TECK AMERICAN INCORPORATED
FINAL TECHNICAL MEMORANDUM
SEDIMENT COMPOSITION AND FACIES MAPS
FOR UPPER REACH OPERABLE UNIT
UPPER COLUMBIA RIVER PHASE 3 SEDIMENT STUDY

1 Introduction

This technical memorandum (tech memo) presents the sediment composition and facies maps developed for the characterization of surface sediment within the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. The Upper Reach OU encompasses the UCR from upstream of Marcus Flats at river mile (RM) 709 to the U.S.-Canada border north of RM 745 and contains three Areas of Interest (AOIs): Evans, China Bend, and Deadman's Eddy.

During fall 2018 and summer 2019, high-resolution data to identify and map sediment grain size fractions and texture of the UCR sediment bed in the Upper Reach OU were collected as described in the U.S. Environmental Protection Agency (EPA)-approved Phase 3 Sediment Facies Mapping Quality Assurance Project Plan (QAPP) (Teck American Incorporated [TAI] 2018). During the 2018 field effort, high resolution data were collected for most of the Upper Reach OU, except for a section north of the Deadman's Eddy AOI between RM 739 and RM 745. Data acquisition between RM 739 and RM 745 was completed in 2019. The following data were collected:

- Bathymetry and acoustic backscatter using a multibeam echosounder (MBES)
- Vertical velocity profile measurements via acoustic Doppler current profiler (ADCP)
- Underwater imagery using a drop-frame camera equipped with scaling lasers

Raw data collected in the field have been postprocessed to yield data for use in mapping of sediment composition and sediment facies. Field documentation (AECOM 2020) and raw data were delivered to EPA in October 2019. The data postprocessing methodology has been fully described in the Phase 3 Sediment Facies Mapping Data Summary Report (DEA 2020), which provides the postprocessed MBES, ADCP, and underwater imagery data.

The sediment facies mapping methodology and preliminary sediment composition and sediment facies maps for the AOIs were provided to EPA in a technical memorandum titled "Sediment Facies Maps for Upper Reach Operable Unit Areas of Interest, Upper Columbia River Phase 3 Sediment Study" (TAI 2019). These preliminary data were provided to EPA as an interim deliverable to support finalization of the Phase 3 Sediment Study QAPP (ERM 2019) and subsequent sediment sampling fieldwork in 2019 which focused on three Areas of Interest (AOIs): Deadman's Eddy, China Bend, and Evans. The tech memo was approved by EPA on May 2, 2019 and finalized on May 6, 2019 (TAI 2019). This tech memo expands on the TAI (2019) memo to include sediment composition and facies maps for the entire Upper Reach OU from the U.S.-Canada border at RM 745 to upstream of Marcus at RM 709.

The following information is included in this tech memo:

- Sediment composition and facies maps for Upper Reach OU
- A description of data processing workflow
- A discussion of interpreted sediment composition and sediment facies map accuracies
- A description of the project-specific texture triangle used for mapping sediment facies based on sediment compositions
- Geospatial data and map files

Examples of information that is not included in this tech memo but is included in the data summary report include copies all field documentation and detailed descriptions of all survey work performed, data postprocessing methods, and quality control measures applied during the field survey, data management, and data processing.

The sediment composition and facies maps provided in this tech memo for the Upper Reach OU do not necessarily reflect the maps that will eventually support the Baseline Ecological Risk Assessment (BERA) and/or Remedial Investigation (RI). The schedule for refining sediment composition and facies maps for the Upper Reach OU is expected to be contingent on several factors:

- Field observations and results from grain size analyses on samples collected as part of sediment sampling efforts during 2019, as well as previous studies, which may inform sediment composition mapping
- EPA review and approval of the Data Summary Report for the Phase 3 Sediment Facies Mapping Study
- Potential future modifications to the texture triangle or other modifications to the method used to define sediment facies[1] of interest for the BERA and/or RI.

1.1 Data Processing and Analysis Workflow

The general workflow for processing field data and analyzing postprocessed data is shown in Figure 1-1. The workflow for data processing and analysis to develop sediment composition and facies map included the steps described below.

1. Raw acoustic and photographic field data were acquired as described in the Phase 3 Sediment Facies Mapping QAPP. All raw data were inspected by the sediment facies mapping (SFM) Task Manager and Quality Assurance (QA) Manager and were confirmed to meet or exceed the performance criteria specified by the Measurement Quality Objectives (MQOs) established in the QAPP (TAI 2018).

2. Raw field data were processed to create a bathymetry digital elevation model (DEM) from MBES data, an acoustic backscatter mosaic from MBES data, and sediment bed composition data from underwater imagery. All processed data were reviewed by the SFM Task Manager and QA Manager and confirmed to meet or exceed the performance criteria specified by the MQOs established in the QAPP (TAI 2018).

3. In preparation for developing the sediment composition maps, the MBES bathymetry and backscatter were enhanced to produce additional first- and second-order statistical layers describing the surface geometry (e.g., slope, aspect, curvature, rugosity) and surface texture (e.g., contrast, homogeneity, entropy, uniformity) of the riverbed. The MBES bathymetry, backscatter, and the statistical layers provided detailed, quantitative information for spatially describing the riverbed.[2] In addition, ground reference data were assembled from the underwater imagery. Each underwater photograph was analyzed to determine the percent composition of surface sediments for specific grain size fractions. A combination of automated and manual image analysis was performed to provide sediment composition (grain size fraction) data from underwater imagery. In-field observations of sediment veneers, vegetation, and other notable features were reviewed and incorporated during the image analysis. The following sediment grain size fractions

[1] Sediment (or sedimentary) facies describe physical, chemical, and biological aspects of bed composition.

[2] The acoustic backscatter mosaic can also provide first-order, qualitative information on sediment texture, where darker (lower backscatter intensity) areas generally indicate softer/smoother materials and lighter (higher backscatter intensity) areas generally indicate harder/rougher materials.

(as percentages of the image area) were used for image analysis, in accordance with the QAPP (TAI 2018):

- Bedrock
- Boulders and cobble (> 64 mm)
- Gravels (2 to 64 mm)
- Finer-grained (< 2 mm)

To facilitate classification, grain size fractions for each sediment type were binned into categories. The binning scheme is shown below.

Percent Composition	Bin/Category
0-10%	1
10-20%	2
20-30%	3
30-40%	4
40-50%	5
50-60%	6
60-70%	7
70-80%	8
80-90%	9
90-100%	10

4. Sediment composition mapping was a multivariate, object-based analysis process that included several phases: segmentation, classification, and validation. The segmentation process transforms pixel-based remote sensing data into groups of pixels (polygons or "objects") based on spatial and/or spectral properties. Segmentation is a fundamental component of the object-based analysis approach, which is superior over pixel-based approaches for analyzing high-resolution remote sensing data. For this project, segmentation was performed using the combined MBES bathymetry, backscatter, and statistical layers, which yielded a data set of objects for classification.
5. During the classification (machine learning) process, the objects and their attributes were related to ground reference data (underwater images) to develop a relationship between the acoustic data (bathymetry, backscatter, and statistics) and the sediment bed composition. The selection of accurate ground reference data is crucial to a successful classification (McClinton et al. 2012), therefore 54 underwater images were excluded from the ground reference data due to a) images being obstructed by dense submerged aquatic vegetation (SAV), or b) images consisting mostly or entirely of bedrock outcrops. In total, 563 underwater images were used as ground reference data for sediment composition classification. Approximately 75 percent of the ground reference data points (*n*=422) were randomly chosen as training data. Underwater imagery locations used as training data are listed in Attachment A, Table A1. After initial testing, a decision forest classification algorithm was chosen as the machine learning method. Classification was an iterative process that continued until optimization of the relationship was achieved (as measured by the validation process).
6. The validation process, also known as an accuracy assessment, measured the agreement between the classification output for grain size fractions (fines, gravel, boulders/cobbles) and the ground

reference data. Prior to classification, the remaining 25% of the ground reference data not used during training (*n*=141) was set aside for use as an independent validation data set (referred to as "testing data"). Underwater imagery locations used as testing data are listed in Attachment A, Table A2. Error matrices were constructed to compare the testing data with the classification output. Accuracy statistics were calculated from the error matrix. The results have been subdivided by discrete sediment grain size categories for clarity. For reference, accuracy levels between 61%-80% indicate "substantial" agreement and levels between 81%-100% indicate "almost perfect" agreement (Landis and Koch 1977; Fleiss 1981). The results of the sediment classification accuracy assessment are provided in Attachment A, Tables A3 through A8.

Overall map accuracy, calculated as the number of correct observations divided by the total number of observations, is 81.03%. Categorical accuracy is 73.05% for fine sediment (< 2 mm), 74.47% for gravel sediment (2 to 64 mm), and 100% for boulder and cobble sediment (> 64 mm).

Recognizing the continuous nature of the sediment composition classification, map accuracy was also calculated using a buffer of +/- 10%. Using this buffer, the sediment classification output was counted as correct if the value was within 10% of that indicated by the testing data. This method yields an overall map accuracy of 94.15% and categorical accuracies of 89.36% for fine sediment (< 2 mm), 92.91% for gravel sediment (2 to 64 mm), and 100% for boulder and cobble sediment (> 64 mm).

7. The classification was then exported to produce calculated sediment composition polygons showing percent of sediment grain size fractions (fines, gravel, boulders/cobbles) and bedrock. Additional review and analysis was conducted by a geophysicist to further subdivide the "finer-grained" category into sand (0.063 to 2 mm) and mud (< 0.063 mm) constituents. Because sand could not be quantitatively and/or reliably differentiated from mud in the underwater imagery using either automated or manual inspection, this analysis utilized Angular Range Analysis (ARA) of the MBES backscatter. ARA (described in detail in Fonseca and Mayer [2007]) is a standard, semi-automatic method for estimating substrate properties directly from MBES backscatter. ARA was applied to the MBES backscatter and clearly distinguished sand from mud. Ground reference data were qualitatively reviewed to validate the accuracy of the ARA method, which was estimated to be comparable with the other sediment composition maps based on the available ground reference data. An attractive byproduct of the ARA method was that it provided an additional validation data set for the sediment composition classification. The sediment composition classification and the ARA analysis were qualitatively reviewed and determined to be in excellent agreement. The sediment composition polygons provide the information needed for mapping any combination of sediment textures through straightforward spatial queries.
8. A project-specific sediment classification system defining surface sediment facies (sediment types) was developed as a sediment texture triangle. The sediment classification system, which is described in the next section, was tailored to physical conditions in the Upper Reach OU and to support development of Phase 3 Sediment Study QAPP (ERM 2019). The sediment texture triangle was approved by EPA on May 2, 2019 (TAI 2019).
9. The sediment classification system was applied to the sediment composition maps to produce sediment facies maps. Because sediment bed facies were mapped directly from the sediment

composition layers, the accuracy of sediment facies interpretations is comparable to the accuracy of sediment compositions.[3]

1.2 Additional Considerations

- Dense SAV in shallow water depths (less than 5 meters) was obvious in the bathymetry DEM and acoustic backscatter imagery. In these areas, the vegetation produced a signal in the MBES data that interfered with (i.e., artificially biased) data analysis. As a result, sediment bed composition (and consequently sediment facies) could not be mapped in densely vegetated areas within the Upper Reach OU. Areas with dense SAV are depicted as green polygons on Maps 3-1a through 3-9e.

- The sediment composition and facies classifications are valid for surficial sediments only and do not include any subsurface components not readily detectable or otherwise visible in the underwater imagery data set.

- During classification, data from previous studies was evaluated to potentially supplement the ground reference dataset used for developing and/or validating the backscatter/bathymetry-sediment composition relationship. Underwater video collected by the Confederated Tribes of the Colville Reservation (CCT) in 2017 did not meet the MQOs specified in the QAPP (ERM et al. 2018); however, these data were qualitatively evaluated as additional ground reference data. Due to the limitations of data from previous studies, and because an acceptable relationship was developed and validated using data for the current study, data from previous studies were not used for sediment composition interpretation. Based on a cursory review of existing sediment grain size analyses, the sediment composition maps are expected to be generally consistent with data and observations from previous studies. It is anticipated that grain size data from these previous studies, as well as the Phase 3 Sediment Study, will be used to refine sediment composition and facies maps.

- The processed ADCP data were evaluated as an additional, independent line of evidence to corroborate the relationship between acoustic signals and sediment compositions and facies. At each ADCP measurement location, the mean current velocity was compared with the assigned sediment facies. Mean velocity profiles with invalid log-fit relationships were excluded from this analysis. The results of this comparison show that, in general, coarser sediment textures are associated with higher mean current velocities, whereas finer sediment textures are associated with lower mean current velocities (Figure 1-2). This relationship is consistent with empirical observations and modeled relationships regarding subaqueous sediment transport processes (e.g. Hjulstrom 1935, Shields 1936, Miedema 2010). The sediment facies map was also compared with the coefficient of friction as calculated from the processed ADCP data. The results of this comparison show that the coarser sediment textures are generally associated with lower friction coefficients, with the friction coefficient increasing as sediment grain sizes decrease (Figure 1-3). This relationship is consistent with empirical observations and modeled relationships suggesting that friction coefficients increase as riverbed sediment mobility (i.e. finer grain sizes) increases (e.g. Rakozsi 1967, Song et al 1998, Carbonneau and Bergeron 2000, Habibzadeh and Omid 2009). These comparisons are supportive of the sediment facies mapping results and the spatial distribution of sediment facies. Note that the ADCP data reflect river conditions during October-November 2018.

[3] During the Phase 3 Sediment Study surface sediment sampling program, the sediment bed was inspected using video or direct observations to confirm that the sediment texture at a proposed sampling location appeared consistent with the target sediment facies from the sampling design. If the actual sediment texture appeared different than the target facies type, the location was adjusted or sampling was performed at an alternate location. These procedures were in the Phase 3 Sediment Study QAPP (ERM 2019).

1.3 Texture Triangle Development and Surface Sediment Facies

As described above under Step 6 of the data workflow and shown in Figure 1-4, a project-specific sediment classification system defining surface sediment facies (sediment types) was developed to support the sample design for the Phase 3 Sediment Study (ERM 2019) and approved by EPA on May 2, 2019 (TAI 2019). The sediment classification system uses a sediment texture triangle (ternary diagram) with end members of sand and mud (combined and collectively referred to as "finer-grained sediment"), gravel, and boulder/cobble (see Figure 1-4). Sediment facies (sediment types) were identified by regions within the triangle, and the texture triangle was applied to sediment composition maps to identify the sediment facies throughout the MBES-mapped areas of the Upper Reach OU.

Divisions were identified within the texture triangle to establish sediment types considering the following factors:

End members – Sediment composition polygons containing 80% or more of one grain size were assigned the sediment type corresponding to that grain size fraction. For example, polygons with 80% or more gravel were assigned a sediment type of "G" (for gravel). Because the finer-grained sediment end member of the texture triangle represents combined sand and mud, polygons containing greater than 80% finer-grained sediment (i.e., within the very top portion of the texture triangle), were identified as either sand or mud. Sediment types identified as end members include sand (type "S"), mud (type "M"), gravel (type "G"), and boulder/cobble (type "B").

Alternate end members evaluated during development of the texture triangle, including a more traditional triangle with end members of sand, mud, and gravel that is used for the Folk classification system (Folk 1954, 1974). The selected end members were found to better illustrate sediment bed heterogeneity and site conditions of the Upper Reach OU, which is characterized by frequent occurrence of cobbles, boulders, and exposed bedrock.

Finer-grained sediment content – Mixed sediment types were identified as having no more than 80% of any grain size fraction. Divisions within the mixed sediment region of the texture triangle were based on the amount of finer-grained sediment, with mixed sediment types corresponding to: predominantly finer-grained (50% to 80% finer grained, type "mF"), predominantly coarse but with finer-grained sediments (50% to 20% finer-grained, types "mC" and "mB"), and negligible finer-grained content (less than 20% finer grained, type "C").

Sub-classes were identified for mixed areas (mixed fine-grained [mF], mixed coarse [mC], and mixed boulder/cobble [mB]) to identify whether the finer-grained sediment is either predominantly sand or predominantly mud (silt and clay), which resulted in the following revised sediment facies for mixed sediments:

mFm = Mixed Fines, predominantly Mud

mFs = Mixed Fines, predominantly Sand

mCm = Mixed Coarse with Mud

mCs = Mixed Coarse with Sand

mBm = Mixed Boulder/Cobble with Mud

mBs = Mixed Boulder/Cobble with Sand

Sampleability – The expected sampling method and potential for collecting bulk sediment samples using various methods (or "sampleability") was a consideration for identifying sediment types, as this

would help inform the sampling method(s) targeted for use at point locations during the Phase 3 sediment study and could also help identify areas that were likely to be not sampleable. As described in the Phase 3 QAPP, sediment types S (sand) and M (mud) are expected to be sampleable using mechanical sampling devices such as a power Van Veen grab or a modified Hamon grab sampler, as these sediment types consist of mostly finer-grained sediments with less than 20% coarse (i.e., gravel and boulder/cobble) content. Mixed type mF, with 50% to 80% finer grained sediment, may be sampleable using a mechanical sampler if the coarse sediment content is low. Mixed type mC, with 20% to 50% finer grained content and less than 50% boulder/cobble, is not expected to be sampleable using mechanical grab methods, but may sampleable using a freeze grab method. Sediments containing more than 50% boulder/cobble or less than 20% finer-grained sediment are not expected to yield an acceptable sample using a freeze grab sampler; therefore sediment types mB (mixed boulder), C (coarse), G (gravel), and B (boulder/cobble) are considered not sampleable for sediment, although porewater sample collection may be possible in these sediment types. Note that sampleability determinations outlined in this document were implemented during the 2019 Phase 3 sediment study and may be reviewed and revised based on those sampling results.

Phase 3 Sediment Study Strata of Interest – The Phase 3 Sediment Study QAPP (ERM 2019) identified four strata of interest (or target strata) for sampling within the Upper Reach OU AOIs. These strata of interest include:

Sampleable Sand - sediment containing more than 50 percent finer-grained sediments, and includes sand and mixed fines, predominantly sand facies classes (S, and mFs)

Mixed Coarse - sediment containing 50 percent to 20 percent finer-grained sediment, and includes mixed coarse with sand facies (mCs)

Mud - sediment containing greater than 80 percent silt and clay (M)

Coarse - sediment containing greater than 50 percent cobbles and boulders (mBs) and/or contains less than 20 percent fine-grained (< 2 mm) sediment (B, C, and G). Due to anticipated difficulties in obtaining bulk samples from this material, only porewater samples were identified for collection from this stratum.

To summarize, the sediment types mapped using the project-specific texture triangle capture the relative amount of finer-grained sediment and the expected sampleability of the sediment bed and the strata of interest at Upper Reach OU AOIs for the Phase 3 sediment study. The table below presents each sediment type, its texture characteristics, and whether it was a Phase 3 sediment study strata of interest.

2 Sediment Composition and Sediment Facies Maps

Calculated/interpreted sediment composition maps for the Upper Reach OU were prepared showing the spatial distribution of percent sediment grain size fractions (mud, sand, gravel, or boulders/cobbles), when present. Areas of bedrock and dense SAV, if present, are shown in each sediment composition map.

Sediment composition data and the project-specific texture triangle (Figure 1-4) were combined to develop a sediment facies map for the Upper Reach OU. The coverage area and relative abundance of each sediment facies are provided in Table A9.

Sediment composition maps and the sediment facies maps for the Upper Reach OU are provided in the Maps 3-1a – 3-9e.

3 Summary and Next Steps

This memo provides a summary of the procedures used by TAI to process field data collected within the Upper Reach OU and to analyze postprocessed data to develop sediment composition maps. A project-specific sediment texture triangle was developed to classify surface sediment facies (sediment types), and this classification was applied to the sediment composition maps to produce sediment facies maps that were used to support the Phase 3 Sediment Study (ERM 2019).

The sediment composition and facies maps for the AOIs and the texture triangle were approved by the EPA on May 2, 2019 (TAI 2019).

It is anticipated that data acquired during the Phase 3 Sediment Study fieldwork, including sediment samples with grain size analyses, will be used to update and refine the sediment composition and facies maps. Grain size analyses from previous studies will also be evaluated for incorporation into the final sediment composition and facies maps.

4 References

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Attachments

Attachment A. Sediment Training Data, Testing Data, and Error Matrices

Attachment B. Digital Deliverable Containing Sediment Grain Size Composition Maps and Sediment Facies Maps (ESRI Shapefile To be provided electronically) and description

List of Figures

List of Maps

Attachment A

Sediment Training Data, Testing Data, and Error Matrices

Table A1 Underwater imagery locations used as training data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
001-03	2407311.44	743766.84	B Boulder/Cobble
001-04	2407487.58	743658.16	B Boulder/Cobble
002-01	2406633.66	741114.47	B Boulder/Cobble
002-02	2406724.46	741104.74	B Boulder/Cobble
002-04	2406986.10	741074.04	B Boulder/Cobble
002-05	2407108.51	741063.26	C Coarse
003-01	2406440.33	738537.73	B Boulder/Cobble
003-02	2406578.66	738489.75	B Boulder/Cobble
003-03	2406709.42	738451.94	B Boulder/Cobble
003-04	2406845.51	738409.18	B Boulder/Cobble
003-05	2406972.81	738369.57	B Boulder/Cobble
004-01	2406132.19	736199.93	B Boulder/Cobble
004-02	2406240.60	736129.36	B Boulder/Cobble
004-03	2406349.75	736064.39	B Boulder/Cobble
004-04	2406460.04	735999.25	B Boulder/Cobble
004-05	2406567.67	735935.94	B Boulder/Cobble
005-01	2404049.95	735054.46	C Coarse
006-02	2401963.39	733480.71	B Boulder/Cobble
006-03	2402033.15	733378.69	C Coarse
006-04	2402103.23	733274.68	mCs Mixed Coarse with Sand
007-01	2399564.62	732316.45	B Boulder/Cobble
007-02	2399631.57	732219.87	B Boulder/Cobble
007-03	2399697.37	732123.89	B Boulder/Cobble
007-04	2399767.24	732026.87	B Boulder/Cobble
007-05	2399835.26	731932.23	mBs Mixed Boulder/Cobble with Sand
008-01	2397615.33	730444.33	B Boulder/Cobble
008-03	2397838.07	730275.46	B Boulder/Cobble
008-04	2397949.16	730191.17	B Boulder/Cobble
008-05	2398060.84	730106.59	B Boulder/Cobble
009-01	2395656.44	728985.72	B Boulder/Cobble
009-02	2395706.75	728881.59	mCs Mixed Coarse with Sand
009-03	2395758.98	728772.74	B Boulder/Cobble
009-04	2395808.26	728661.75	B Boulder/Cobble
009-05	2395863.60	728555.37	B Boulder/Cobble
010-01	2393403.02	727704.00	B Boulder/Cobble
010-02	2393423.69	727607.31	B Boulder/Cobble
010-03	2393445.71	727511.65	B Boulder/Cobble
010-04	2393469.09	727414.08	B Boulder/Cobble
010-05	2393491.85	727319.20	B Boulder/Cobble
011-01	2390910.19	726771.59	B Boulder/Cobble
011-02	2390965.51	726670.97	B Boulder/Cobble
012-04	2389671.70	724539.87	B Boulder/Cobble
013-02	2389080.22	723824.15	B Boulder/Cobble
013-03	2389130.55	723775.80	C Coarse
013-05	2389214.83	723687.27	C Coarse
013-06	2389260.69	723647.50	C Coarse
014-01	2388382.37	723074.34	B Boulder/Cobble

