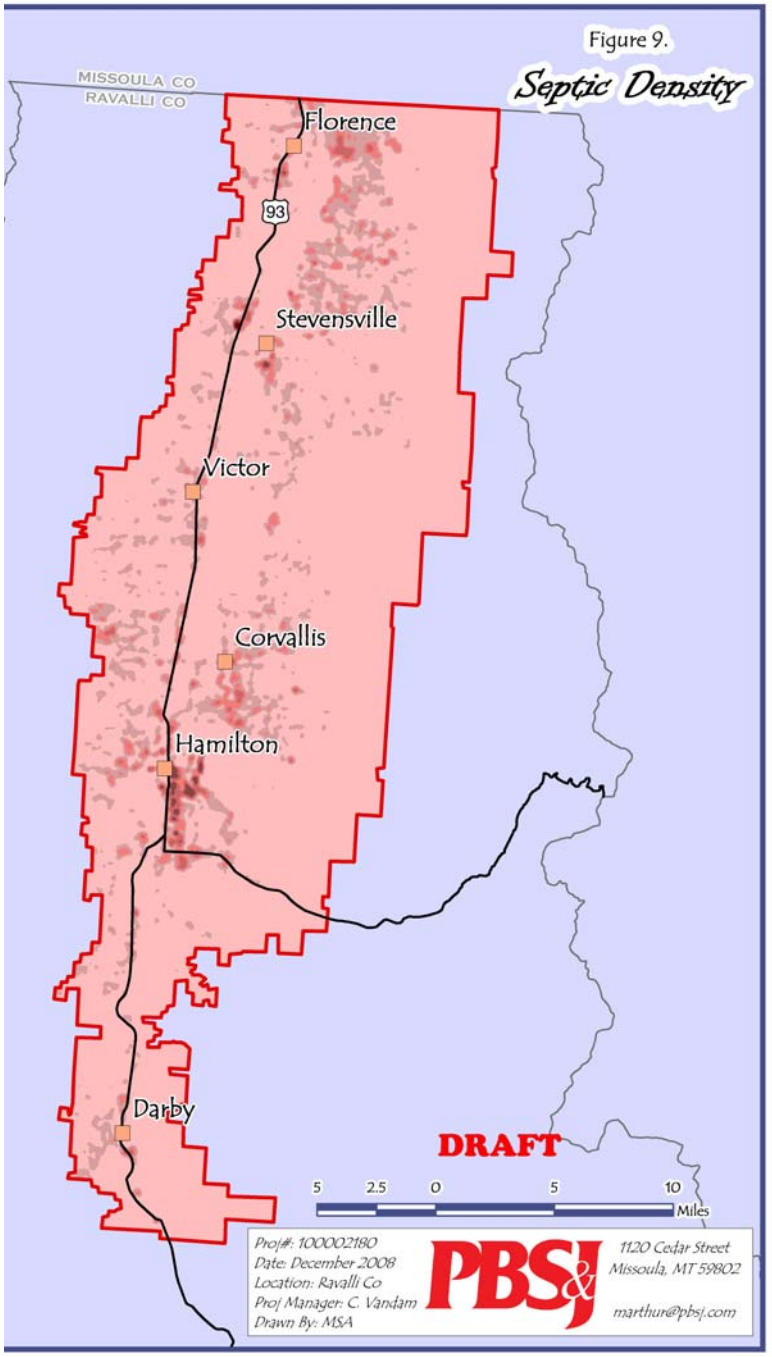


Figure 9.
Septic Density
MISSOULA CO
RAVALLI CO
Florence
93
Stevensville
Victor
Corvallis
Hamilton
Darby
DRAFT
5 2.5 0 5 10
Miles
Proj#: 100002180
Date: December 2008
Location: Ravalli Co
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Missoula, MT 59802
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Groundwater Vulnerability Mapping Project Limitations

- Simple Regional Model Based on Assumed Hydrogeologic Parameters
  - Should not be used to explain site specific conditions
- Statistical Analysis showed correlations but were weak
  - Environmental Models should have Pearson correlations >0.5
- Nitrate Data is highly variable
  - Does not account for seasonal variations
  - Limited QA/QC for sample methods
  - Limited data to account for agricultural nitrate sources
- Site specific conditions can dominate
  - Preferential flow paths
  - Proximity of septics to wells
  - Well and Septic construction methods

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Groundwater Vulnerability Mapping Project Conclusions

- Phase 1 DRASTIC did not appear to explain (correlate) Nitrates in Groundwater
- Reversing Recharge and Soil Parameter Values provided better fit
- Highest Vulnerability appears along eastside terraces
- Tool that can be refined as better data becomes available

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