Table A1 Underwater imagery locations used as training data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
014-02	2388416.78	723017.18	B Boulder/Cobble
014-03	2388459.66	722963.70	B Boulder/Cobble
014-04	2388500.07	722904.81	B Boulder/Cobble
014-05	2388546.66	722857.15	B Boulder/Cobble
014-06	2388581.64	722796.73	B Boulder/Cobble
015-01	2387545.74	722458.37	B Boulder/Cobble
015-02	2387614.79	722375.65	B Boulder/Cobble
015-03	2387684.05	722305.19	B Boulder/Cobble
015-04	2387761.66	722230.80	B Boulder/Cobble
015-06	2387916.71	722096.93	B Boulder/Cobble
015-08	2388062.34	721945.43	B Boulder/Cobble
016-01	2387398.18	722283.85	B Boulder/Cobble
016-02	2387384.12	722075.09	B Boulder/Cobble
016-03	2387372.10	721868.37	B Boulder/Cobble
016-04	2387361.03	721652.11	B Boulder/Cobble
016-05	2387352.41	721445.91	C Coarse
016-06	2387339.66	721233.74	C Coarse
016-07	2387320.36	721017.43	C Coarse
016-09	2387300.60	720601.12	mFs Mixed Fines, predominantly Sand
016-10	2387289.70	720389.23	mFs Mixed Fines, predominantly Sand
017-01	2387200.45	722275.03	C Coarse
017-06	2386827.06	721379.71	C Coarse
017-07	2386748.39	721203.83	B Boulder/Cobble
017-08	2386680.06	721026.10	mCs Mixed Coarse with Sand
017-10	2386533.02	720664.54	C Coarse
018-02	2386516.36	722143.46	B Boulder/Cobble
018-03	2386478.04	722039.80	B Boulder/Cobble
018-04	2386440.59	721939.30	B Boulder/Cobble
019-04	2385678.48	722343.58	C Coarse
019-05	2385610.82	722150.76	B Boulder/Cobble
019-06	2385578.47	722024.35	B Boulder/Cobble
019-07	2385526.54	721881.92	B Boulder/Cobble
020-01	2384948.74	723386.25	C Coarse
020-05	2384885.18	722763.97	C Coarse
020-06	2384872.05	722629.68	C Coarse
020-07	2384851.08	722494.56	C Coarse
020-09	2384825.29	722236.48	B Boulder/Cobble
021-03	2384244.68	722906.92	B Boulder/Cobble
021-04	2384247.37	722737.38	C Coarse
022-02	2381903.95	721905.61	B Boulder/Cobble
023-01	2379991.75	721239.56	B Boulder/Cobble
023-02	2379987.36	721076.74	B Boulder/Cobble
023-03	2379978.75	720919.63	B Boulder/Cobble
023-04	2379972.24	720762.69	mFs Mixed Fines, predominantly Sand
023-05	2379969.48	720604.50	B Boulder/Cobble
024-05	2379033.31	719755.93	B Boulder/Cobble
025-02	2377252.97	717796.60	B Boulder/Cobble

Table A1 Underwater imagery locations used as training data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
025-03	2377376.98	717712.85	B Boulder/Cobble
025-04	2377505.45	717635.74	B Boulder/Cobble
026-01	2375388.62	716375.37	mCs Mixed Coarse with Sand
026-02	2375455.23	716215.13	B Boulder/Cobble
026-04	2375584.03	715895.45	B Boulder/Cobble
026-05	2375601.14	715843.29	B Boulder/Cobble
027-01	2373272.99	715431.64	C Coarse
027-03	2373372.97	715045.74	C Coarse
027-04	2373428.87	714854.48	C Coarse
027-05	2373474.46	714688.52	B Boulder/Cobble
028-01	2371028.92	713977.95	B Boulder/Cobble
028-02	2371215.16	713859.88	C Coarse
028-03	2371390.32	713734.84	C Coarse
028-04	2371577.33	713616.17	B Boulder/Cobble
028-05	2371685.10	713546.89	C Coarse
029-01	2369093.50	712437.12	B Boulder/Cobble
029-02	2369243.95	712295.31	B Boulder/Cobble
029-03	2369398.03	712161.97	B Boulder/Cobble
029-04	2369544.95	712021.79	C Coarse
030-01	2367748.54	710218.34	B Boulder/Cobble
030-02	2368103.82	710178.57	B Boulder/Cobble
031-01	2366409.41	708098.55	C Coarse
031-02	2366760.47	707942.45	C Coarse
031-03	2367108.04	707785.85	C Coarse
031-04	2367459.33	707630.00	C Coarse
032-02	2364989.15	706476.93	C Coarse
032-04	2365340.33	706050.16	C Coarse
032-05	2365515.18	705835.64	C Coarse
033-02	2363571.94	704692.91	B Boulder/Cobble
033-03	2363793.45	704533.54	C Coarse
033-04	2364004.61	704362.59	C Coarse
033-05	2364227.72	704211.15	B Boulder/Cobble
034-01	2361367.37	703198.74	mFs Mixed Fines, predominantly Sand
034-03	2361832.53	702766.40	C Coarse
034-05	2362172.58	702444.54	C Coarse
035-01	2360334.25	700703.42	C Coarse
035-02	2360447.47	700598.46	C Coarse
035-03	2360565.26	700505.12	B Boulder/Cobble
035-04	2360694.13	700413.38	C Coarse
035-05	2360813.44	700317.54	mBs Mixed Boulder/Cobble with Sand
036-01	2358708.80	698770.52	C Coarse
036-03	2359151.60	698371.13	C Coarse
037-01	2356295.78	697792.03	C Coarse
037-02	2356350.50	697706.66	C Coarse
037-03	2356411.97	697626.30	C Coarse
037-05	2356532.56	697461.93	B Boulder/Cobble
039-05	2351940.20	695745.57	mFs Mixed Fines, predominantly Sand

Table A1 Underwater imagery locations used as training data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
041-01	2348647.65	692233.03	S Sand
041-02	2348781.62	691998.90	mFs Mixed Fines, predominantly Sand
041-03	2348924.70	691775.38	C Coarse
041-04	2349056.95	691544.40	C Coarse
041-05	2349208.38	691323.68	B Boulder/Cobble
042-01	2346526.69	690952.87	mBs Mixed Boulder/Cobble with Sand
042-02	2346598.06	690804.40	S Sand
042-03	2346670.44	690660.34	mFs Mixed Fines, predominantly Sand
042-04	2346740.17	690516.96	mCs Mixed Coarse with Sand
042-05	2346817.42	690373.20	mCs Mixed Coarse with Sand
043-04	2344701.15	689071.76	B Boulder/Cobble
044-04	2342958.13	687546.35	mFs Mixed Fines, predominantly Sand
044-05	2343031.79	687301.46	C Coarse
045-01	2340850.58	686076.73	B Boulder/Cobble
045-02	2341021.29	685995.61	mCs Mixed Coarse with Sand
045-04	2341365.44	685857.03	mCs Mixed Coarse with Sand
045-05	2341534.16	685791.43	mFs Mixed Fines, predominantly Sand
046-03	2340880.36	683367.02	G Gravel
047-01	2339972.47	680908.61	M Mud
047-03	2340619.64	680873.51	C Coarse
047-04	2340942.88	680848.92	mFs Mixed Fines, predominantly Sand
047-05	2341267.50	680830.79	mFs Mixed Fines, predominantly Sand
048-01	2340411.09	679181.13	mFs Mixed Fines, predominantly Sand
048-02	2340582.93	679047.46	mCs Mixed Coarse with Sand
048-03	2340715.32	678949.70	mFs Mixed Fines, predominantly Sand
048-05	2341142.62	678617.57	mBs Mixed Boulder/Cobble with Sand
048-06	2341358.63	678457.71	mBs Mixed Boulder/Cobble with Sand
048-07	2341522.29	678332.74	C Coarse
048-08	2341626.89	678260.81	mBs Mixed Boulder/Cobble with Sand
049-03	2340363.72	677980.80	C Coarse
049-04	2340530.33	677864.54	C Coarse
049-05	2340650.60	677781.46	C Coarse
049-07	2340943.40	677587.22	C Coarse
049-08	2341079.25	677487.80	C Coarse
049-09	2341238.78	677379.63	C Coarse
050-03	2340008.55	677431.54	mCs Mixed Coarse with Sand
050-04	2340090.71	677288.29	C Coarse
050-05	2340153.37	677177.82	C Coarse
050-06	2340262.49	677013.27	C Coarse
050-07	2340342.63	676878.96	C Coarse
050-08	2340443.58	676720.15	C Coarse
050-09	2340534.87	676580.26	C Coarse
050-10	2340651.69	676386.23	C Coarse
051-05	2339317.69	676525.81	mFs Mixed Fines, predominantly Sand
051-06	2339420.77	676361.68	C Coarse
051-07	2339479.43	676263.30	mBs Mixed Boulder/Cobble with Sand
051-08	2339561.01	676137.17	C Coarse

Table A1 Underwater imagery locations used as training data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
051-09	2339644.21	676001.20	B Boulder/Cobble
052-07	2338455.64	676219.72	mCs Mixed Coarse with Sand
052-08	2338531.43	675989.17	C Coarse
052-09	2338610.21	675763.13	C Coarse
052-10	2338736.87	675390.13	C Coarse
053-06	2337496.77	675571.98	mFs Mixed Fines, predominantly Sand
053-07	2337567.66	675429.48	C Coarse
053-08	2337642.50	675288.58	C Coarse
053-09	2337715.76	675145.85	B Boulder/Cobble
054-04	2336656.79	675259.73	mCs Mixed Coarse with Sand
054-08	2336849.58	674787.22	C Coarse
054-09	2336959.15	674521.71	C Coarse
055-04	2336018.37	674749.63	mCs Mixed Coarse with Sand
055-05	2336070.46	674697.36	mCs Mixed Coarse with Sand
055-06	2336137.70	674639.75	C Coarse
055-07	2336260.37	674519.22	C Coarse
055-08	2336431.26	674356.15	C Coarse
055-09	2336557.43	674245.32	mBs Mixed Boulder/Cobble with Sand
055-10	2336636.58	674171.02	mFm Mixed Fines, predominantly Mud
056-01	2335500.88	674696.24	C Coarse
056-02	2335546.97	674580.98	mCs Mixed Coarse with Sand
056-03	2335581.87	674466.48	mBs Mixed Boulder/Cobble with Sand
056-04	2335624.59	674353.69	mCs Mixed Coarse with Sand
056-05	2335659.76	674236.35	C Coarse
056-06	2335700.55	674118.16	C Coarse
056-07	2335759.20	673975.60	B Boulder/Cobble
057-05	2335007.44	674171.42	C Coarse
057-06	2335030.96	674007.30	C Coarse
057-07	2335056.92	673829.92	B Boulder/Cobble
057-08	2335068.49	673687.59	C Coarse
057-10	2335104.90	673437.06	mFm Mixed Fines, predominantly Mud
058-01	2334106.27	674762.70	C Coarse
058-03	2334060.39	674576.16	C Coarse
058-04	2334032.28	674486.36	C Coarse
058-05	2334015.45	674420.24	C Coarse
058-06	2333988.40	674299.78	B Boulder/Cobble
058-07	2333961.86	674207.60	B Boulder/Cobble
058-08	2333930.94	674109.04	B Boulder/Cobble
058-10	2333887.89	673924.07	mFm Mixed Fines, predominantly Mud
059-02	2333214.56	675271.70	mCs Mixed Coarse with Sand
059-06	2333069.59	674890.24	B Boulder/Cobble
059-07	2333035.79	674817.49	mCs Mixed Coarse with Sand
059-08	2332996.76	674724.79	B Boulder/Cobble
059-09	2332981.05	674665.31	mCs Mixed Coarse with Sand
059-10	2332944.93	674571.18	mBs Mixed Boulder/Cobble with Sand
060-08	2332352.94	674869.98	B Boulder/Cobble
060-09	2332346.70	674807.43	B Boulder/Cobble

Table A1 Underwater imagery locations used as training data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
060-10	2332317.67	674703.71	mCm Mixed Coarse with Mud
061-01	2330614.20	675851.97	S Sand
061-03	2330576.53	675533.89	mCs Mixed Coarse with Sand
061-04	2330544.66	675376.30	B Boulder/Cobble
061-05	2330520.65	675217.96	mCs Mixed Coarse with Sand
062-01	2328023.24	676961.46	mCm Mixed Coarse with Mud
063-01	2325322.40	675834.30	mBs Mixed Boulder/Cobble with Sand
063-02	2325417.15	675688.57	C Coarse
063-03	2325502.32	675539.53	B Boulder/Cobble
063-04	2325591.52	675392.21	mFs Mixed Fines, predominantly Sand
063-05	2325685.00	675243.71	mFs Mixed Fines, predominantly Sand
064-01	2323332.66	674557.07	S Sand
064-02	2323404.91	674375.29	mCs Mixed Coarse with Sand
064-03	2323485.45	674194.71	mCs Mixed Coarse with Sand
064-04	2323556.59	674010.87	mCs Mixed Coarse with Sand
064-05	2323633.76	673832.49	S Sand
065-02	2321129.54	672830.88	B Boulder/Cobble
065-03	2321262.99	672647.49	S Sand
065-04	2321398.75	672466.72	mBs Mixed Boulder/Cobble with Sand
065-05	2321537.30	672287.81	mFs Mixed Fines, predominantly Sand
066-01	2319793.32	670254.64	S Sand
066-02	2319988.01	670241.08	mCs Mixed Coarse with Sand
066-03	2320177.14	670224.69	mFs Mixed Fines, predominantly Sand
066-04	2320364.57	670220.81	S Sand
067-01	2320247.50	667586.96	mFs Mixed Fines, predominantly Sand
067-02	2320541.47	667751.47	mBs Mixed Boulder/Cobble with Sand
067-03	2320804.77	667884.55	C Coarse
067-04	2321064.42	668027.92	mFs Mixed Fines, predominantly Sand
067-05	2321327.47	668161.90	C Coarse
068-01	2320539.54	665560.59	mFs Mixed Fines, predominantly Sand
068-04	2321704.26	665488.89	mFs Mixed Fines, predominantly Sand
069-01	2320831.17	662975.09	S Sand
069-02	2321180.24	663009.25	mBs Mixed Boulder/Cobble with Sand
069-03	2321526.98	663045.79	mFs Mixed Fines, predominantly Sand
070-01	2320264.79	660878.64	S Sand
070-02	2320399.68	660701.88	B Boulder/Cobble
070-03	2320535.02	660535.71	S Sand
070-04	2320674.98	660361.37	S Sand
070-05	2320812.04	660190.51	B Boulder/Cobble
071-02	2318390.45	659252.86	B Boulder/Cobble
073-01	2313517.71	656867.44	S Sand
073-02	2313809.52	656663.60	mCs Mixed Coarse with Sand
073-03	2314095.17	656451.93	B Boulder/Cobble
073-04	2314389.23	656247.72	C Coarse
073-05	2314486.12	656179.76	S Sand
074-04	2312893.59	654524.30	C Coarse
075-01	2310533.02	653193.06	mFs Mixed Fines, predominantly Sand

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STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
075-02	2310712.87	653060.71	mFs Mixed Fines, predominantly Sand
075-03	2310893.45	652929.59	C Coarse
075-04	2311066.98	652793.20	mFs Mixed Fines, predominantly Sand
076-03	2309823.58	650690.14	C Coarse
076-04	2310165.11	650510.36	C Coarse
077-01	2309116.24	648041.89	C Coarse
077-03	2309774.12	648245.54	mBs Mixed Boulder/Cobble with Sand
077-04	2310097.81	648353.96	C Coarse
077-05	2310429.42	648449.65	mFs Mixed Fines, predominantly Sand
078-01	2309627.68	645693.80	B Boulder/Cobble
078-02	2309912.57	645827.60	mFs Mixed Fines, predominantly Sand
078-04	2310484.55	646099.71	mFs Mixed Fines, predominantly Sand
079-02	2310980.62	643453.52	mFs Mixed Fines, predominantly Sand
079-03	2311308.93	643608.33	mBs Mixed Boulder/Cobble with Sand
080-01	2312354.45	641238.81	mBs Mixed Boulder/Cobble with Sand
080-02	2312555.92	641437.78	mBs Mixed Boulder/Cobble with Sand
080-03	2312753.53	641641.04	mBs Mixed Boulder/Cobble with Sand
080-05	2313145.36	642042.61	S Sand
081-01	2313416.58	639120.52	C Coarse
081-04	2313933.64	639515.03	mFs Mixed Fines, predominantly Sand
081-05	2314107.20	639651.32	B Boulder/Cobble
082-01	2314616.42	637073.71	mFs Mixed Fines, predominantly Sand
082-02	2314833.84	637123.87	mBs Mixed Boulder/Cobble with Sand
083-01	2315860.48	635202.24	mFs Mixed Fines, predominantly Sand
083-02	2316323.87	635211.58	S Sand
083-03	2316789.84	635222.70	mCs Mixed Coarse with Sand
084-02	2316546.82	632848.77	mBs Mixed Boulder/Cobble with Sand
085-03	2317172.33	631751.27	C Coarse
085-06	2317899.50	631970.04	mFs Mixed Fines, predominantly Sand
086-03	2317233.80	630813.24	mBs Mixed Boulder/Cobble with Sand
087-01	2317300.63	629951.99	mFs Mixed Fines, predominantly Sand
087-04	2318350.06	629947.53	mBs Mixed Boulder/Cobble with Sand
087-05	2318600.01	629946.20	mBs Mixed Boulder/Cobble with Sand
088-01	2317014.81	628921.12	S Sand
088-02	2317307.06	628928.37	M Mud
088-03	2317798.60	628940.52	mBs Mixed Boulder/Cobble with Sand
088-04	2318367.66	628968.12	S Sand
088-05	2318529.79	628970.82	S Sand
088-06	2318751.31	628985.88	S Sand
088-07	2319355.21	629002.84	M Mud
088-08	2319747.40	629023.82	M Mud
089-01	2317064.33	628293.68	S Sand
089-02	2317450.15	628360.04	M Mud
089-03	2317955.37	628453.35	mFs Mixed Fines, predominantly Sand
089-04	2318491.07	628556.64	S Sand
089-05	2318677.40	628590.23	S Sand
089-06	2318808.78	628615.68	S Sand

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STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
089-07	2319312.19	628713.73	M Mud
089-08	2319720.89	628788.95	M Mud
089-09	2320120.95	628860.77	M Mud
089-10	2320525.82	628940.49	M Mud
090-01	2316862.85	627743.65	M Mud
090-02	2317285.62	627716.53	S Sand
090-03	2317707.95	627679.13	M Mud
090-04	2318326.61	627637.79	mFs Mixed Fines, predominantly Sand
090-05	2318830.75	627600.06	S Sand
090-06	2318982.22	627590.62	S Sand
090-07	2319100.51	627584.68	mFs Mixed Fines, predominantly Sand
090-08	2319835.01	627529.98	M Mud
090-09	2320253.70	627502.69	M Mud
090-10	2320854.46	627460.01	M Mud
091-01	2316816.97	627164.65	M Mud
091-02	2317570.91	626969.85	M Mud
091-03	2317957.95	626870.82	mFs Mixed Fines, predominantly Sand
091-04	2318343.02	626770.01	C Coarse
091-06	2319048.90	626598.03	S Sand
091-07	2319175.54	626565.57	S Sand
091-08	2319459.47	626486.41	mBs Mixed Boulder/Cobble with Sand
091-09	2319861.66	626380.13	M Mud
091-10	2320250.00	626287.64	M Mud
092-03	2316953.53	626281.36	S Sand
092-04	2317652.49	626207.77	S Sand
092-05	2317958.57	626171.53	S Sand
092-06	2318494.17	626118.25	C Coarse
092-07	2318818.69	626082.96	S Sand
092-08	2319169.43	626042.33	S Sand
092-10	2319976.54	625958.72	M Mud
093-01	2316709.19	626881.64	M Mud
093-02	2317111.30	626503.10	S Sand
093-04	2317876.39	625770.42	S Sand
093-05	2318107.46	625549.98	S Sand
093-06	2318343.10	625325.87	mFs Mixed Fines, predominantly Sand
093-09	2318693.76	625001.05	mFs Mixed Fines, predominantly Sand
093-10	2318808.38	624881.00	C Coarse
094-01	2316904.90	624881.09	mFs Mixed Fines, predominantly Sand
094-02	2317094.11	624795.38	mFs Mixed Fines, predominantly Sand
094-03	2317236.37	624718.45	S Sand
094-04	2317355.03	624655.23	S Sand
094-05	2317462.36	624604.16	mFs Mixed Fines, predominantly Sand
094-06	2317592.28	624537.42	mCs Mixed Coarse with Sand
094-08	2317864.67	624402.39	mBs Mixed Boulder/Cobble with Sand
094-09	2318040.56	624309.79	C Coarse
094-10	2318304.19	624177.04	mCs Mixed Coarse with Sand
095-02	2316421.38	624336.97	S Sand

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STATION	X (FEET)	Y (FEET)	SEDIMENT FACIES CLASSIFICATION
095-03	2316398.43	624201.25	S Sand
095-04	2316379.68	624047.22	S Sand
095-05	2316355.87	623930.07	mFs Mixed Fines, predominantly Sand
095-07	2316295.59	623543.04	C Coarse
095-08	2316267.07	623370.79	C Coarse
095-09	2316234.00	623160.65	C Coarse
095-10	2316199.80	622951.06	S Sand
096-01	2315320.11	623947.31	mFs Mixed Fines, predominantly Sand
096-05	2315977.06	623705.10	mFs Mixed Fines, predominantly Sand
096-07	2316328.89	623583.11	C Coarse
096-09	2316558.20	623506.05	mBs Mixed Boulder/Cobble with Sand
096-10	2316841.56	623401.07	mBs Mixed Boulder/Cobble with Sand
097-01	2314681.82	623682.72	M Mud
097-02	2314707.55	623611.38	S Sand
097-05	2314859.07	623178.56	mFs Mixed Fines, predominantly Sand
097-07	2314962.91	622904.76	mFs Mixed Fines, predominantly Sand
097-08	2315014.00	622762.40	C Coarse
097-09	2315061.59	622618.39	mCs Mixed Coarse with Sand
097-10	2315110.83	622475.11	mFs Mixed Fines, predominantly Sand
098-02	2313666.72	623321.64	M Mud
098-03	2313721.96	623183.00	mCs Mixed Coarse with Sand
098-06	2313919.71	622760.21	S Sand
098-07	2313979.91	622619.23	mFs Mixed Fines, predominantly Sand
098-08	2314037.98	622475.86	mCs Mixed Coarse with Sand
098-09	2314104.72	622339.60	mCs Mixed Coarse with Sand
098-10	2314167.68	622197.57	mCs Mixed Coarse with Sand
099-01	2312700.55	623244.28	M Mud
099-02	2312732.04	623082.17	M Mud
099-03	2312764.63	622923.03	M Mud
099-04	2312797.26	622771.78	mFs Mixed Fines, predominantly Sand
099-05	2312830.09	622612.32	S Sand
099-06	2312858.62	622452.99	S Sand
099-07	2312890.42	622297.03	S Sand
099-08	2312925.28	622139.56	mCs Mixed Coarse with Sand
099-09	2312959.29	621979.32	mCs Mixed Coarse with Sand
099-10	2312992.19	621825.29	mFs Mixed Fines, predominantly Sand
100-01	2311955.93	623167.74	M Mud
100-02	2311988.49	623003.32	M Mud
100-03	2312025.06	622838.98	mFs Mixed Fines, predominantly Sand
100-04	2312063.97	622674.46	S Sand
100-05	2312093.17	622498.80	S Sand
100-06	2312135.33	622336.50	S Sand
100-07	2312167.07	622173.16	S Sand
100-08	2312201.70	622007.82	S Sand
100-09	2312236.14	621839.68	mFs Mixed Fines, predominantly Sand
100-10	2312272.59	621676.20	mBs Mixed Boulder/Cobble with Sand

Table A2 Underwater imagery locations used as testing data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	OBSERVED SEDIMENT COMPOSITION (%)			PREDICTED SEDIMENT COMPOSITION (%)		
			FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)	FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)
001-01	2406994.69	743989.19	100.00	0.00	0.00	90-100	0-10	0-10
001-02	2407157.05	743879.40	100.00	0.00	0.00	90-100	0-10	0-10
001-05	2407646.15	743550.92	4.17	16.67	79.17	0-10	10-20	70-80
006-01	2401893.60	733586.77	10.42	10.42	79.17	0-10	10-20	70-80
006-05	2402171.99	733172.09	27.08	10.42	62.50	10-20	10-20	60-70
008-02	2397728.97	730360.38	2.08	22.92	75.00	0-10	0-10	70-80
012-05	2389875.12	724487.13	0.00	31.25	68.75	0-10	20-30	60-70
013-04	2389171.46	723735.42	67.59	32.41	0.00	40-50	30-40	0-10
015-05	2387845.26	722166.28	0.00	22.92	77.08	0-10	10-20	70-80
015-07	2387994.41	722022.37	3.23	19.35	77.42	0-10	10-20	70-80
015-10	2388215.89	721804.59	18.75	22.92	58.33	10-20	10-20	50-60
016-08	2387316.40	720809.88	33.33	52.08	14.58	20-30	40-50	10-20
017-02	2387127.08	722094.24	4.17	27.08	68.75	0-10	10-20	60-70
017-09	2386602.37	720844.36	100.00	0.00	0.00	90-100	0-10	0-10
018-01	2386558.71	722264.83	0.00	27.08	72.92	0-10	10-20	70-80
019-03	2385717.59	722458.08	27.08	6.25	66.67	20-30	0-10	60-70
019-08	2385496.64	721762.68	22.92	10.42	66.67	0-10	10-20	60-70
020-03	2384914.70	723032.88	100.00	0.00	0.00	90-100	0-10	0-10
020-04	2384897.70	722894.73	27.08	70.83	2.08	20-30	50-60	0-10
020-08	2384836.64	722366.70	0.00	20.00	80.00	0-10	10-20	70-80
021-01	2384239.35	723248.96	100.00	0.00	0.00	80-90	0-10	0-10
021-02	2384244.13	723076.09	6.25	29.17	64.58	0-10	10-20	60-70
021-05	2384249.43	722638.94	0.00	8.33	91.67	0-10	70-80	10-20
022-01	2381772.22	722058.47	0.00	25.00	75.00	0-10	0-10	80-90
022-04	2382173.45	721583.00	14.58	41.67	43.75	30-40	0-10	40-50
022-05	2382298.02	721423.57	6.25	79.17	14.58	0-10	70-80	10-20
025-01	2377126.77	717876.09	2.08	4.17	93.75	0-10	0-10	80-90
025-05	2377629.80	717561.04	2.08	10.42	87.50	0-10	0-10	80-90
026-03	2375520.83	716049.50	0.00	0.00	100.00	0-10	0-10	90-100
027-02	2373325.84	715233.87	0.00	25.00	75.00	0-10	10-20	70-80
030-03	2368440.48	710146.60	16.67	16.67	66.67	0-10	10-20	60-70
031-05	2367800.11	707478.85	89.58	6.25	4.17	90-100	0-10	0-10
032-01	2364820.53	706688.99	100.00	0.00	0.00	90-100	0-10	0-10
032-03	2365166.46	706262.22	8.33	22.92	68.75	0-10	10-20	60-70
034-04	2361970.40	702631.27	2.08	18.75	79.17	0-10	10-20	70-80
036-02	2358930.90	698571.43	4.17	37.50	58.33	10-20	10-20	50-60
036-04	2359381.02	698161.21	100.00	0.00	0.00	80-90	0-10	0-10
036-05	2359603.61	697965.18	100.00	0.00	0.00	90-100	0-10	0-10
037-04	2356471.75	697542.29	0.00	50.00	50.00	0-10	40-50	40-50
040-03	2350642.76	693489.06	22.92	52.08	25.00	20-30	50-60	20-30
040-04	2350868.63	693316.20	100.00	0.00	0.00	90-100	0-10	0-10
040-05	2351090.95	693134.40	100.00	0.00	0.00	90-100	0-10	0-10
043-05	2344908.29	688970.77	89.58	10.42	0.00	90-100	0-10	0-10
044-01	2342755.39	688266.44	100.00	0.00	0.00	90-100	0-10	0-10

Table A2 Underwater imagery locations used as testing data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	OBSERVED SEDIMENT COMPOSITION (%)			PREDICTED SEDIMENT COMPOSITION (%)		
			FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)	FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)
044-02	2342826.48	688027.48	100.00	0.00	0.00	90-100	0-10	0-10
044-03	2342889.99	687784.93	6.25	85.42	8.33	0-10	80-90	0-10
045-03	2341189.32	685926.08	4.17	2.08	93.75	0-10	0-10	90-100
046-01	2340423.13	683140.57	100.00	0.00	0.00	90-100	0-10	0-10
046-02	2340647.23	683253.52	2.08	93.75	4.17	0-10	80-90	0-10
046-04	2341107.01	683482.60	8.33	87.50	4.17	0-10	80-90	0-10
046-05	2341335.66	683593.77	100.00	0.00	0.00	90-100	0-10	0-10
048-04	2340886.73	678811.30	47.92	6.25	45.83	40-50	0-10	40-50
048-09	2341682.88	678223.58	41.67	10.42	47.92	40-50	0-10	40-50
049-02	2340224.92	678091.57	25.00	56.25	18.75	20-30	40-50	10-20
049-06	2340752.77	677714.55	31.25	18.75	50.00	30-40	10-20	40-50
049-10	2341435.05	677240.65	95.83	2.08	2.08	90-100	0-10	0-10
050-02	2339913.23	677567.40	66.67	16.67	16.67	50-60	10-20	10-20
051-03	2339154.12	676787.91	41.67	43.75	14.58	30-40	30-40	10-20
051-04	2339235.84	676655.66	27.08	35.42	37.50	10-20	20-30	30-40
051-10	2339757.80	675828.30	39.58	41.67	18.75	30-40	40-50	10-20
052-06	2338391.37	676429.88	39.58	56.25	4.17	30-40	40-50	0-10
053-03	2337302.80	675936.76	100.00	0.00	0.00	90-100	0-10	0-10
053-04	2337368.50	675818.57	100.00	0.00	0.00	90-100	0-10	0-10
053-05	2337420.45	675712.39	29.79	34.04	36.17	20-30	30-40	30-40
053-10	2337828.73	674941.26	35.42	35.42	29.17	30-40	30-40	20-30
054-02	2336606.94	675395.35	58.33	2.08	39.58	40-50	0-10	30-40
054-03	2336639.45	675311.56	8.33	75.00	16.67	0-10	60-70	10-20
054-05	2336678.86	675207.61	88.89	6.67	4.44	70-80	0-10	0-10
054-06	2336709.83	675118.60	14.58	8.33	77.08	10-20	30-40	30-40
054-07	2336783.03	674946.88	14.58	37.50	47.92	10-20	30-40	40-50
054-10	2337006.38	674412.16	100.00	0.00	0.00	90-100	0-10	0-10
055-01	2335868.36	674884.27	6.25	85.42	8.33	40-50	40-50	0-10
055-03	2335983.12	674780.18	43.75	27.08	29.17	40-50	20-30	20-30
056-08	2335812.38	673812.21	100.00	0.00	0.00	90-100	0-10	0-10
056-09	2335837.08	673733.26	100.00	0.00	0.00	90-100	0-10	0-10
057-01	2334950.00	674640.73	8.33	58.33	33.33	0-10	40-50	30-40
057-02	2334974.35	674503.80	0.00	100.00	0.00	0-10	90-100	0-10
057-03	2334982.40	674395.35	8.33	58.33	33.33	0-10	40-50	30-40
057-09	2335089.53	673576.23	100.00	0.00	0.00	90-100	0-10	0-10
058-02	2334072.73	674644.91	0.00	100.00	0.00	10-20	60-70	0-10
058-09	2333909.83	674019.15	50.00	0.00	50.00	40-50	0-10	40-50
059-01	2333242.95	675365.31	100.00	0.00	0.00	90-100	0-10	0-10
059-03	2333177.03	675184.59	100.00	0.00	0.00	90-100	0-10	0-10
059-04	2333131.73	675070.16	100.00	0.00	0.00	90-100	0-10	0-10
059-05	2333090.68	674969.24	76.60	6.38	17.02	60-70	10-20	10-20
060-01	2332479.32	675423.83	83.33	14.58	2.08	70-80	10-20	0-10
060-02	2332456.41	675342.41	100.00	0.00	0.00	90-100	0-10	0-10
060-03	2332438.63	675263.42	100.00	0.00	0.00	90-100	0-10	0-10

Table A2 Underwater imagery locations used as testing data. Listed positions are in NAD83 State Plane Washington North in units of US Survey Feet.

STATION	X (FEET)	Y (FEET)	OBSERVED SEDIMENT COMPOSITION (%)			PREDICTED SEDIMENT COMPOSITION (%)		
			FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)	FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)
060-04	2332420.84	675185.67	100.00	0.00	0.00	90-100	0-10	0-10
060-05	2332408.58	675105.46	83.33	0.00	16.67	70-80	0-10	10-20
060-06	2332389.91	675027.36	100.00	0.00	0.00	90-100	0-10	0-10
060-07	2332369.49	674946.64	0.00	93.75	6.25	0-10	70-80	0-10
062-02	2328007.81	676598.19	64.58	2.08	33.33	40-50	0-10	30-40
062-03	2327986.73	676230.30	89.58	10.42	0.00	90-100	0-10	0-10
062-04	2327964.79	675861.95	85.42	14.58	0.00	80-90	0-10	0-10
062-05	2327951.40	675489.03	100.00	0.00	0.00	90-100	0-10	0-10
065-01	2321004.58	673009.84	100.00	0.00	0.00	90-100	0-10	0-10
066-05	2320554.77	670205.34	100.00	0.00	0.00	90-100	0-10	0-10
068-02	2320935.07	665539.29	95.83	0.00	4.17	90-100	0-10	0-10
069-04	2321876.30	663081.87	0.00	0.00	0.00	90-100	0-10	0-10
071-01	2318306.42	659431.56	100.00	0.00	0.00	90-100	0-10	0-10
071-03	2318467.31	659074.60	31.25	62.50	6.25	80-90	0-10	0-10
072-05	2316587.72	657451.41	41.67	4.17	54.17	20-30	0-10	50-60
074-03	2312704.48	654570.94	93.75	0.00	6.25	70-80	0-10	0-10
075-05	2311245.74	652658.59	100.00	0.00	0.00	70-80	0-10	0-10
076-01	2309134.88	651034.96	100.00	0.00	0.00	90-100	0-10	0-10
076-05	2310507.32	650339.88	100.00	0.00	0.00	90-100	0-10	0-10
077-02	2309444.44	648140.58	89.58	2.08	8.33	90-100	0-10	0-10
078-05	2310769.28	646232.00	100.00	0.00	0.00	70-80	0-10	0-10
079-01	2310647.62	643298.48	100.00	0.00	0.00	90-100	0-10	0-10
079-04	2311637.63	643766.91	27.08	22.92	50.00	40-50	0-10	40-50
079-05	2311964.69	643926.67	100.00	0.00	0.00	90-100	0-10	0-10
080-04	2312950.59	641839.88	100.00	0.00	0.00	70-80	0-10	0-10
082-03	2315047.61	637178.41	100.00	0.00	0.00	70-80	0-10	0-10
082-04	2315271.70	637225.42	83.33	16.67	0.00	90-100	0-10	0-10
082-05	2315488.46	637282.74	40.43	10.64	48.94	10-20	10-20	40-50
084-01	2315871.42	632818.40	100.00	0.00	0.00	90-100	0-10	0-10
084-03	2317223.72	632878.16	100.00	0.00	0.00	90-100	0-10	0-10
084-04	2317830.23	632913.27	100.00	0.00	0.00	90-100	0-10	0-10
085-01	2316653.34	631597.74	100.00	0.00	0.00	90-100	0-10	0-10
085-02	2316755.80	631633.30	100.00	0.00	0.00	90-100	0-10	0-10
085-04	2317479.54	631848.87	95.83	4.17	0.00	90-100	0-10	0-10
085-05	2317660.29	631898.58	100.00	0.00	0.00	90-100	0-10	0-10
085-09	2318958.50	632296.24	100.00	0.00	0.00	90-100	0-10	0-10
085-10	2319161.59	632358.27	100.00	0.00	0.00	90-100	0-10	0-10
086-04	2317880.20	630968.77	100.00	0.00	0.00	90-100	0-10	0-10
086-05	2318006.35	631006.77	100.00	0.00	0.00	90-100	0-10	0-10
086-06	2318156.37	631044.56	100.00	0.00	0.00	90-100	0-10	0-10
086-07	2318727.65	631177.86	100.00	0.00	0.00	90-100	0-10	0-10
086-08	2319087.61	631265.09	100.00	0.00	0.00	90-100	0-10	0-10
086-09	2319444.26	631356.17	100.00	0.00	0.00	90-100	0-10	0-10
087-02	2317730.21	629949.03	16.28	16.28	67.44	10-20	0-10	60-70

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STATION	X (FEET)	Y (FEET)	OBSERVED SEDIMENT COMPOSITION (%)			PREDICTED SEDIMENT COMPOSITION (%)		
			FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)	FINES (<2mm)	GRAVEL (2-64 mm)	COBBLE (>64 mm)
087-03	2318112.26	629949.15	100.00	0.00	0.00	90-100	0-10	0-10
087-06	2319320.54	629940.79	100.00	0.00	0.00	90-100	0-10	0-10
087-07	2320106.89	629933.82	100.00	0.00	0.00	90-100	0-10	0-10
087-08	2319874.69	629937.82	100.00	0.00	0.00	90-100	0-10	0-10
087-09	2320188.07	629932.51	93.75	0.00	6.25	90-100	0-10	0-10
087-10	2320651.82	629939.15	100.00	0.00	0.00	90-100	0-10	0-10
088-08	2319747.40	629023.82	100.00	0.00	0.00	90-100	0-10	0-10
088-09	2320140.08	629034.01	89.58	10.42	0.00	70-80	10-20	0-10
088-10	2320527.84	629046.78	85.42	14.58	0.00	70-80	10-20	0-10

Table A3 Error Matrix and Overall Accuracy Results for Fines (< 2 mm).

		MAP CLASSIFICATION: FINES									
	BIN	1	2	3	4	5	6	7	8	9	10
TESTING DATA	1	28	2	0	0	1	0	0	0	0	1
	2	2	4	0	1	0	0	0	0	0	0
	3	1	2	5	0	1	0	0	0	0	0
	4	0	0	1	4	0	0	0	0	1	0
	5	0	1	1	1	4	0	0	0	0	0
	6	0	0	0	0	1	0	0	0	0	0
	7	0	0	0	0	2	1	0	0	0	0
	8	0	0	0	0	0	0	1	0	0	0
	9	0	0	0	0	0	0	0	5	1	5
	10	0	0	0	0	0	0	0	5	2	57

Overall Accuracy* **73.05%**

*Overall Accuracy = Number Correct / Number of Observations
Shaded regions indicate correct classification

Table A4 Error Matrix and Overall Accuracy Results (Buffered +/-10%) for Fines (< 2 mm).

		MAP CLASSIFICATION: FINES (BUFFERED +/-10%)									
	BIN	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
TESTING DATA	**1**	28	2	0	0	1	0	0	0	0	1
	2	2	4	0	1	0	0	0	0	0	0
	3	1	2	5	0	1	0	0	0	0	0
	4	0	0	1	4	0	0	0	0	1	0
	5	0	1	1	1	4	0	0	0	0	0
	6	0	0	0	0	1	0	0	0	0	0
	7	0	0	0	0	2	1	0	0	0	0
	8	0	0	0	0	0	0	1	0	0	0
	9	0	0	0	0	0	0	0	5	1	5
	10	0	0	0	0	0	0	0	5	2	57

Overall Accuracy **89.36%**

*Overall Accuracy = Number Correct / Number of Observations
Shaded regions indicate correct classification

Table A5 Error Matrix and Overall Accuracy Results for Gravel (2 - 64 mm).

		MAP CLASSIFICATION: GRAVEL									
	BIN	1	2	3	4	5	6	7	8	9	10
TESTING DATA	1	79	1	0	1	0	0	0	0	0	0
	2	7	14	0	0	0	0	0	0	0	0
	3	2	8	1	0	0	0	0	0	0	0
	4	0	1	2	4	0	0	0	0	0	0
	5	1	0	0	1	2	0	0	0	0	0
	6	0	0	0	0	5	1	0	0	0	0
	7	1	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	1	1	1	0	0
	9	0	0	0	0	1	0	0	0	2	0
	10	0	0	0	0	0	0	1	1	1	1

Overall Accuracy* **74.47%**

*Overall Accuracy = Number Correct / Number of Observations
Shaded regions indicate correct classification

Table A6 Error Matrix and Overall Accuracy Results (Buffered +/-10%) for Gravel (2 - 64 mm).

		MAP CLASSIFICATION: GRAVEL (BUFFERED +/-10%)									
	BIN	1	2	3	4	5	6	7	8	9	10
TESTING DATA	1	79	1	0	1	0	0	0	0	0	0
	2	7	14	0	0	0	0	0	0	0	0
	3	2	8	1	0	0	0	0	0	0	0
	4	0	1	2	4	0	0	0	0	0	0
	5	1	0	0	1	2	0	0	0	0	0
	6	0	0	0	0	5	1	0	0	0	0
	7	1	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	1	1	1	0	0
	9	0	0	0	0	1	0	0	0	2	0
	10	0	0	0	0	0	0	1	1	1	1

Overall Accuracy* **92.91%**

*Overall Accuracy = Number Correct / Number of Observations
Shaded regions indicate correct classification

Table A7 Error Matrix and Overall Accuracy Results for Cobble/Boulder (> 64 mm).

		MAP CLASSIFICATION: COBBLE/BOULDER									
	BIN	1	2	3	4	5	6	7	8	9	10
TESTING DATA	1	86	0	0	0	0	0	0	0	0	0
	2	0	9	0	0	0	0	0	0	0	0
	3	0	0	3	0	0	0	0	0	0	0
	4	0	0	0	7	0	0	0	0	0	0
	5	0	0	0	0	9	0	0	0	0	0
	6	0	0	0	0	0	3	0	0	0	0
	7	0	0	0	0	0	0	9	0	0	0
	8	0	0	0	0	0	0	0	10	0	0
	9	0	0	0	0	0	0	0	0	2	0
	10	0	0	0	0	0	0	0	0	0	3

Overall Accuracy* **100.00%**

*Overall Accuracy = Number Correct / Number of Observations
Shaded regions indicate correct classification

Table A8 Error Matrix and Overall Accuracy Results (Buffered +/-10%) for Cobble/Boulder (> 64 mm).

		MAP CLASSIFICATION: COBBLE/BOULDER (BUFFERD +/-10%)									
	BIN	1	2	3	4	5	6	7	8	9	10
TESTING DATA	1	86	0	0	0	0	0	0	0	0	0
	2	0	9	0	0	0	0	0	0	0	0
	3	0	0	3	0	0	0	0	0	0	0
	4	0	0	0	7	0	0	0	0	0	0
	5	0	0	0	0	9	0	0	0	0	0
	6	0	0	0	0	0	3	0	0	0	0
	7	0	0	0	0	0	0	9	0	0	0
	8	0	0	0	0	0	0	0	10	0	0
	9	0	0	0	0	0	0	0	0	2	0
	10	0	0	0	0	0	0	0	0	0	3

Overall Accuracy* **100.00%**

*Overall Accuracy = Number Correct / Number of Observations
Shaded regions indicate correct classification

Table A9 Coverage Area and Relative Abundance of Sediment Facies in the Upper Reach OU.

SEDIMENT FACIES	COVERAGE AREA (KM^2)	RELATIVE ABUNDANCE (%)
B Boulder/Cobble	3.43	14.8
G Gravel	0.05	0.2
S Sand	3.64	15.6
M Mud	2.46	10.6
mFs Mixed Finer-grained, predominantly Sand	2.75	11.8
mCs Mixed Coarse with Sand	1.33	5.7
mBs Mixed Boulder/Cobble with Sand	1.53	6.6
mFm Mixed Finer-grained, predominantly Mud	0.10	0.4
mCm Mixed Coarse with Mud	0.07	0.3
mBm Mixed Boulder/Cobble with Mud	0.03	0.1
C Coarse	4.18	18.0
Bedrock	2.51	10.8
Dense Vegetation	1.19	5.1
TOTAL COVERAGE AREA	23.25	

Attachment B

Digital Deliverable Containing Sediment Grain Size Composition Maps and Sediment Facies Maps (ESRI Shapefile To be provided electronically) and description

These files are available on the OneDrive link provided

Figures

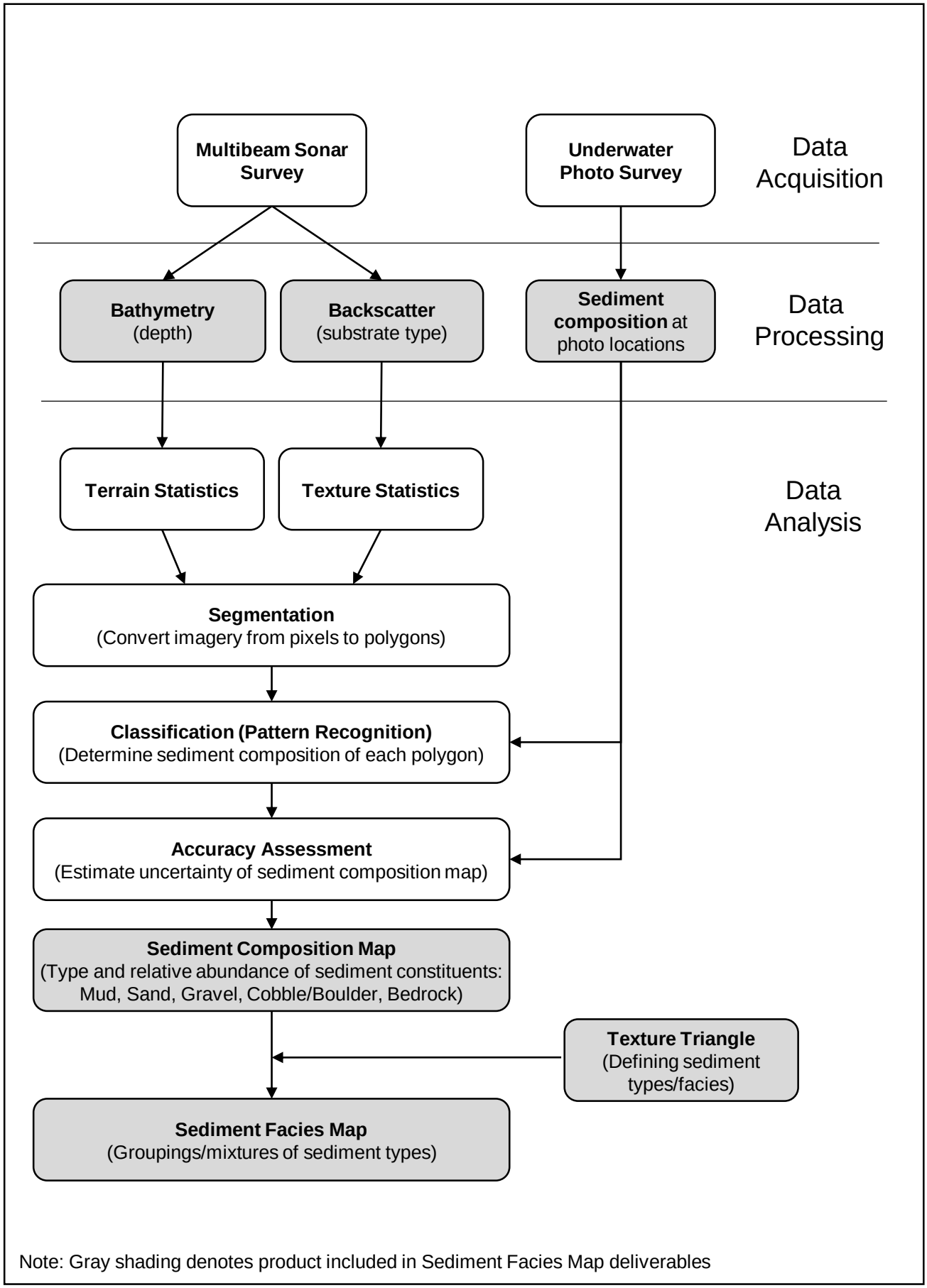


Figure 1-1. Data Processing and Analysis Workflow

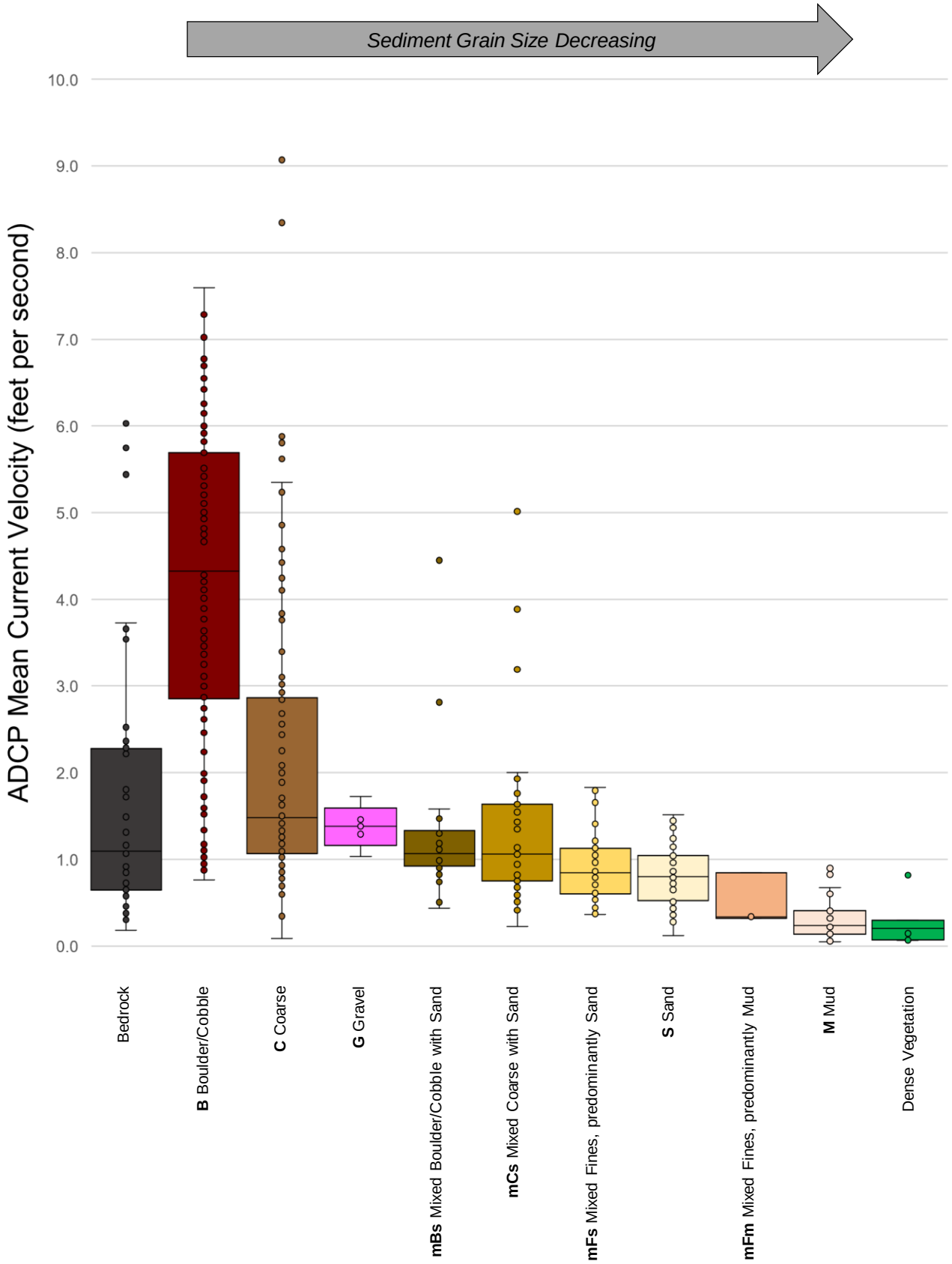


Figure 1-2. Comparison of ADCP Mean Current Velocity and Sediment Facies

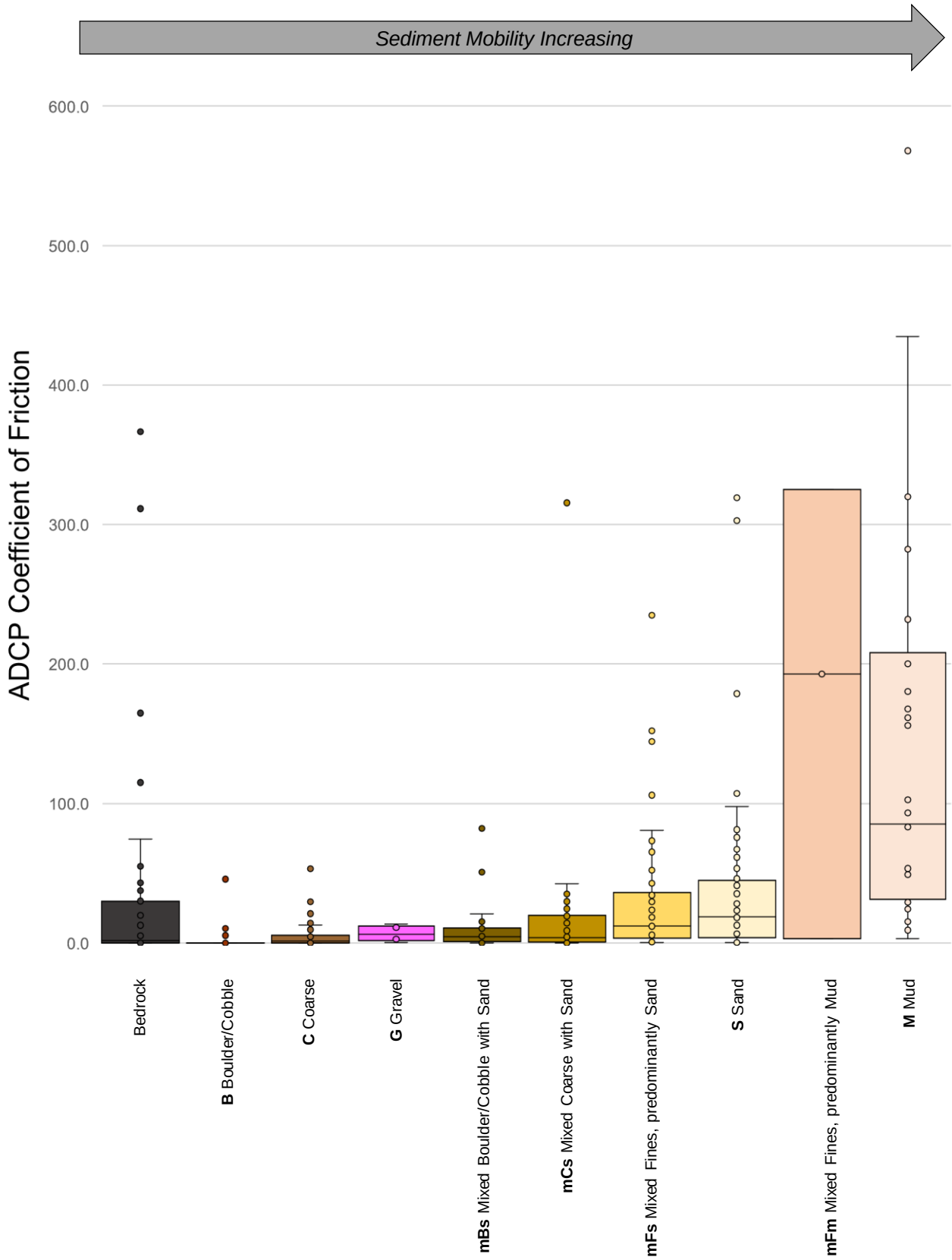
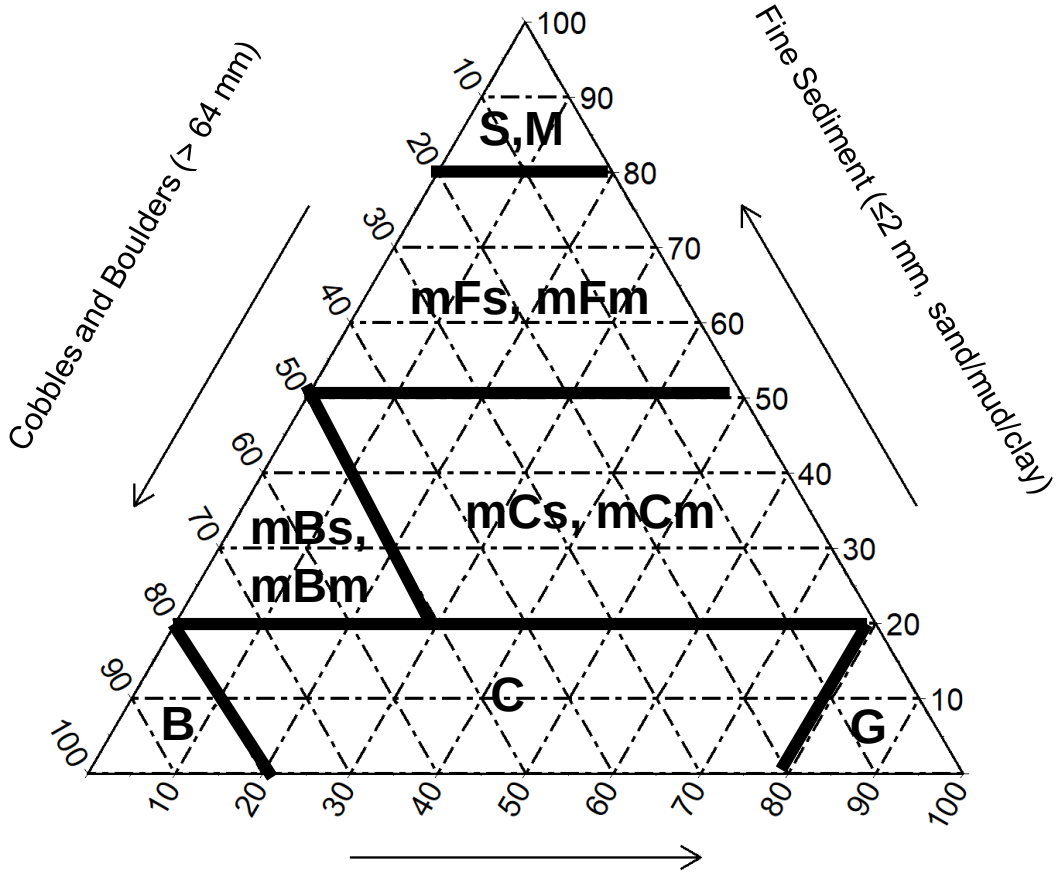


Figure 1-3. Comparison of ADCP Coefficient of Friction and Sediment Facies

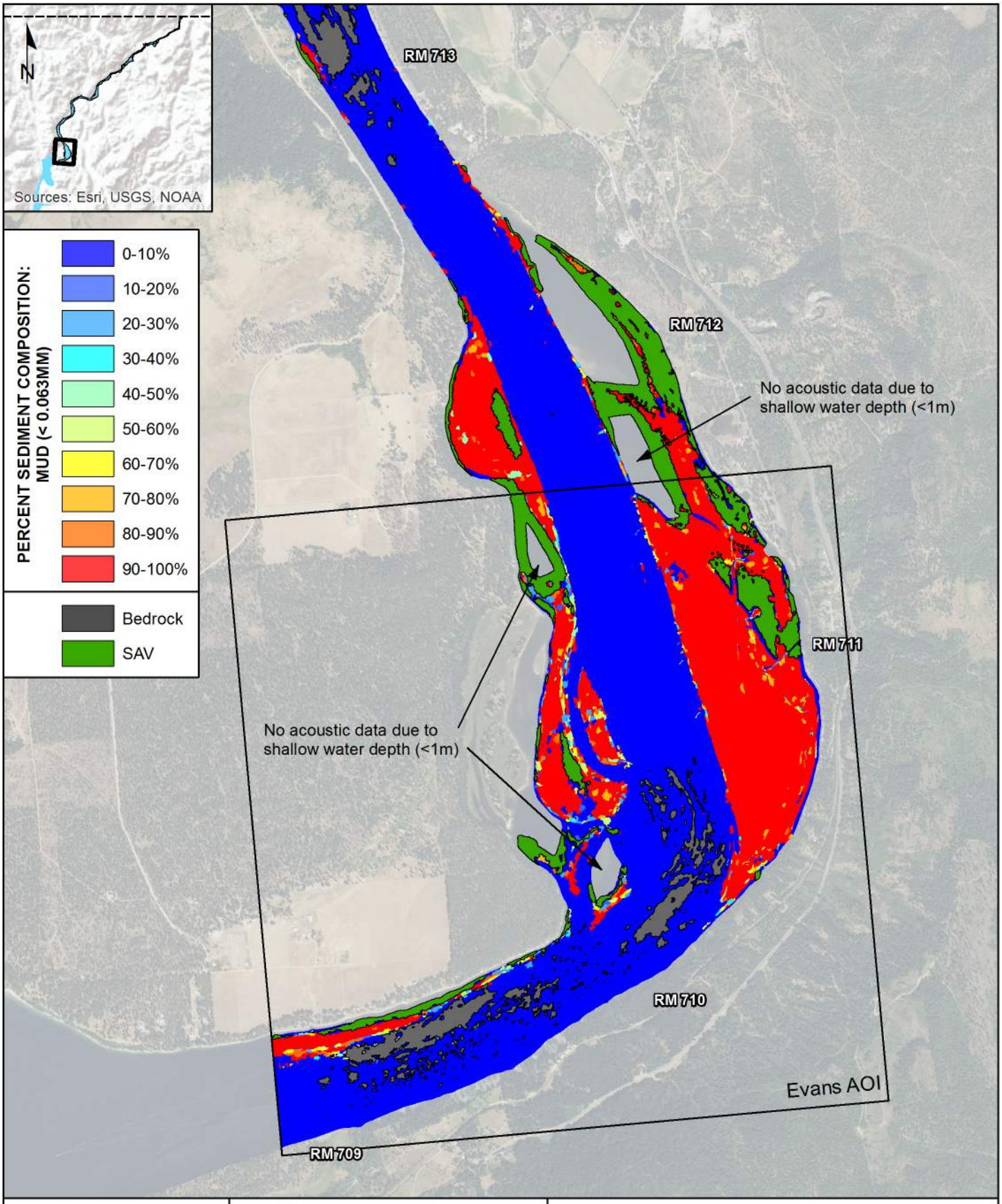


Sediment Bed Surface Facies
M = Mud (Silt and clay, < 0.063 mm)
S = Sand (0.063 mm – 2 mm)
G = Gravel (2 mm – 64 mm)
B = Boulder/Cobble (> 64 mm)
mFm = Mixed Finer-grained, predominantly mud
mFs = Mixed Finer-grained, predominantly sand
mCm = Mixed Coarse, with mud
mCs = Mixed Coarse, with sand
mBm = Mixed Boulder/Cobble, with mud
mBs = Mixed Boulder/Cobble, with sand
C = Coarse

Note:
Bedrock is included as a sediment bed type in facies maps but is not shown in texture triangle

Figure 1-4. Texture Triangle for Sediment Bed Surface Facies

Maps



DAVID EVANS AND ASSOCIATES INC.

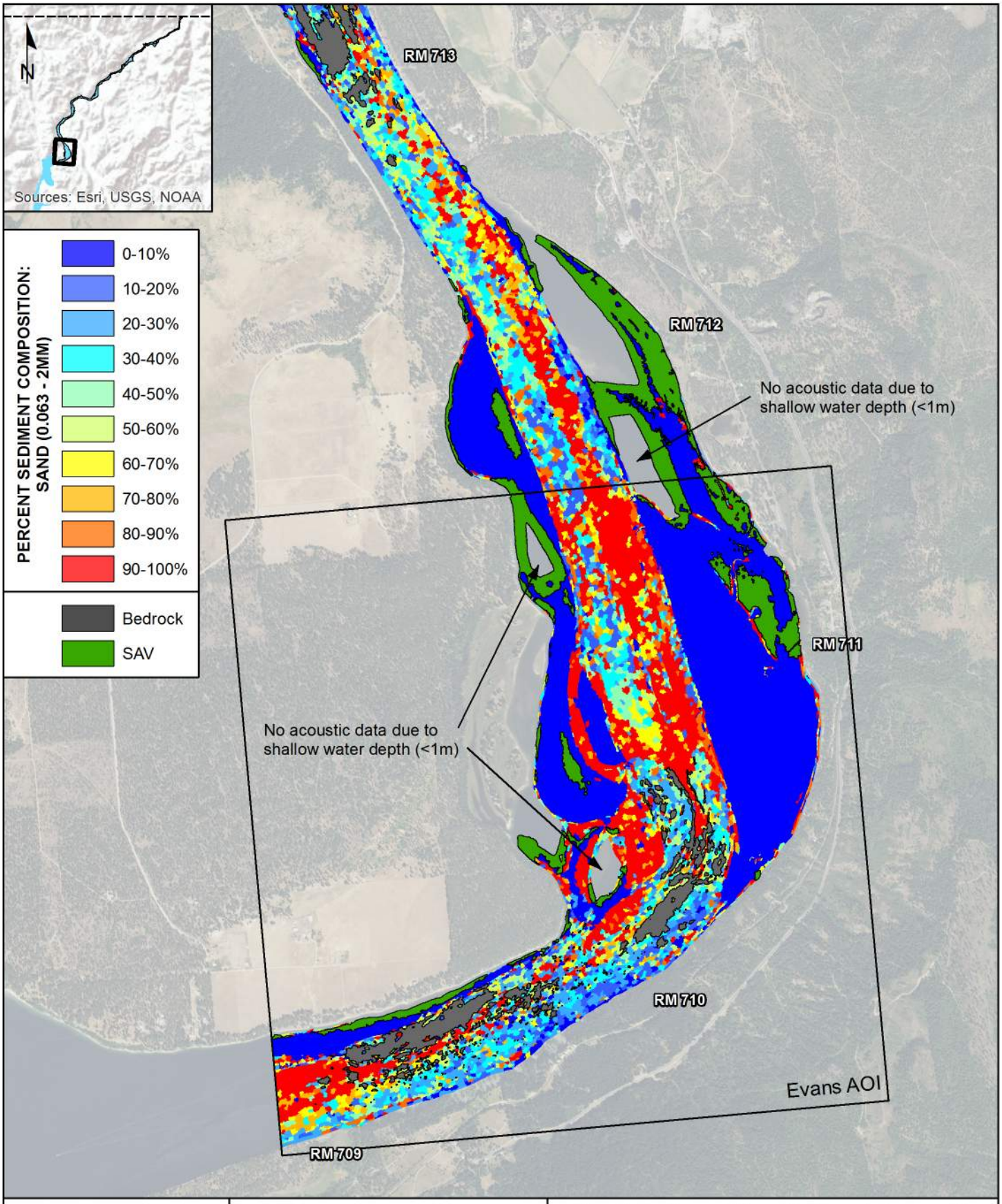
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-1a. **Percent Mud Sediment Composition for RM 709-713 Including Evans AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

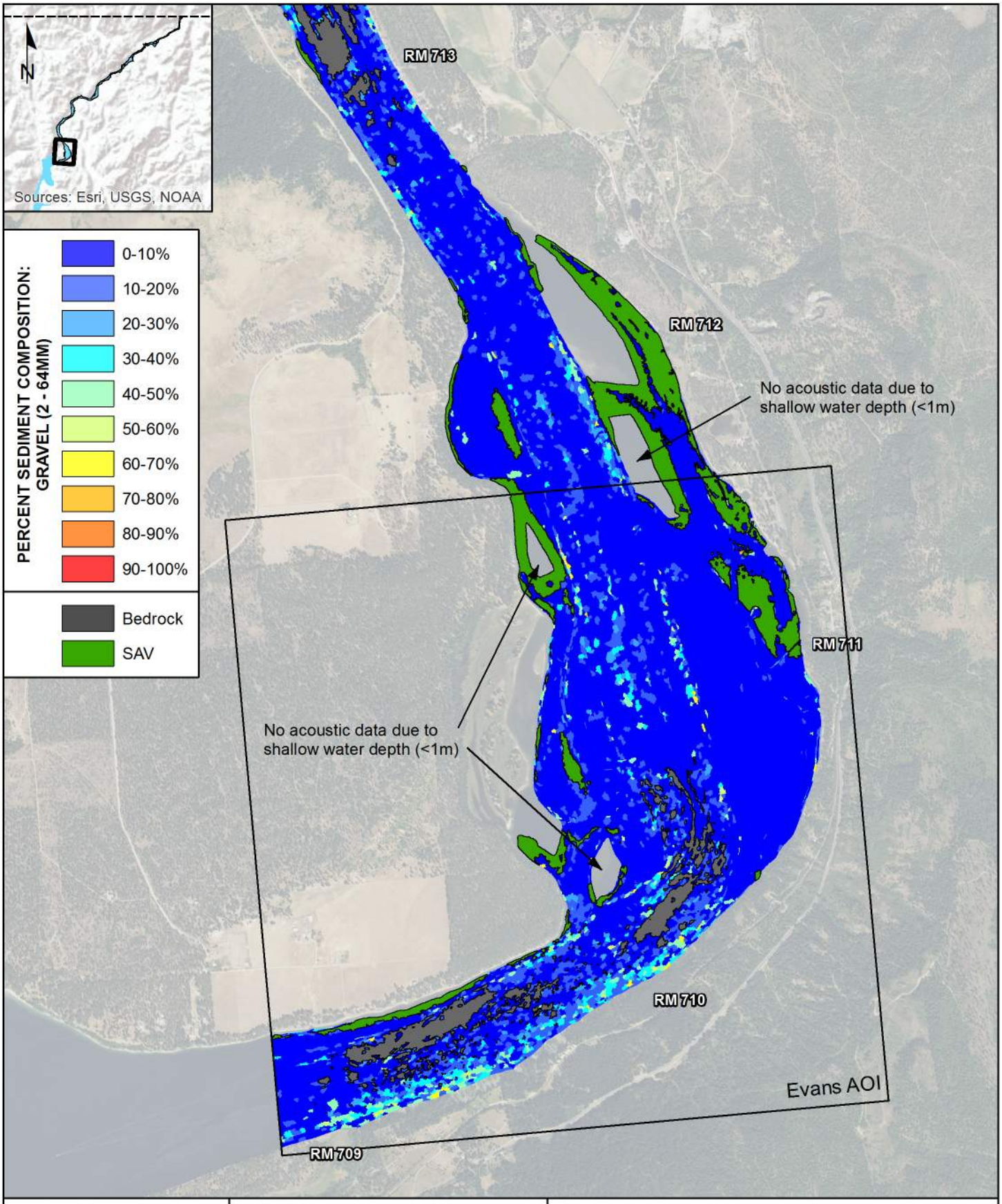
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-1b. **Percent Sand Sediment Composition for RM 709-713 Including Evans AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

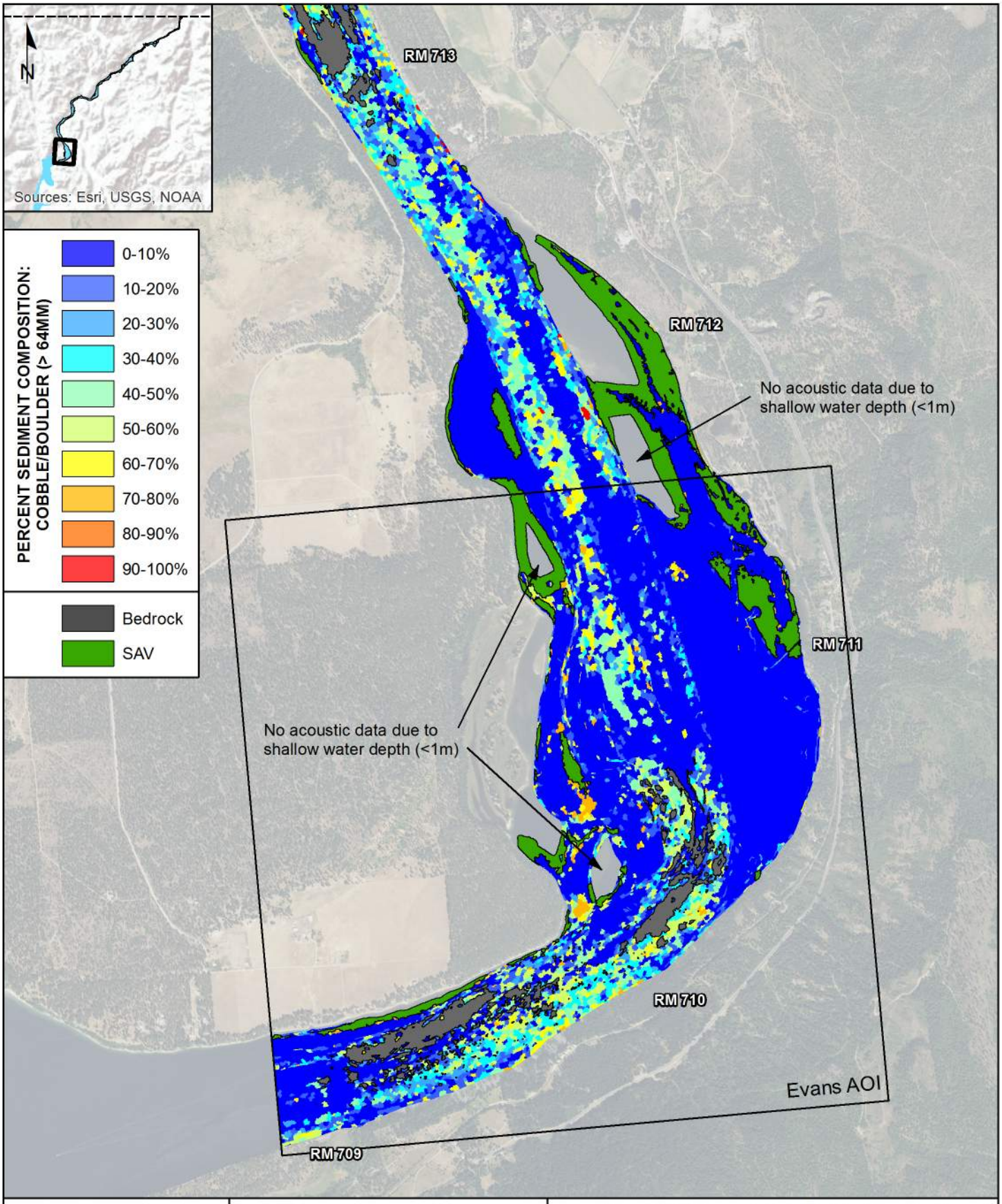
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-1c. **Percent Gravel Sediment Composition for RM 709-713 Including Evans AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

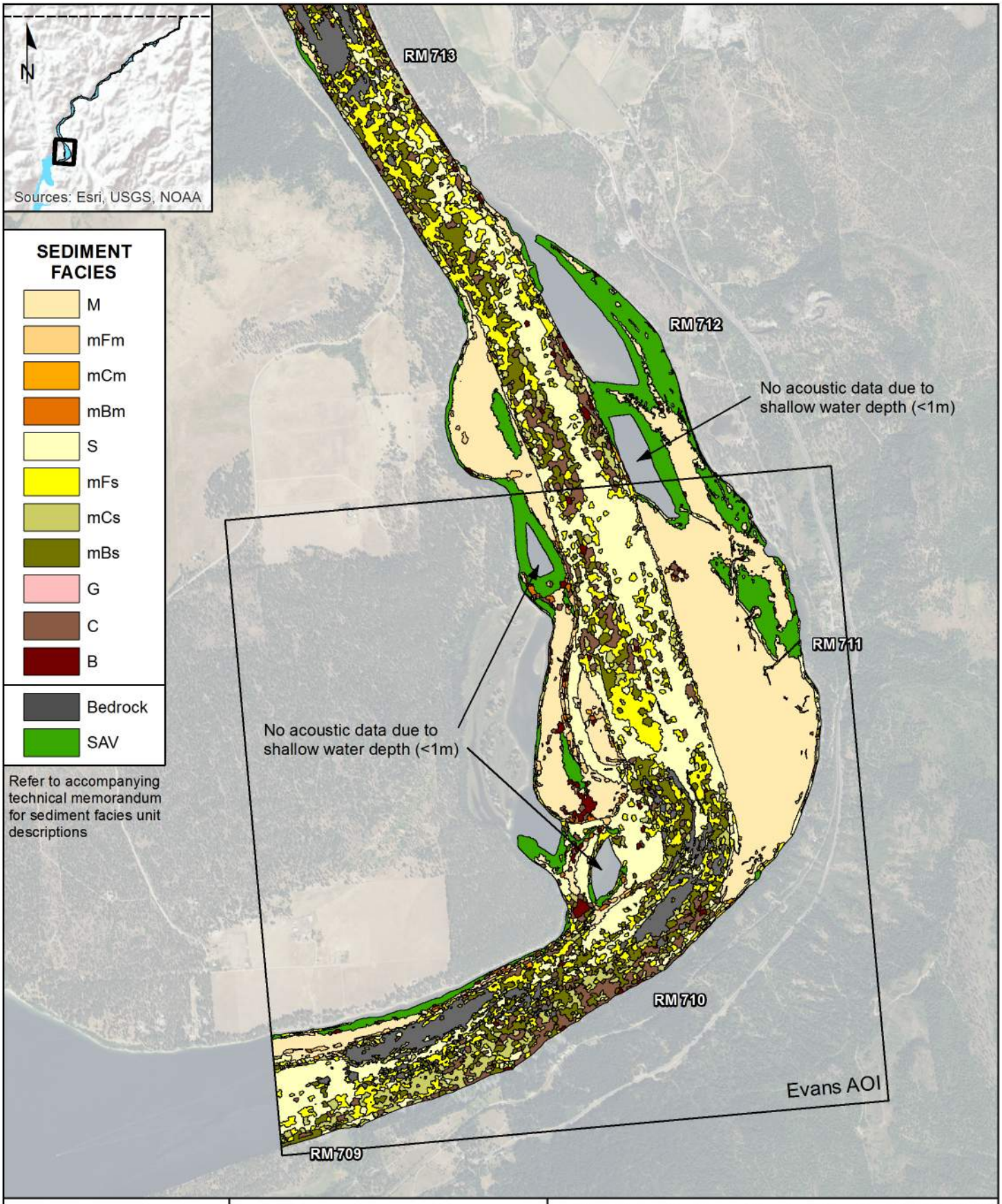
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-1d. **Percent Cobble/Boulder Sediment Composition for RM 709-713 Including Evans AOI**

Upper Columbia River, WA



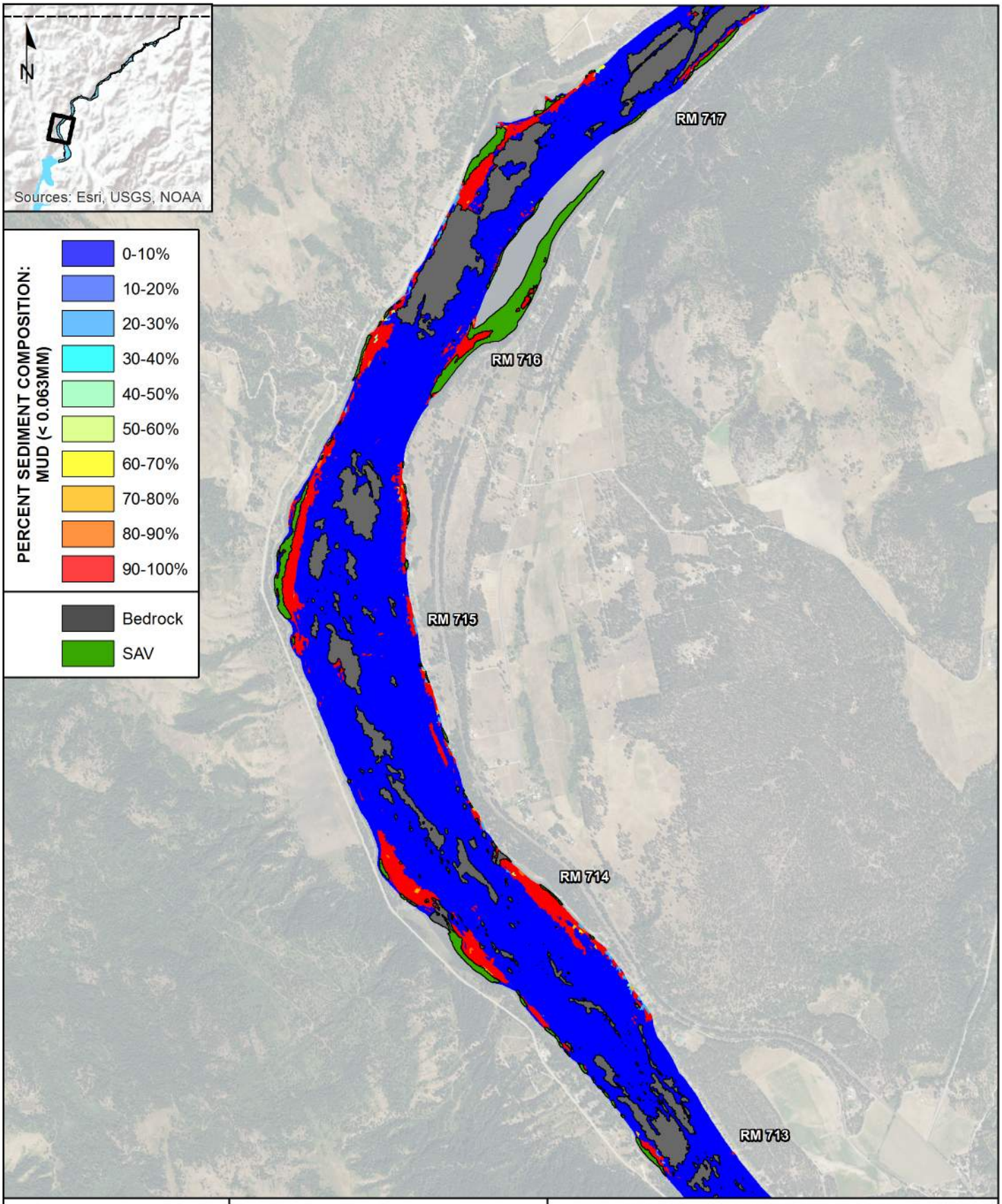
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-1e. **Sediment Facies Map for RM 709-713 Including Evans AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

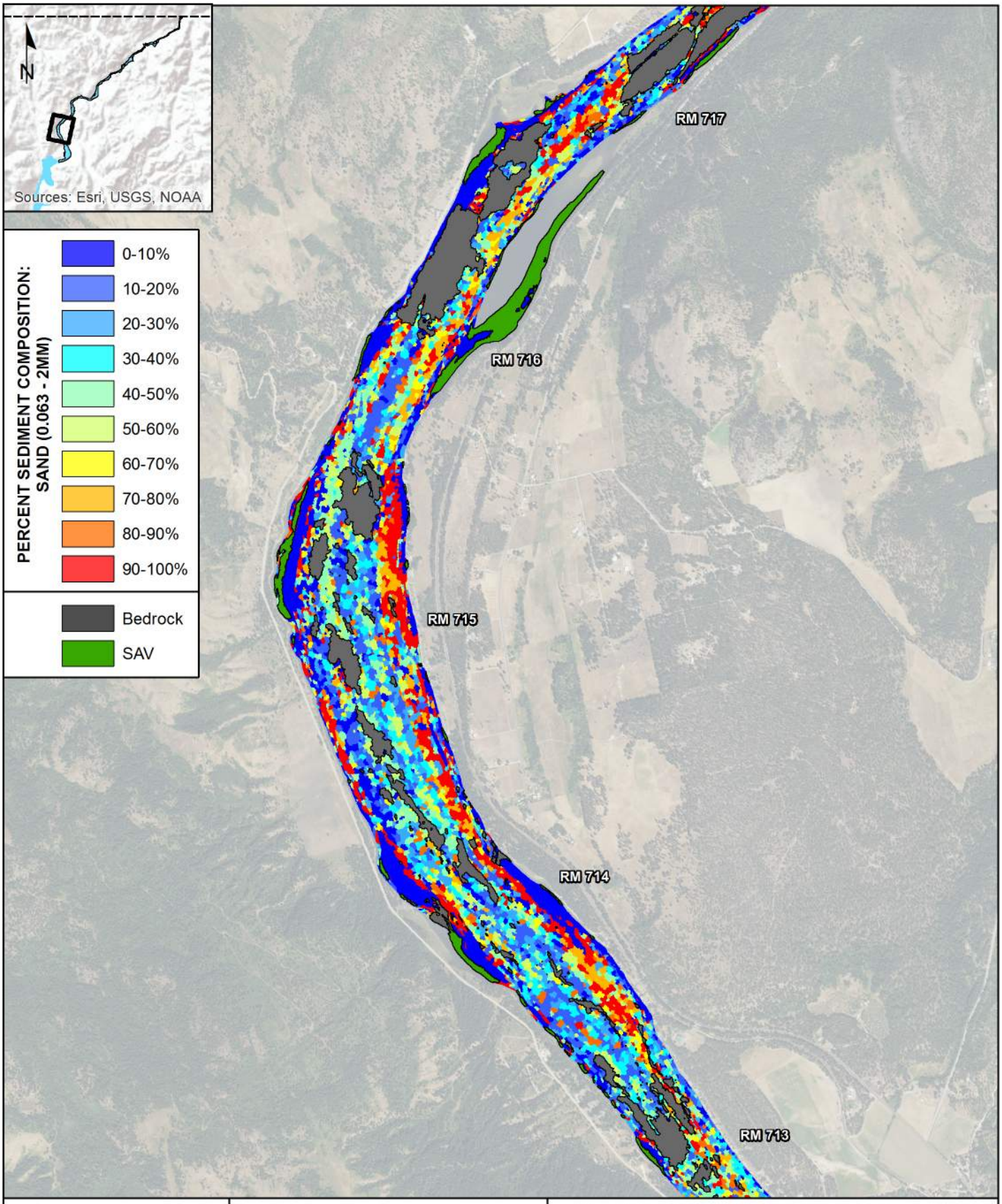
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-2a. **Percent Mud Sediment Composition for RM 713-717**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

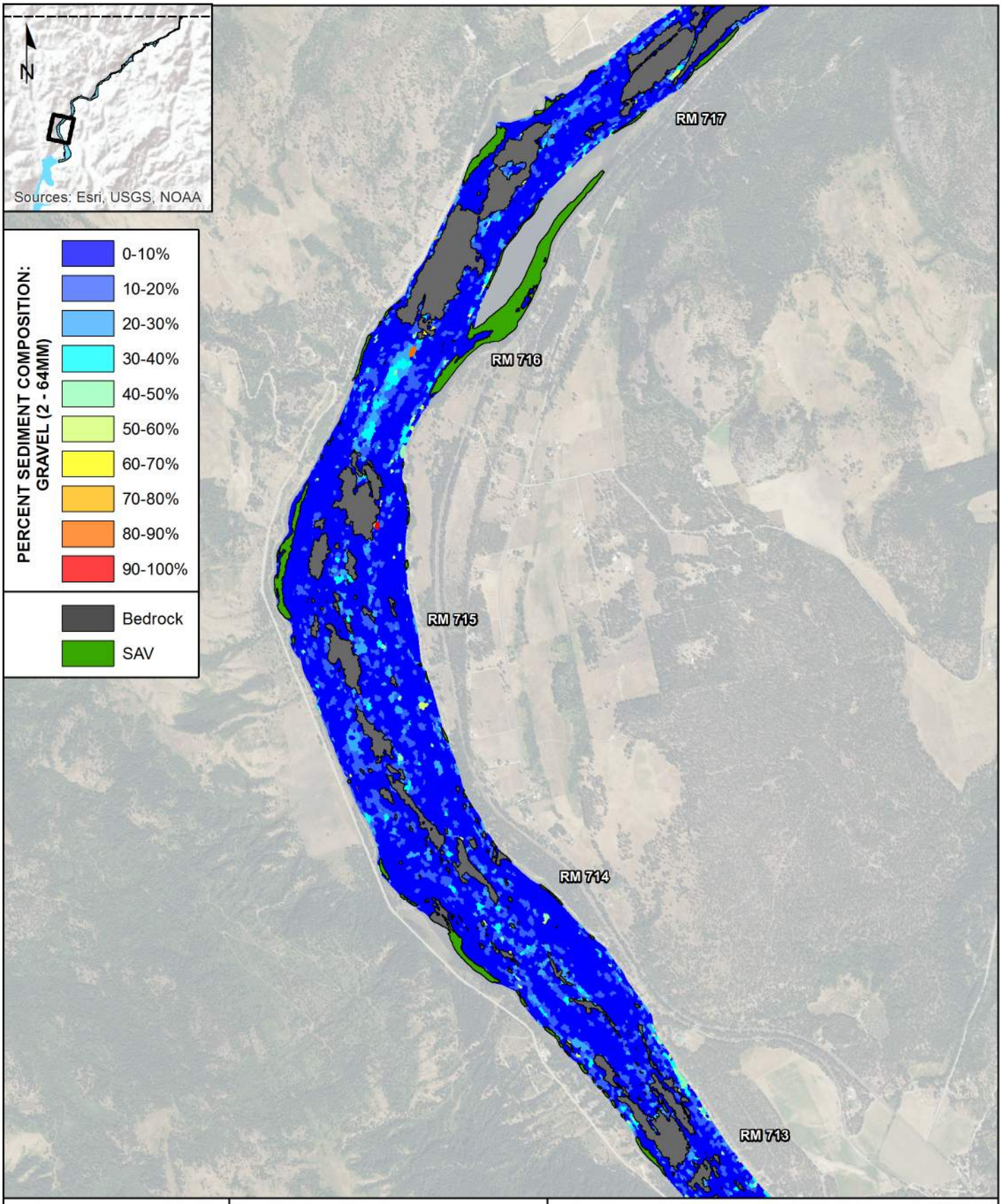
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-2b. **Percent Sand Sediment Composition for RM 713-717**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

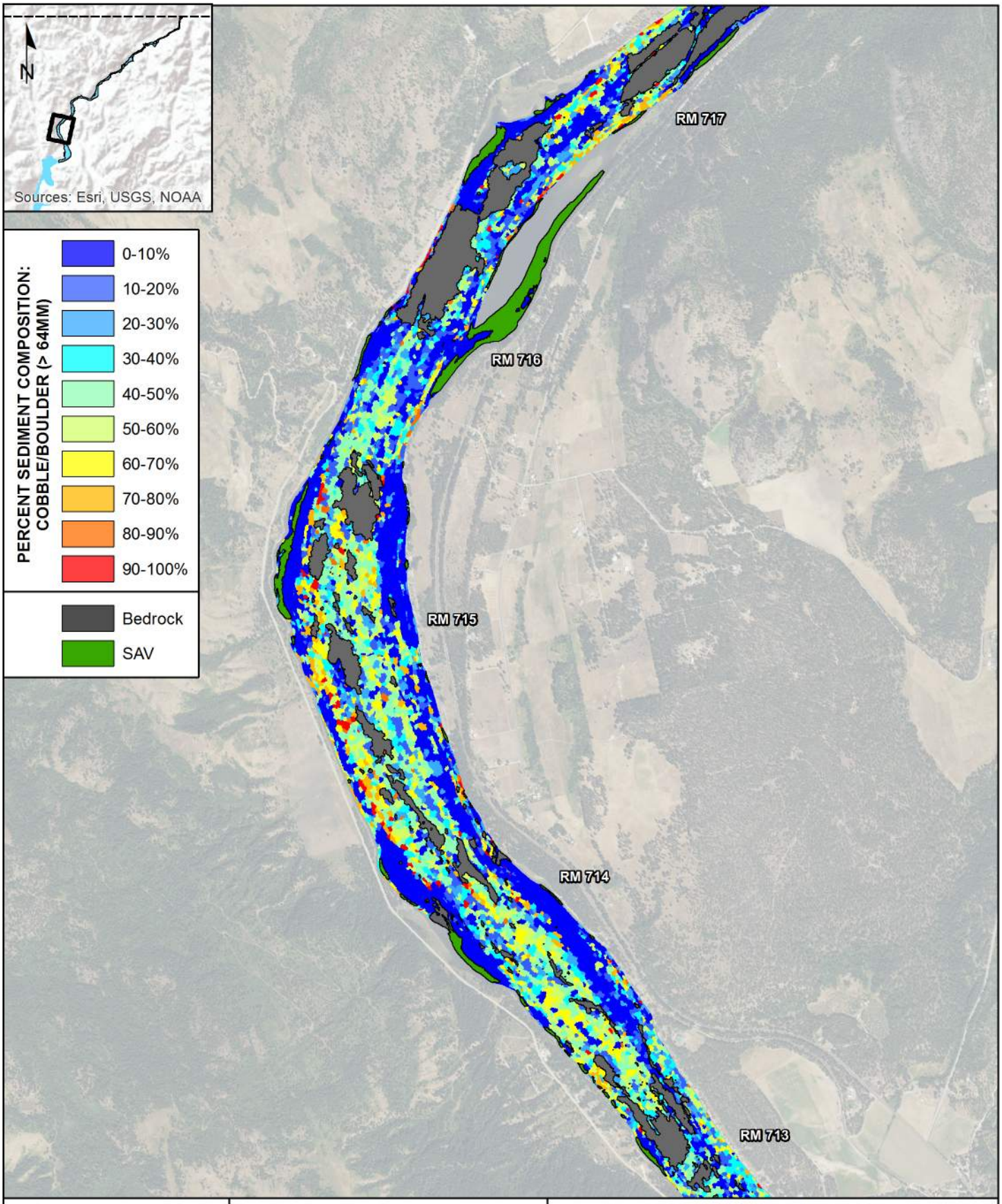
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-2c. **Percent Gravel Sediment Composition for RM 713-717**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

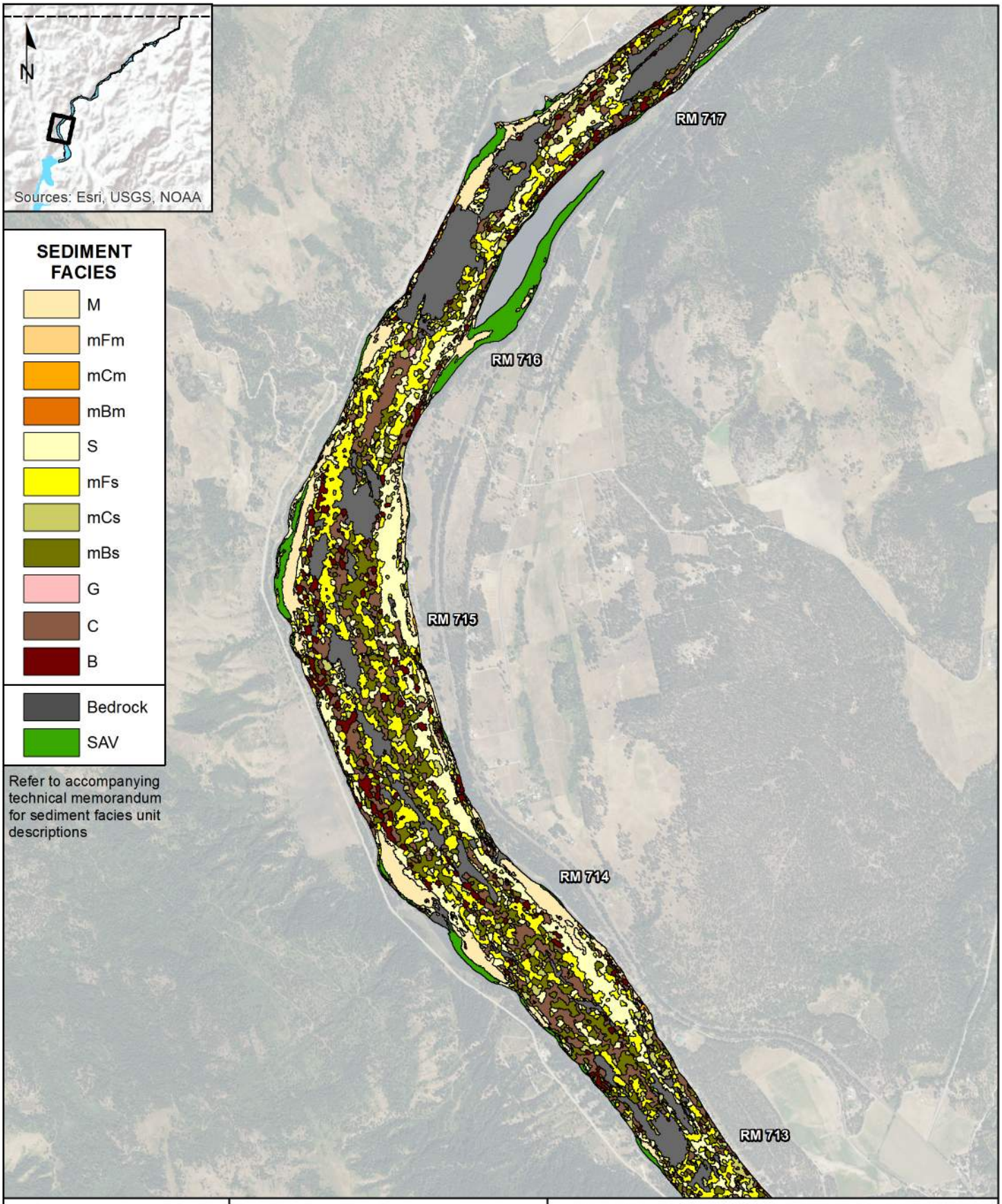
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-2d. **Percent Cobble/Boulder Sediment Composition for RM 713-717**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

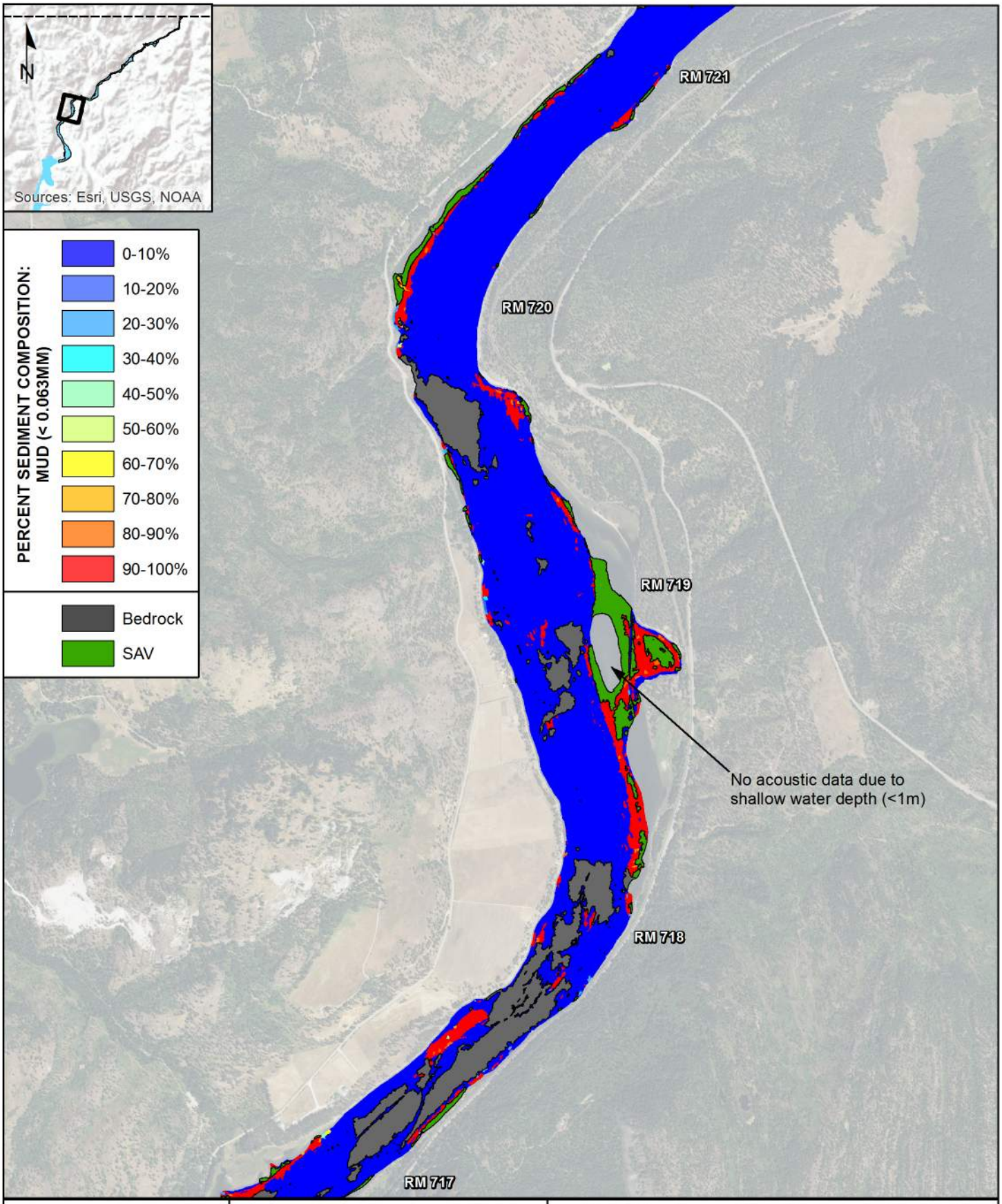
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-2e. **Sediment Facies Map for RM 713-717**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

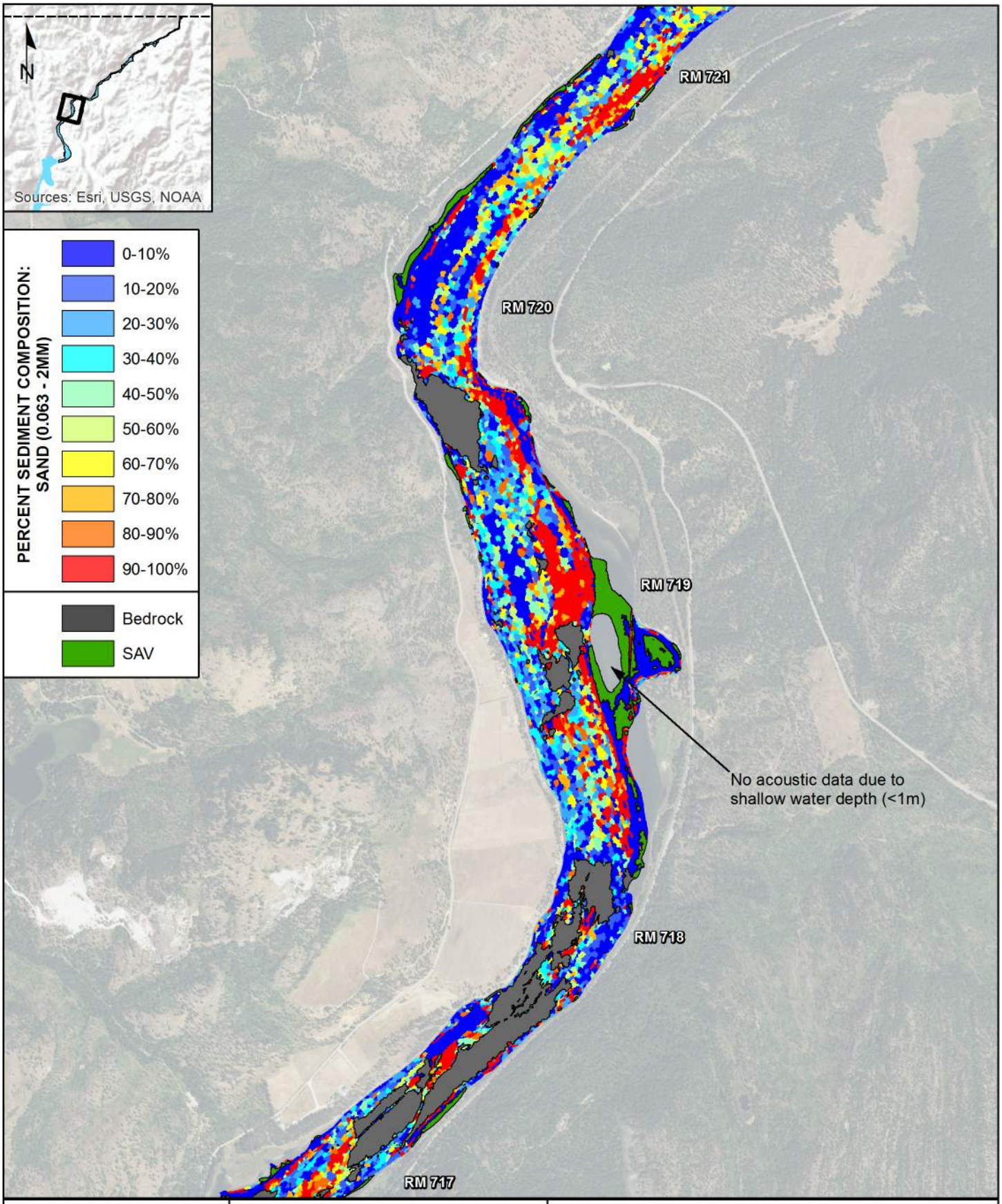
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-3a. **Percent Mud Sediment Composition for RM 717-721**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

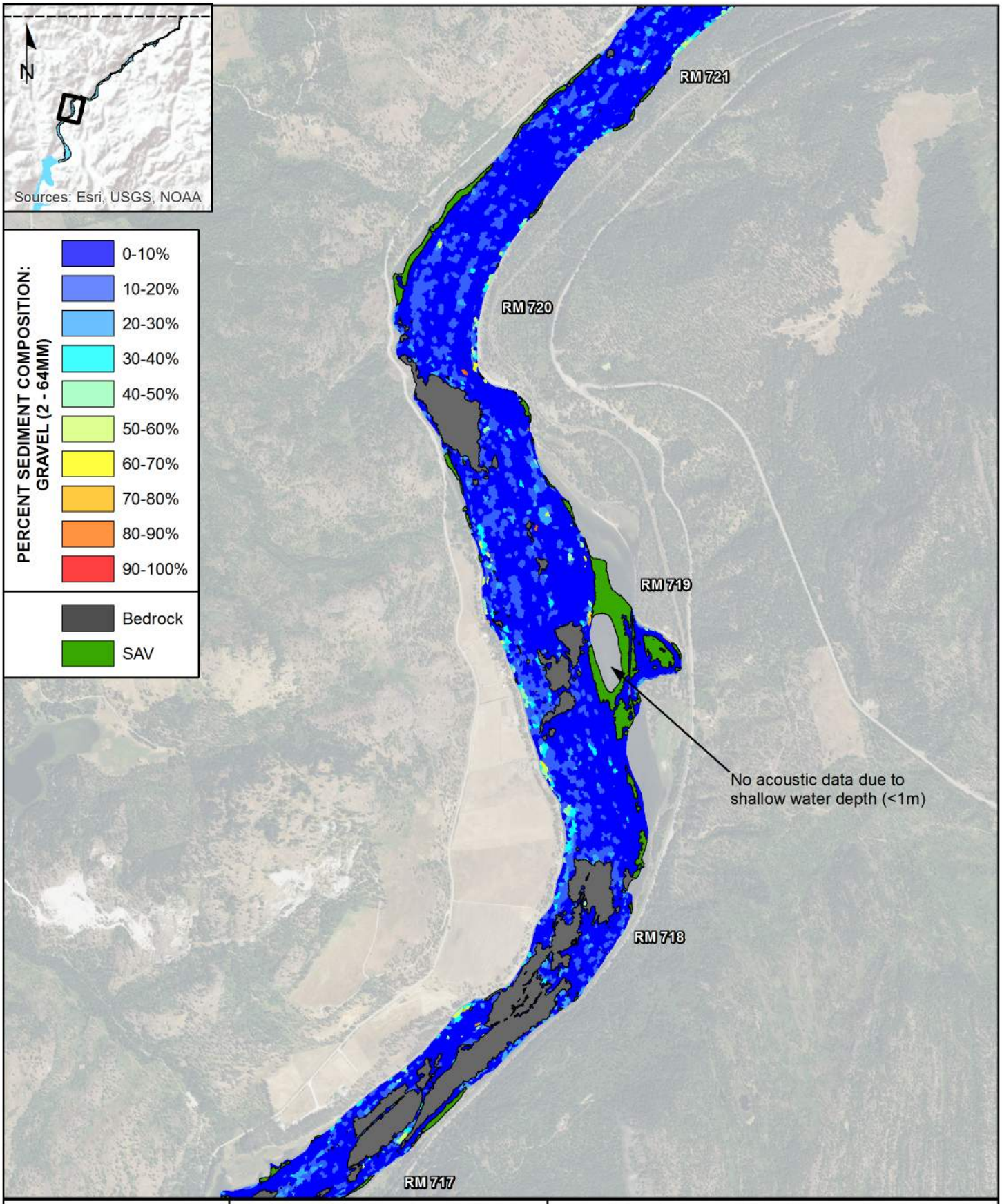
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-3b. **Percent Sand Sediment Composition for RM 717-721**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

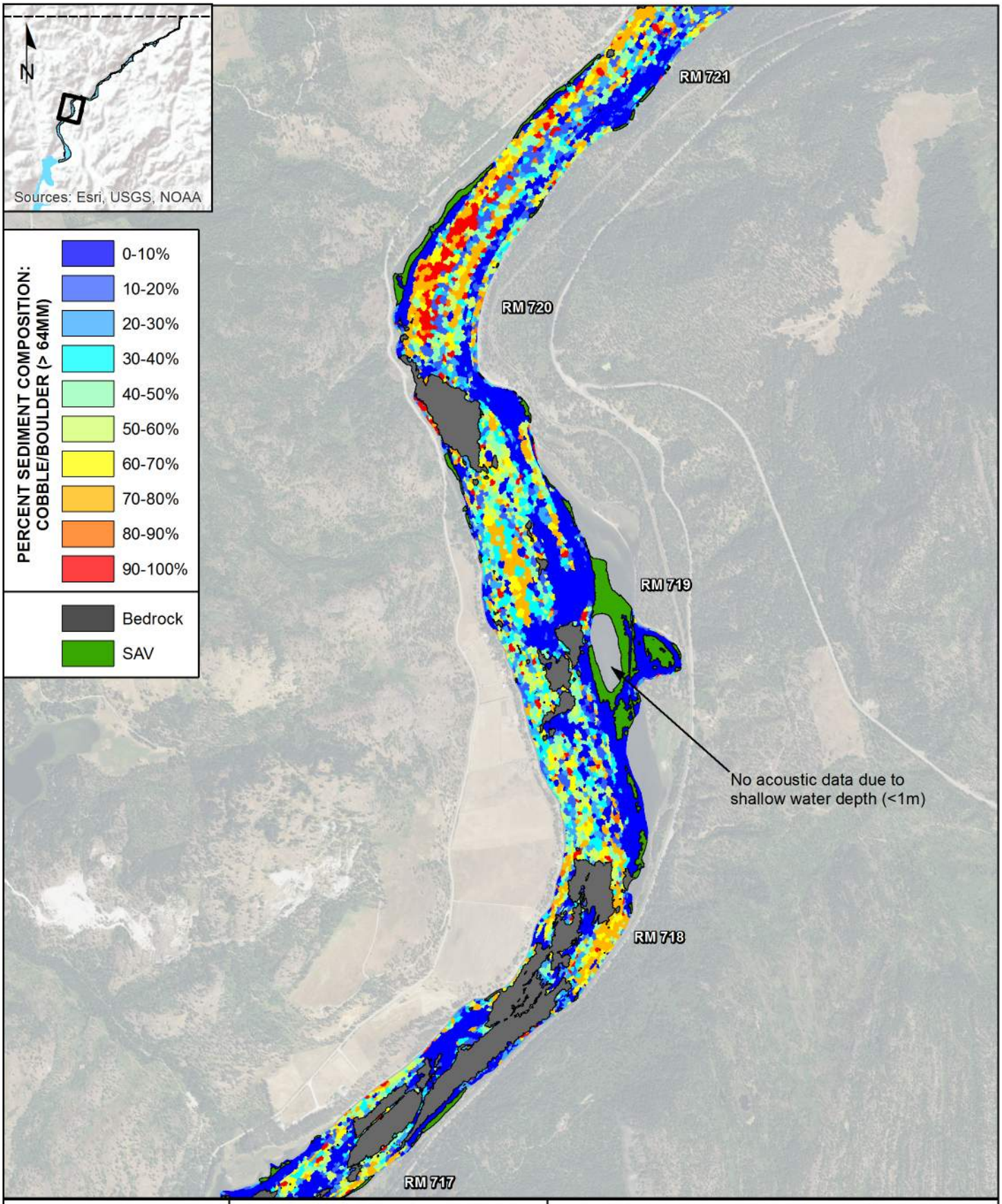
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-3c. **Percent Gravel Sediment Composition for RM 717-721**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

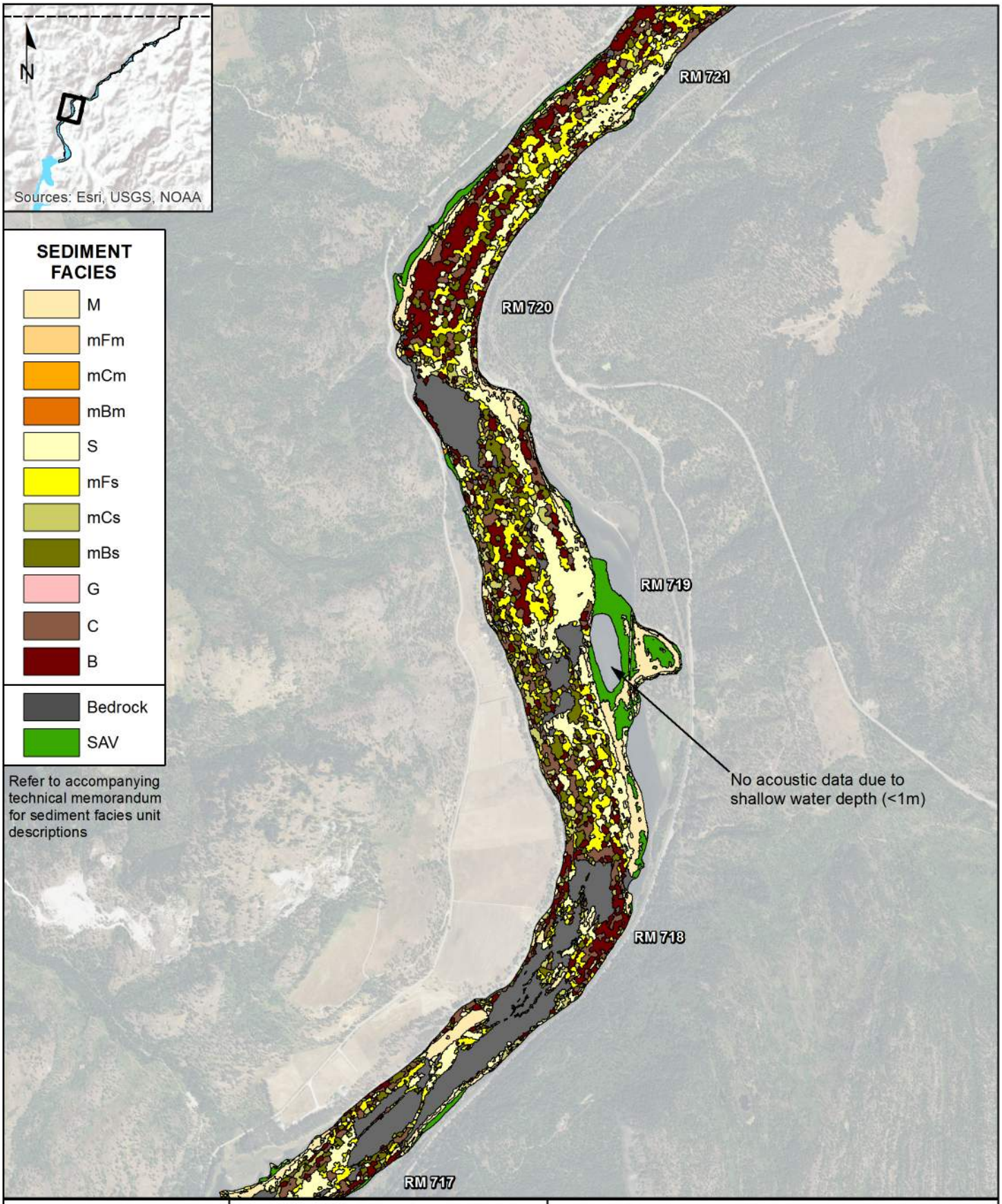
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-3d. **Percent Cobble/Boulder Sediment Composition for RM 717-721**

Upper Columbia River, WA



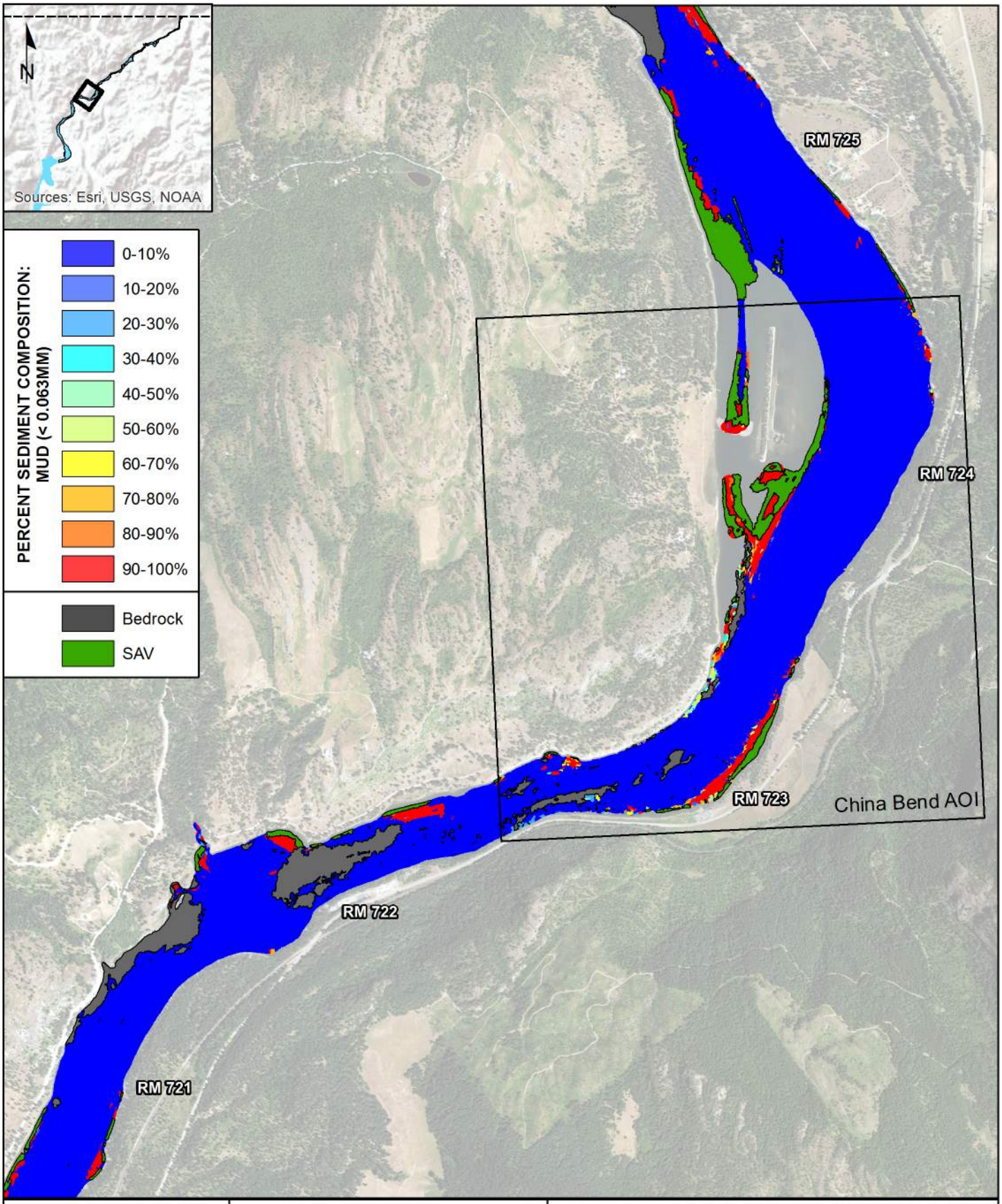
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-3e. **Sediment Facies Map for RM 717-721**

Upper Columbia River, WA



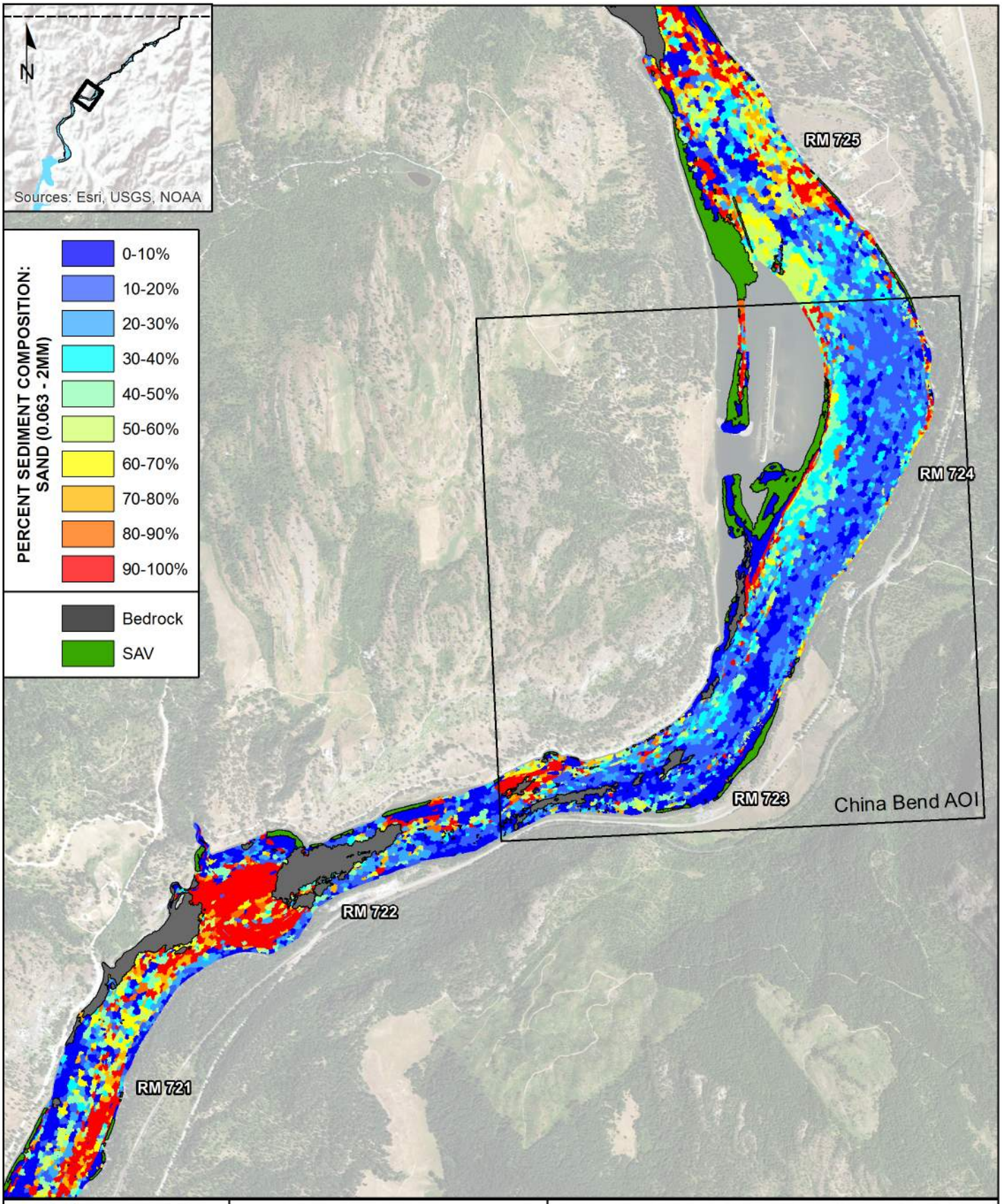
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-4a. **Percent Mud Sediment Composition for RM 721-725 Including China Bend AOI**

Upper Columbia River, WA



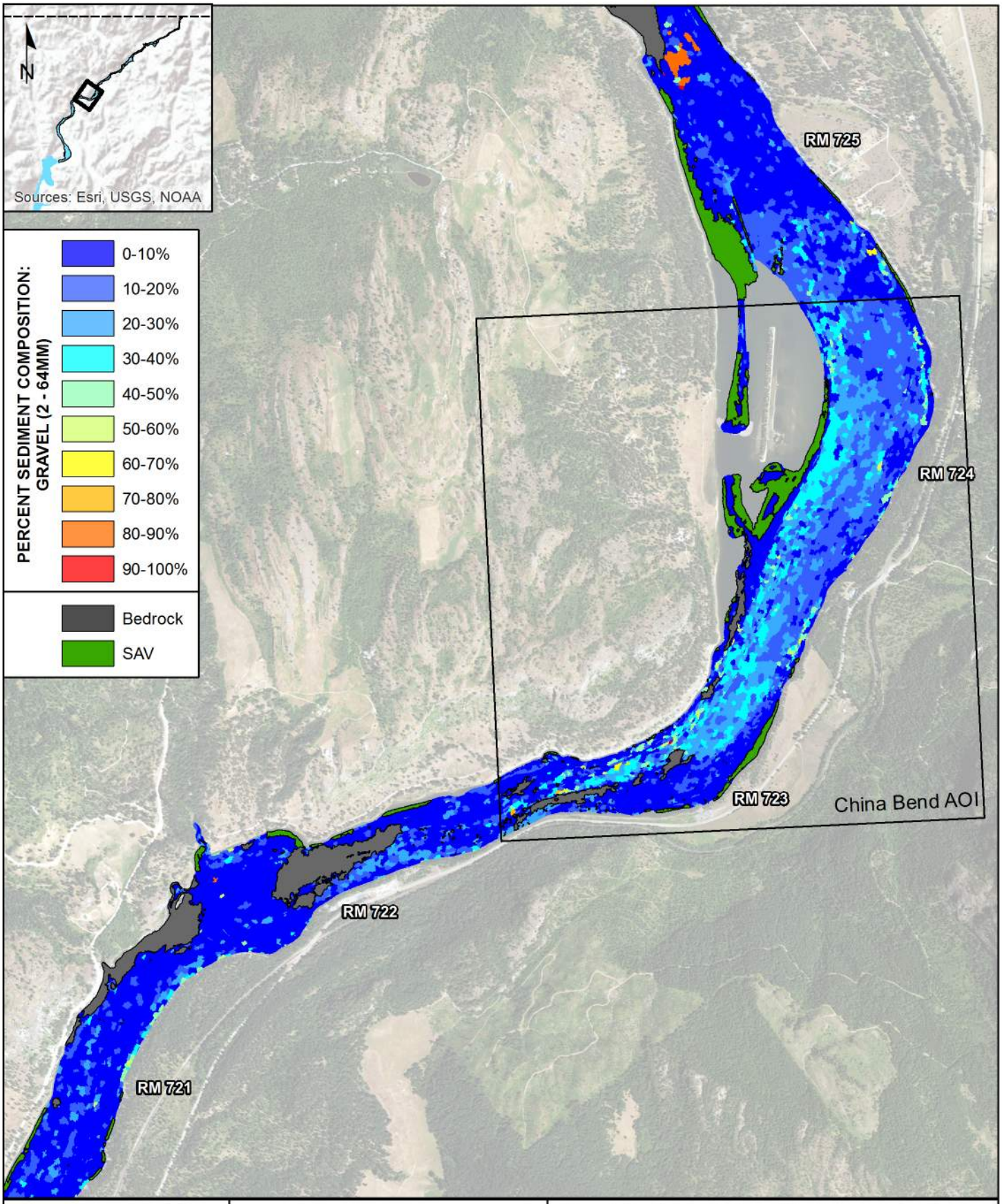
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-4b. **Percent Sand Sediment Composition for RM 721-725 Including China Bend AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

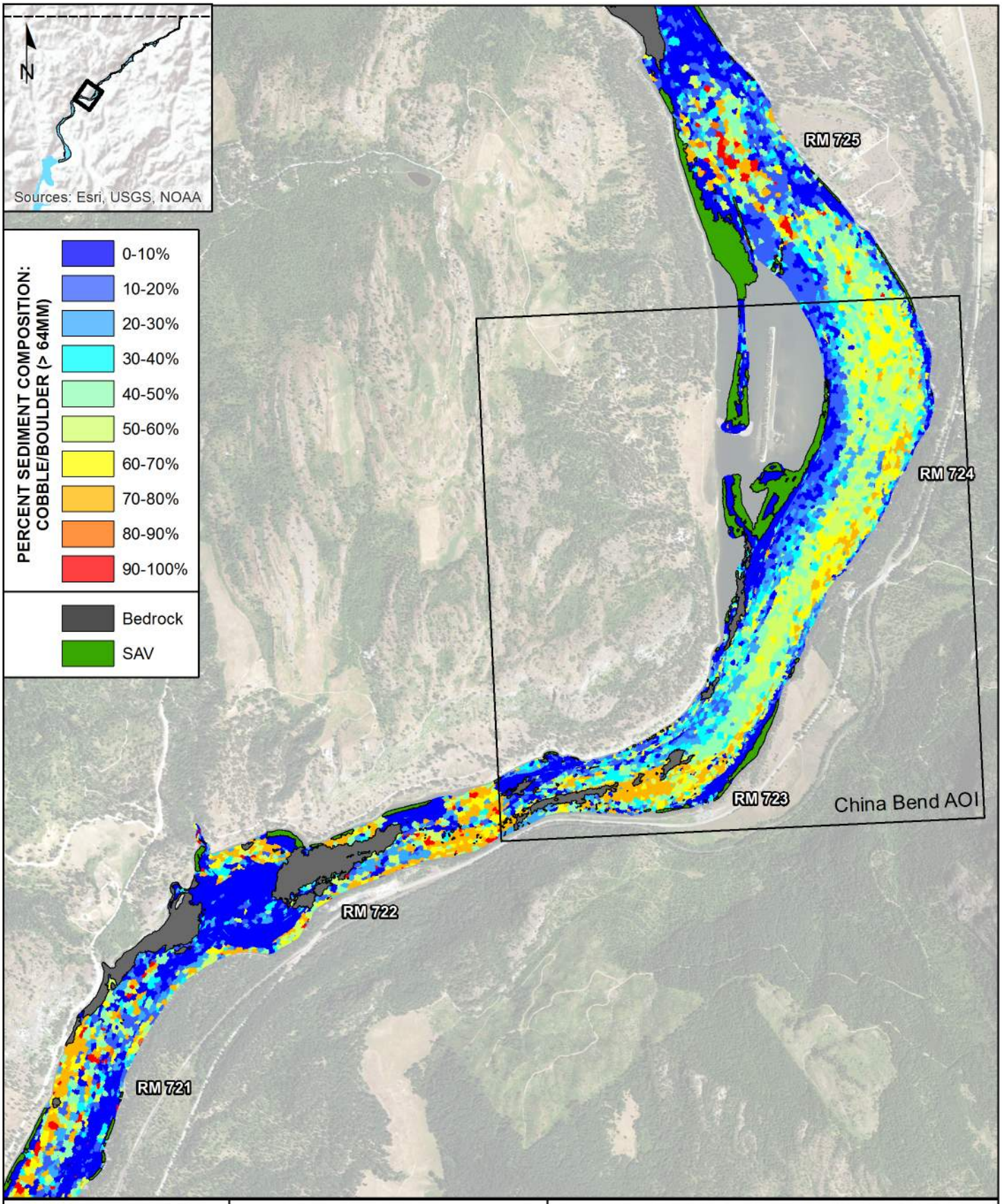
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-4c. **Percent Gravel Sediment Composition for RM 721-725 Including China Bend AOI**

Upper Columbia River, WA



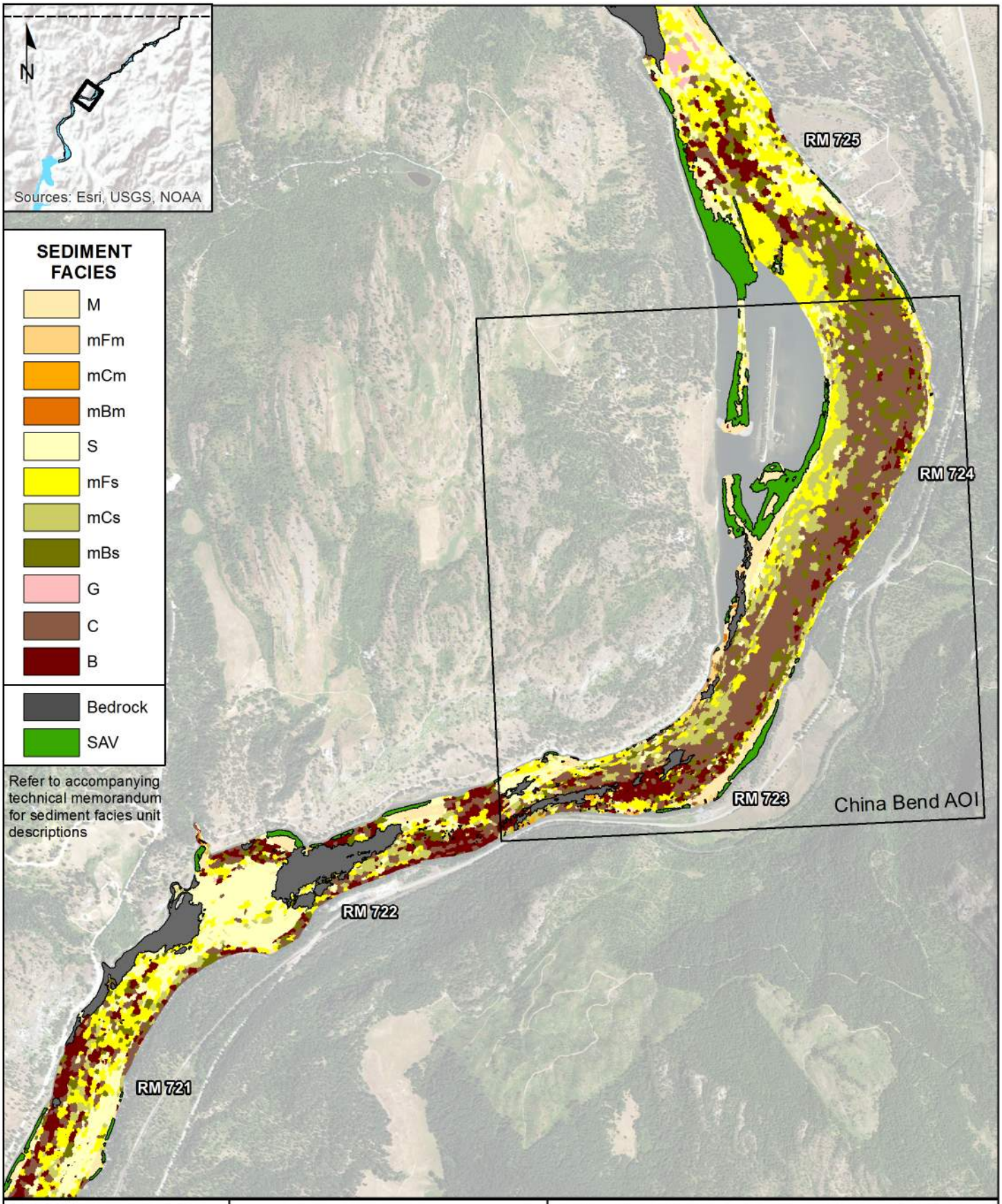
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-4d. **Percent Cobble/Boulder Sediment Composition for RM 721-725 Including China Bend AOI**

Upper Columbia River, WA



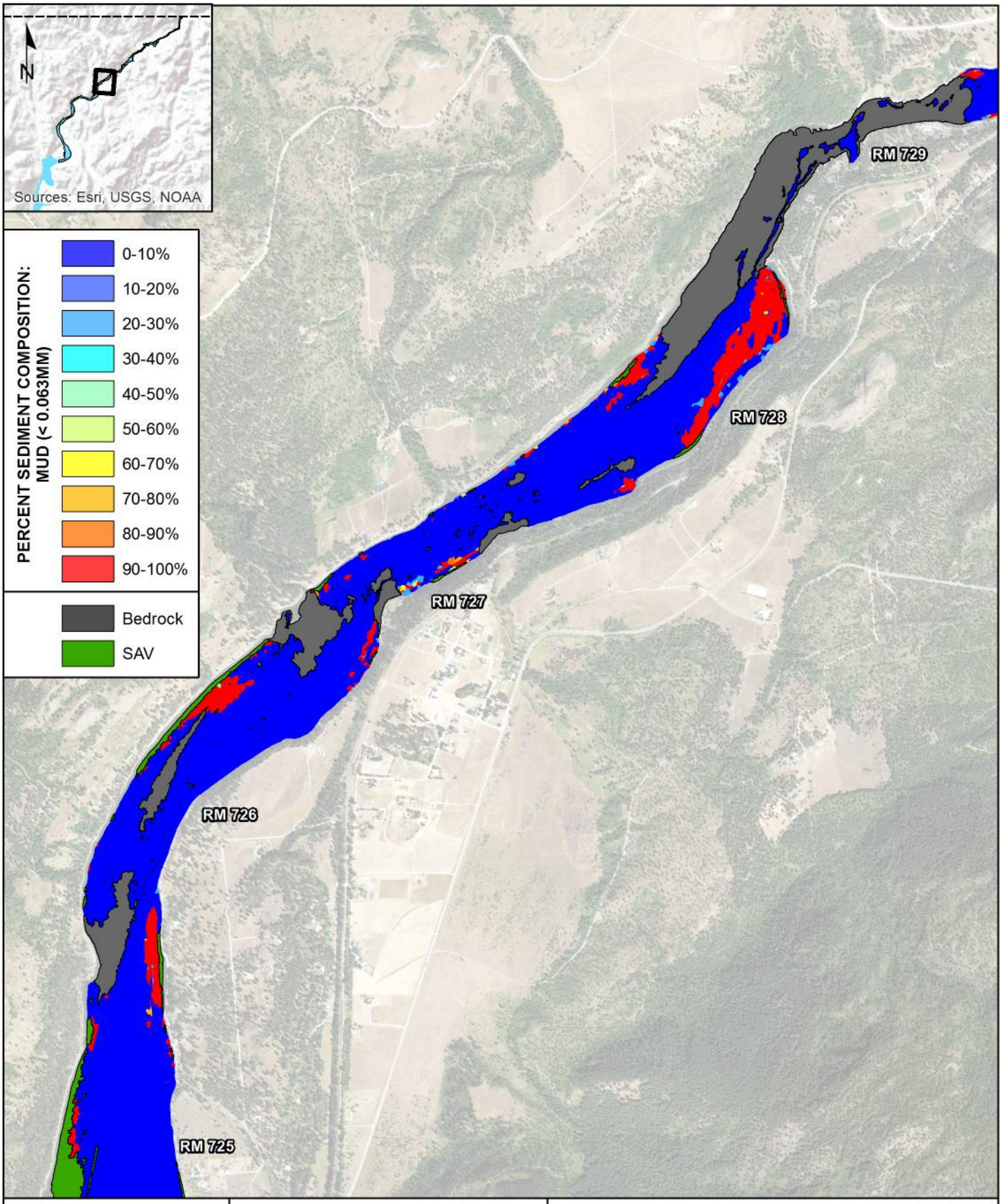
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-4e. **Sediment Facies Map for RM 721-725 Including China Bend AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

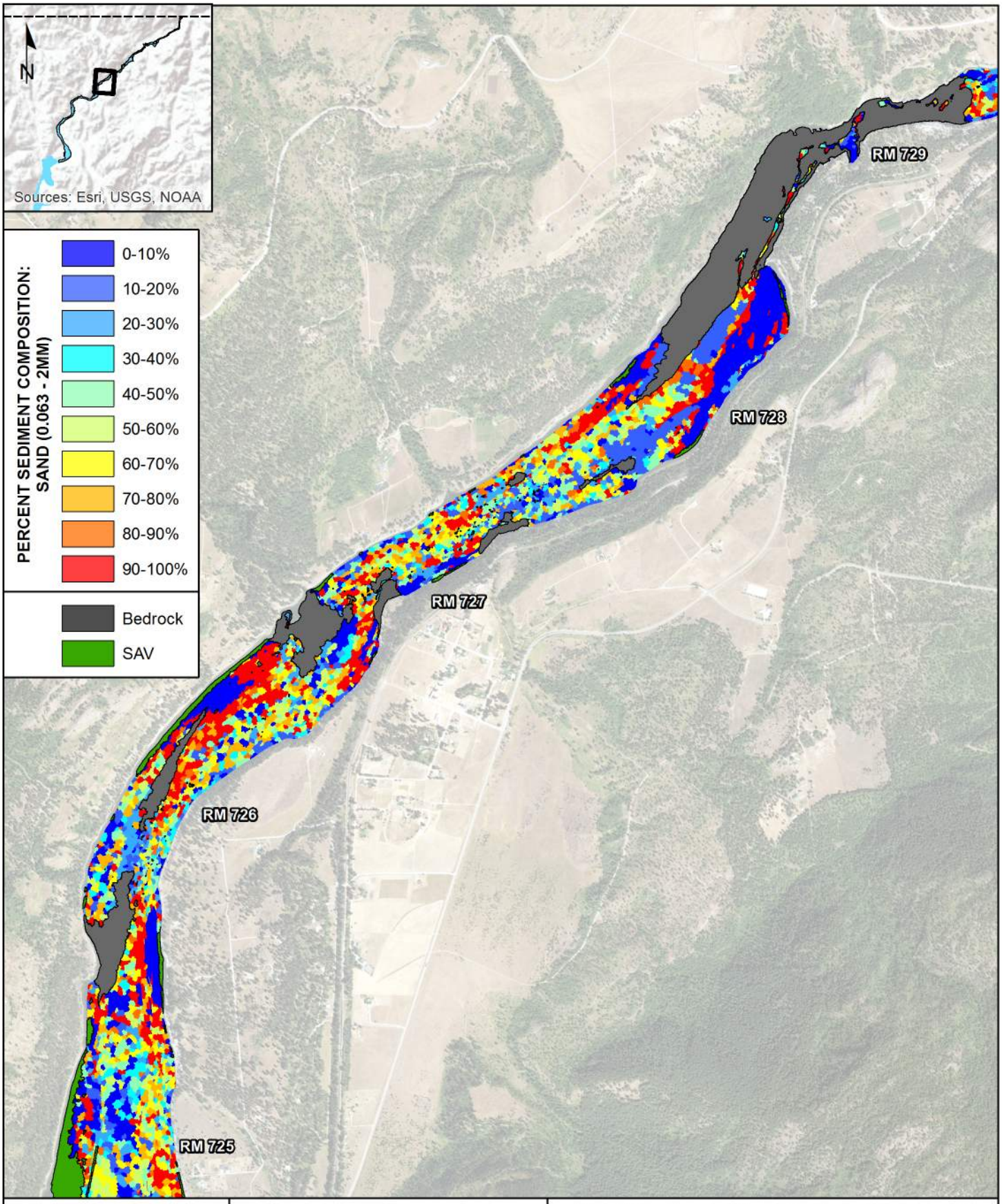
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-5a. **Percent Mud Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

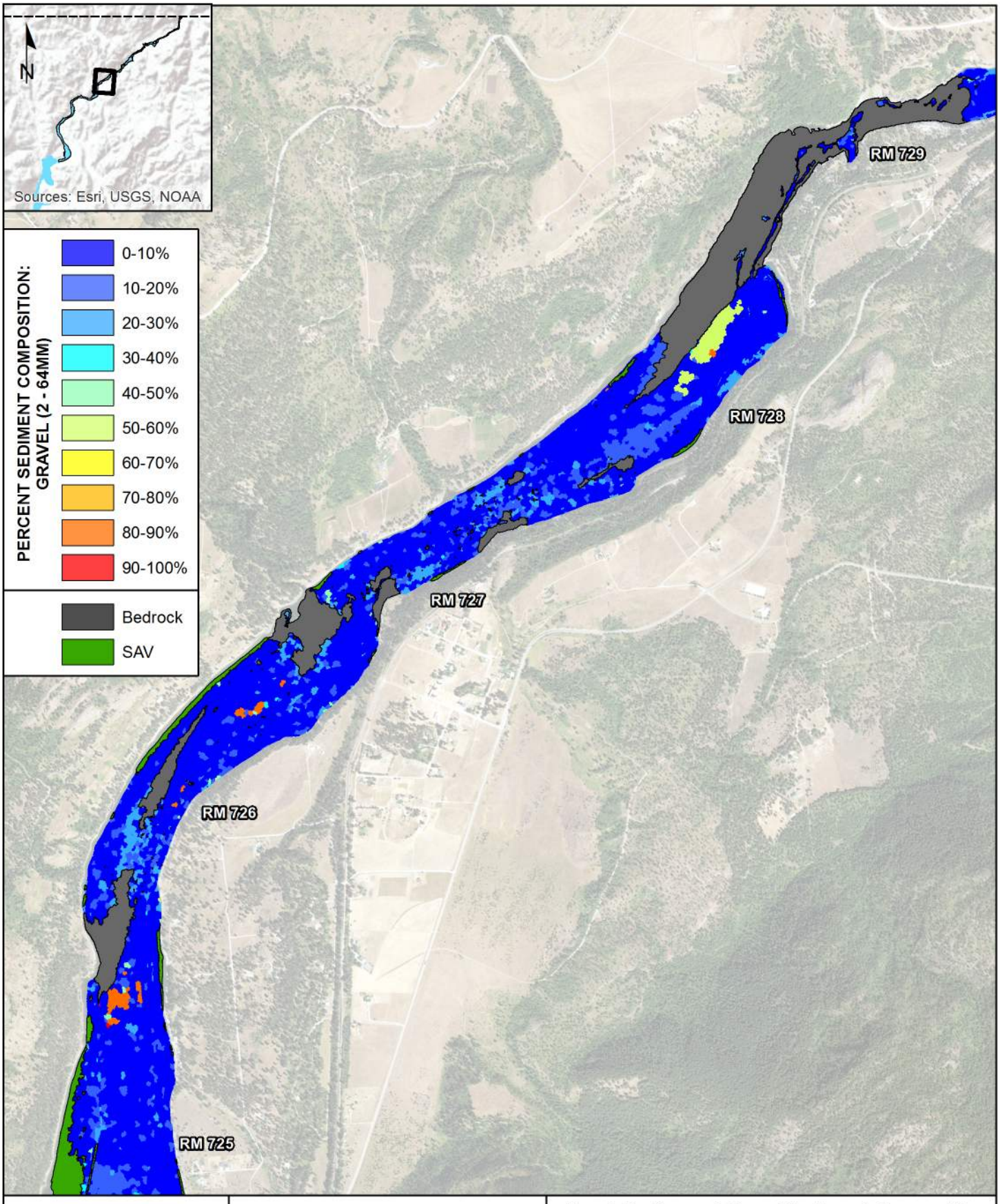
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-5b. **Percent Sand Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

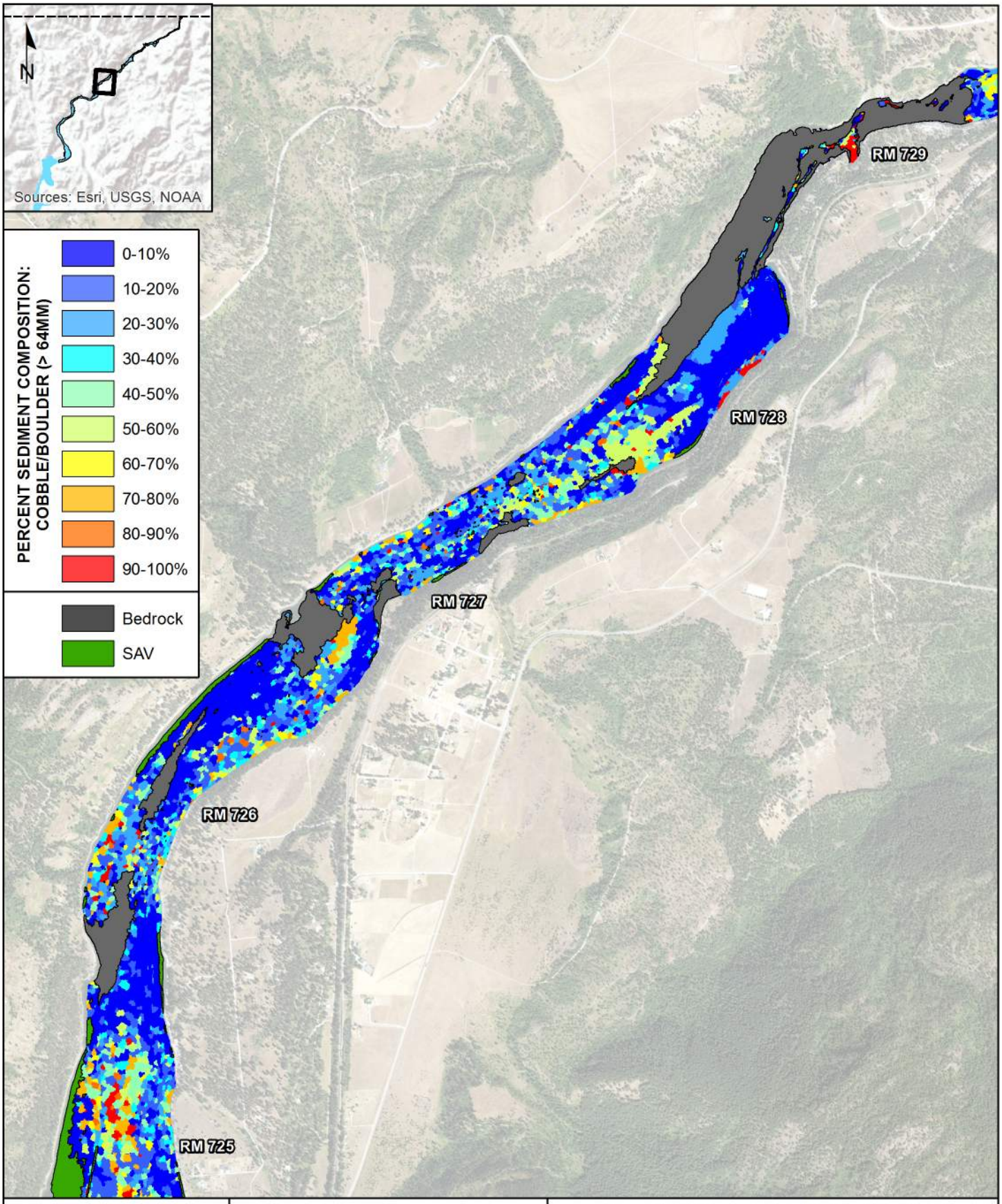
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-5c. **Percent Gravel Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

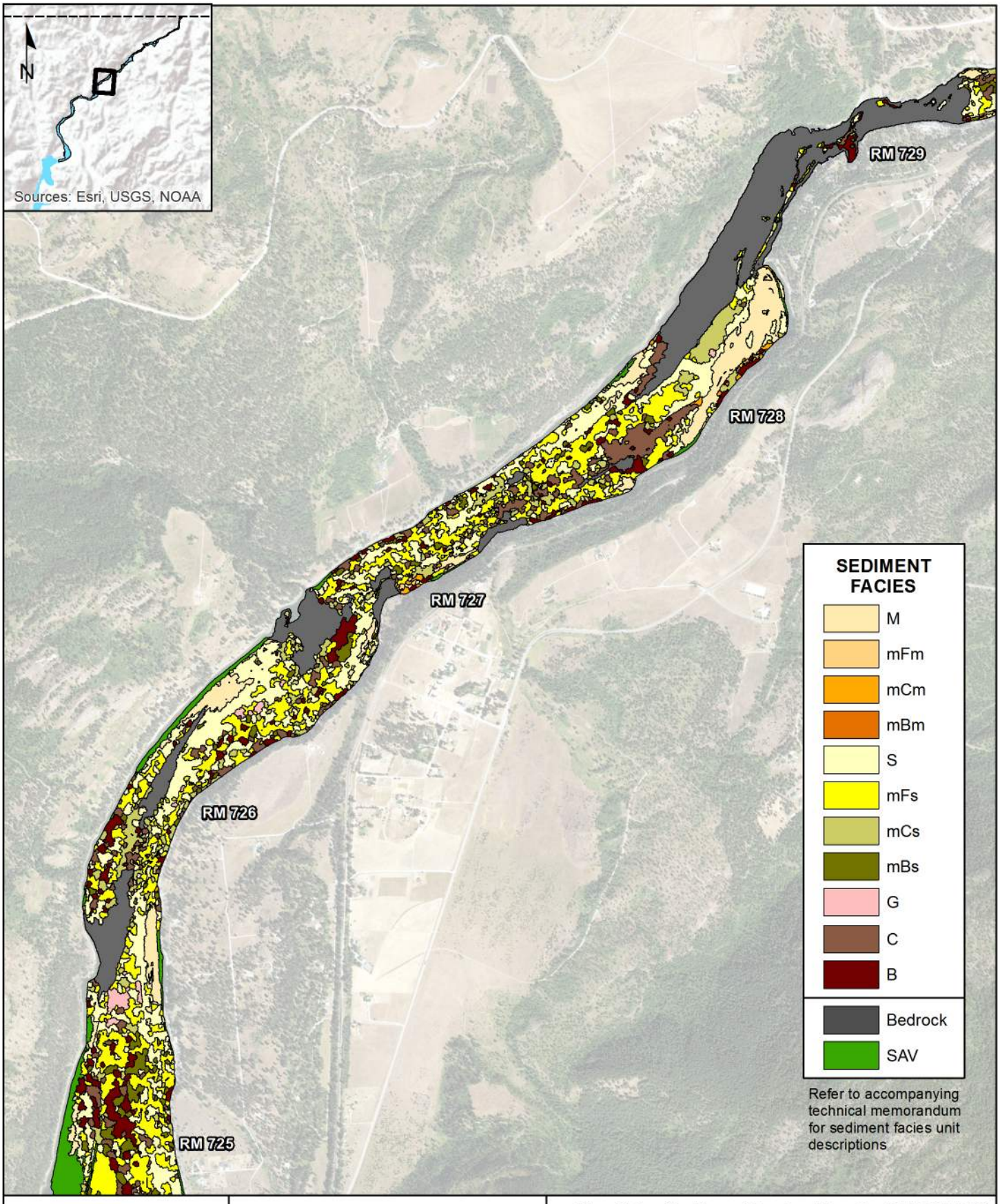
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-5d. **Percent Cobble/Boulder Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

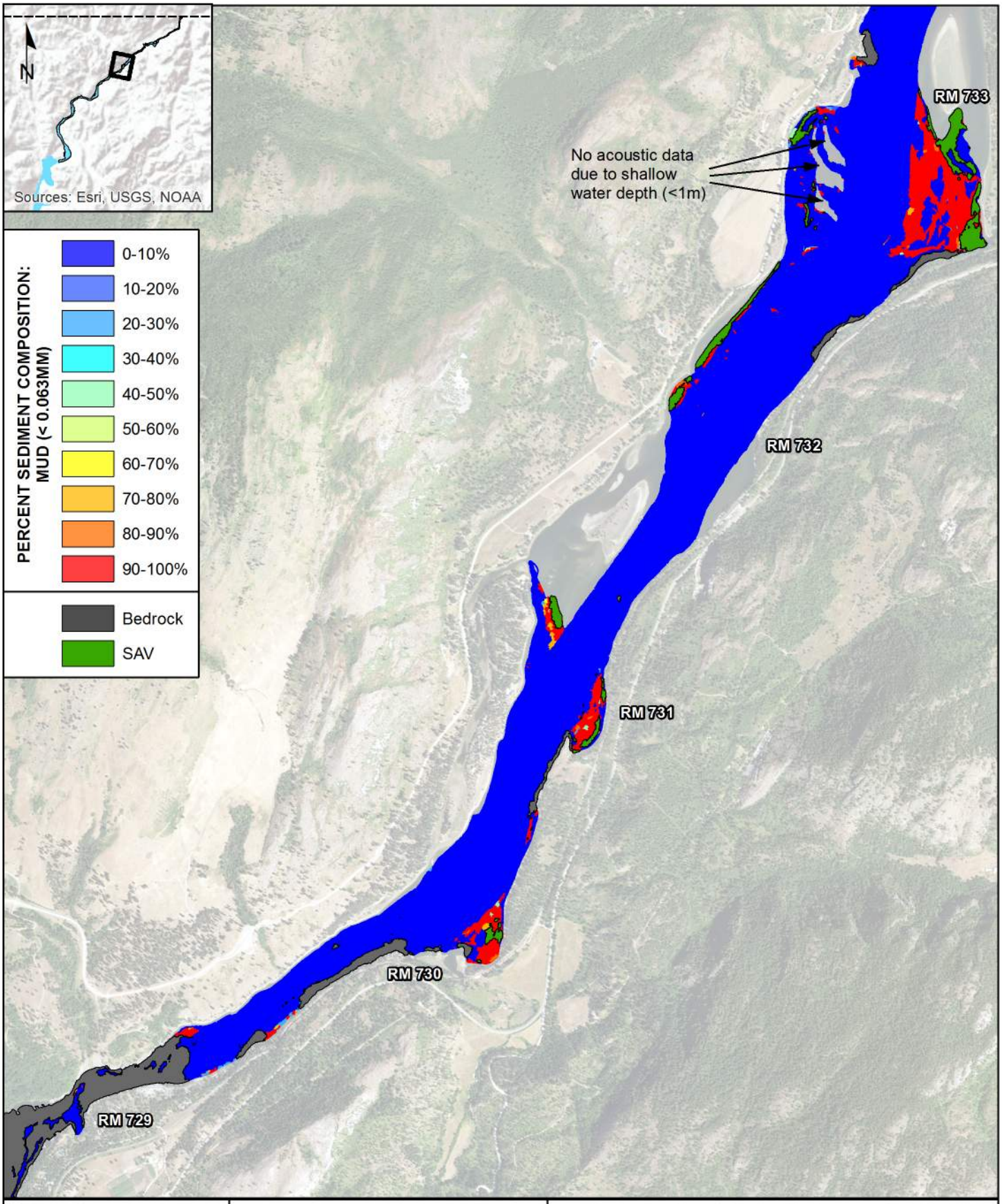
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-5e. **Sediment Facies Map for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

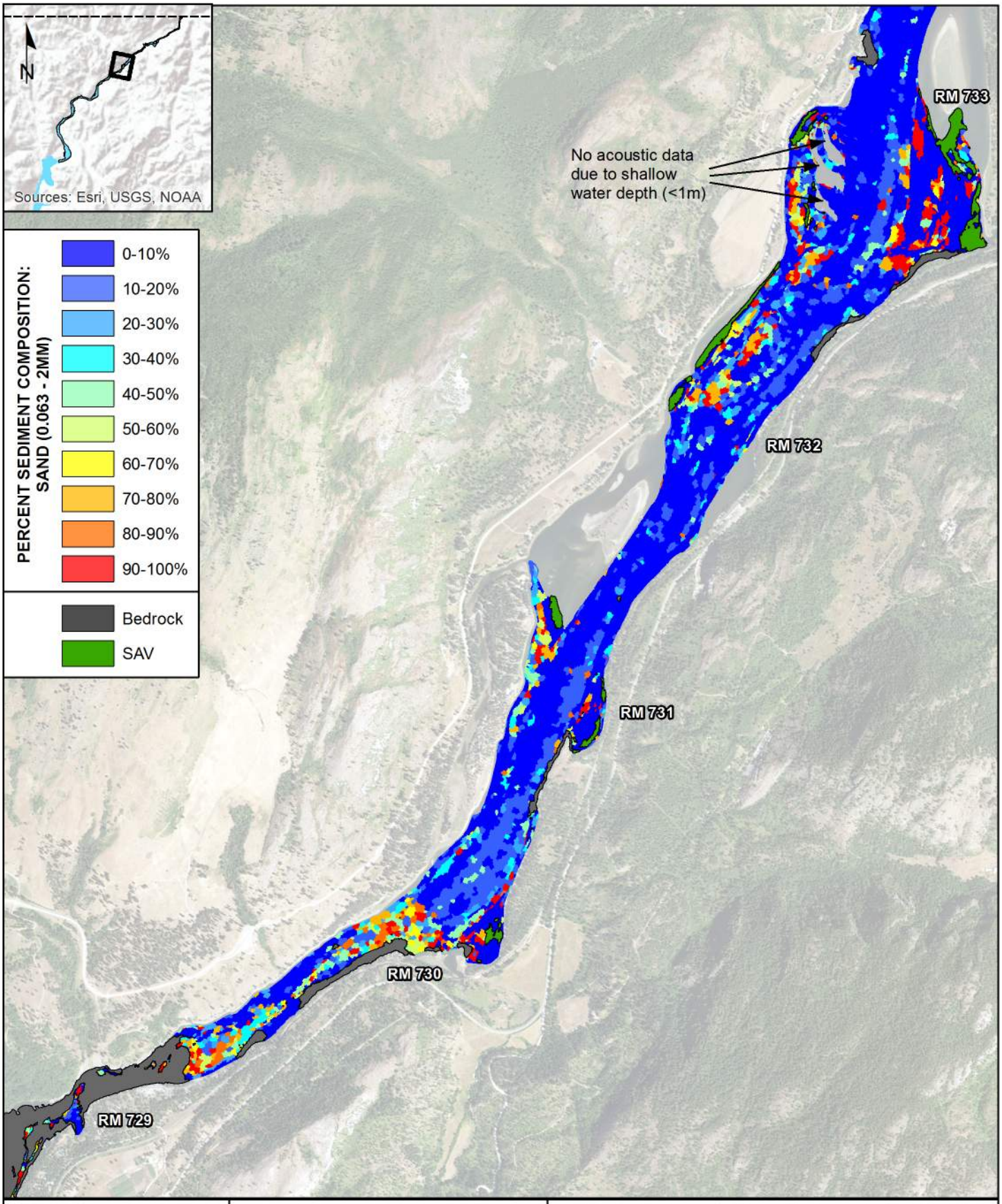
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-6a. **Percent Mud Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

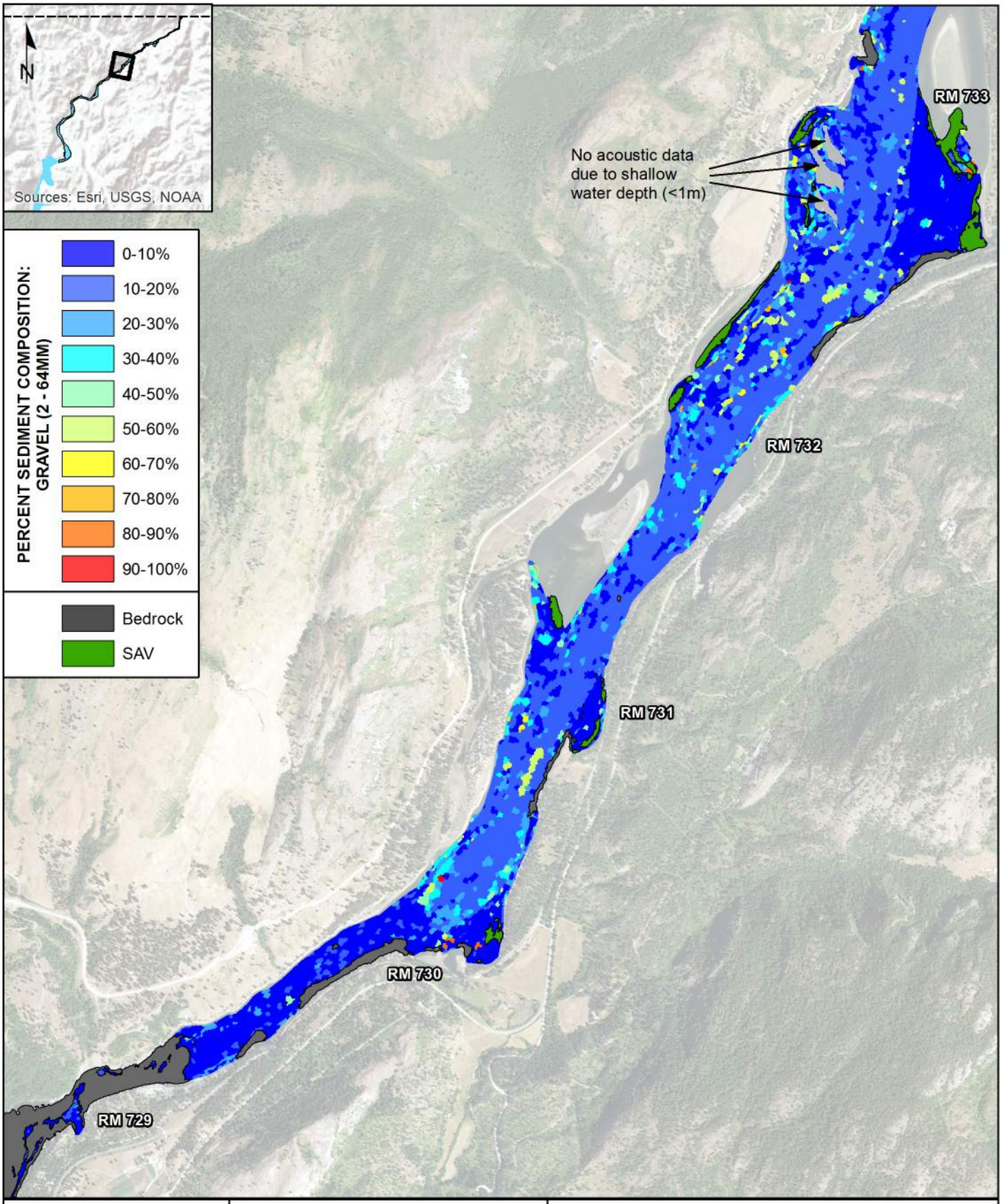
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-6b. **Percent Sand Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

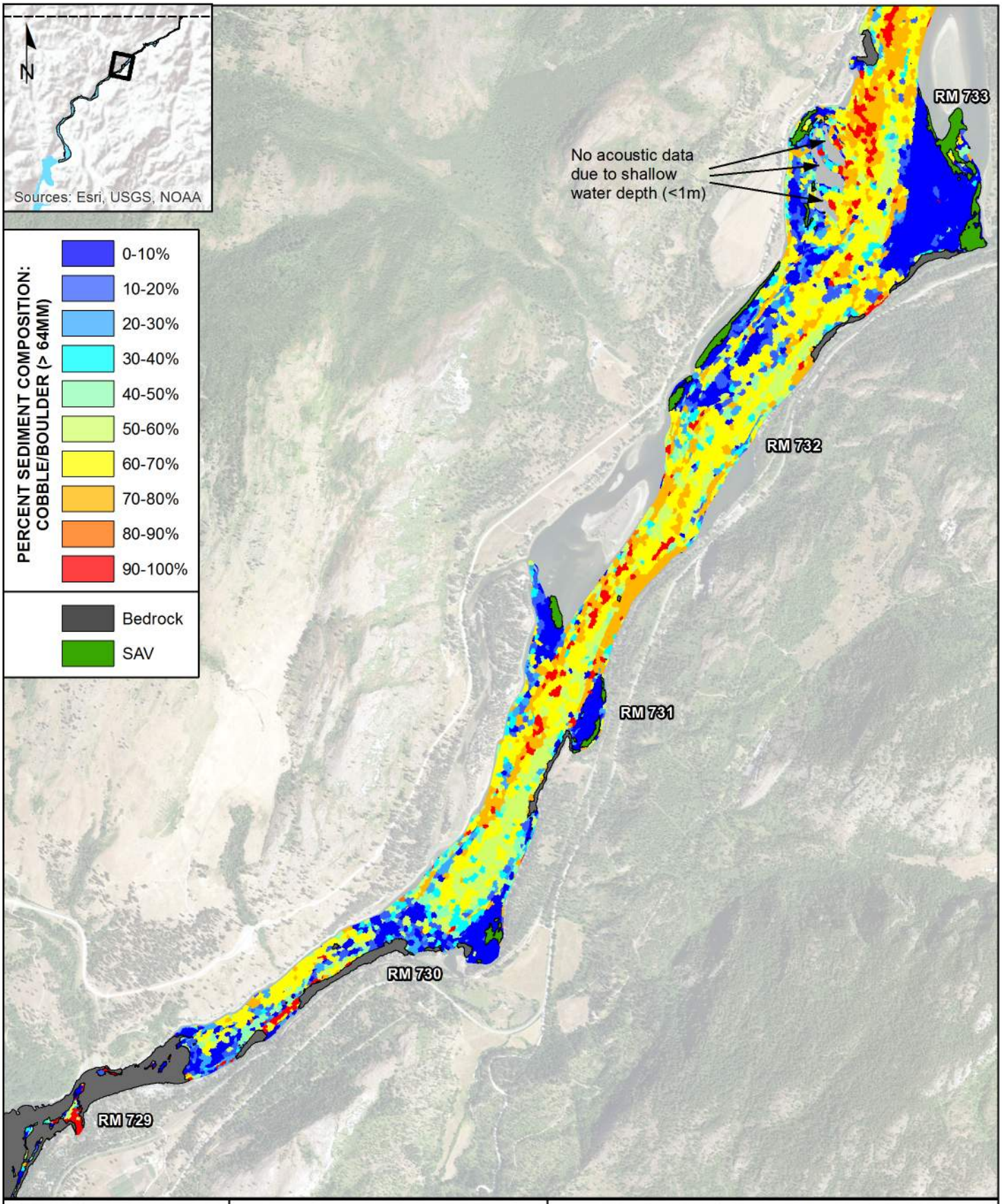
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-6c. **Percent Gravel Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

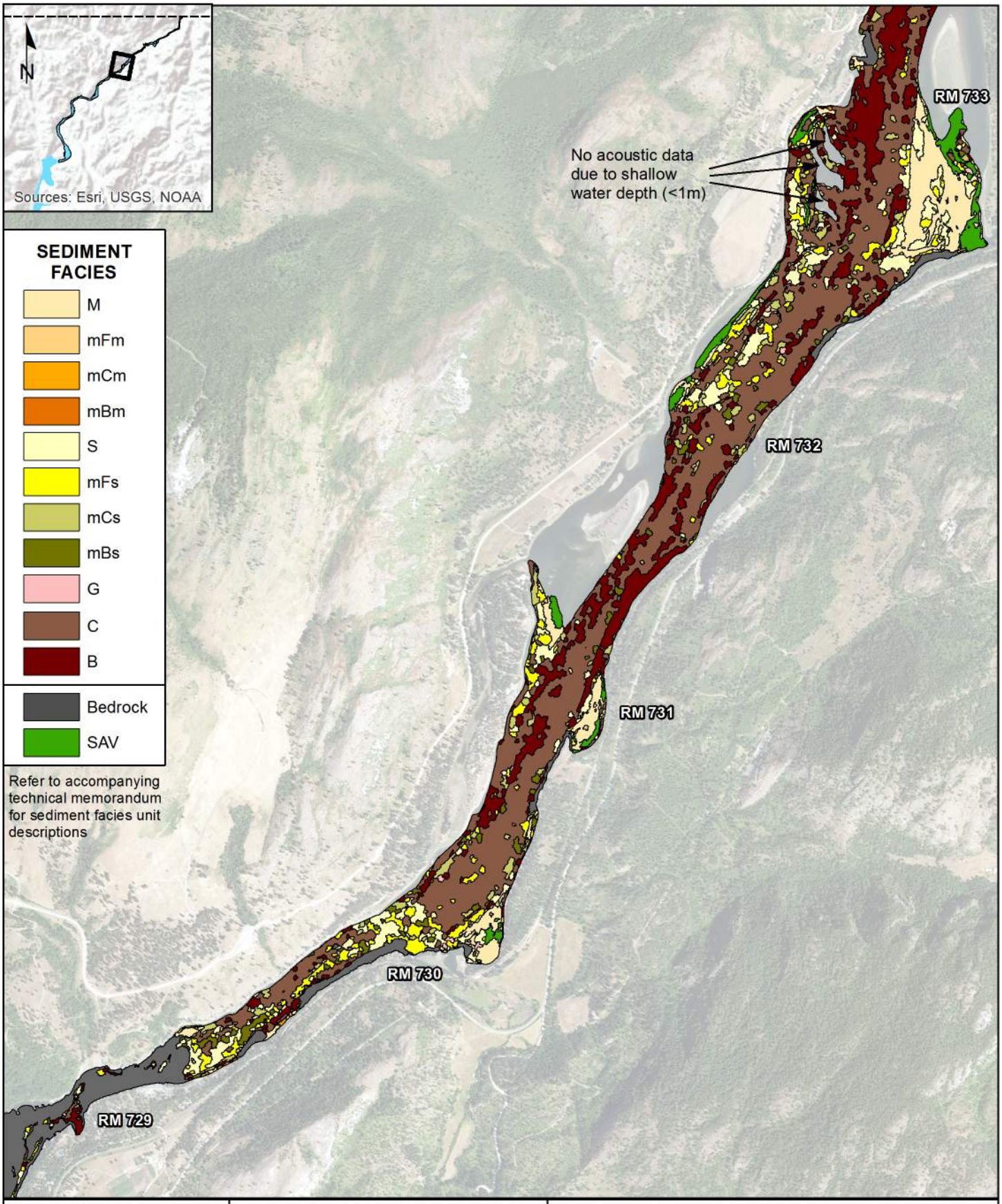
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-6d. **Percent Cobble/Boulder Sediment Composition for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

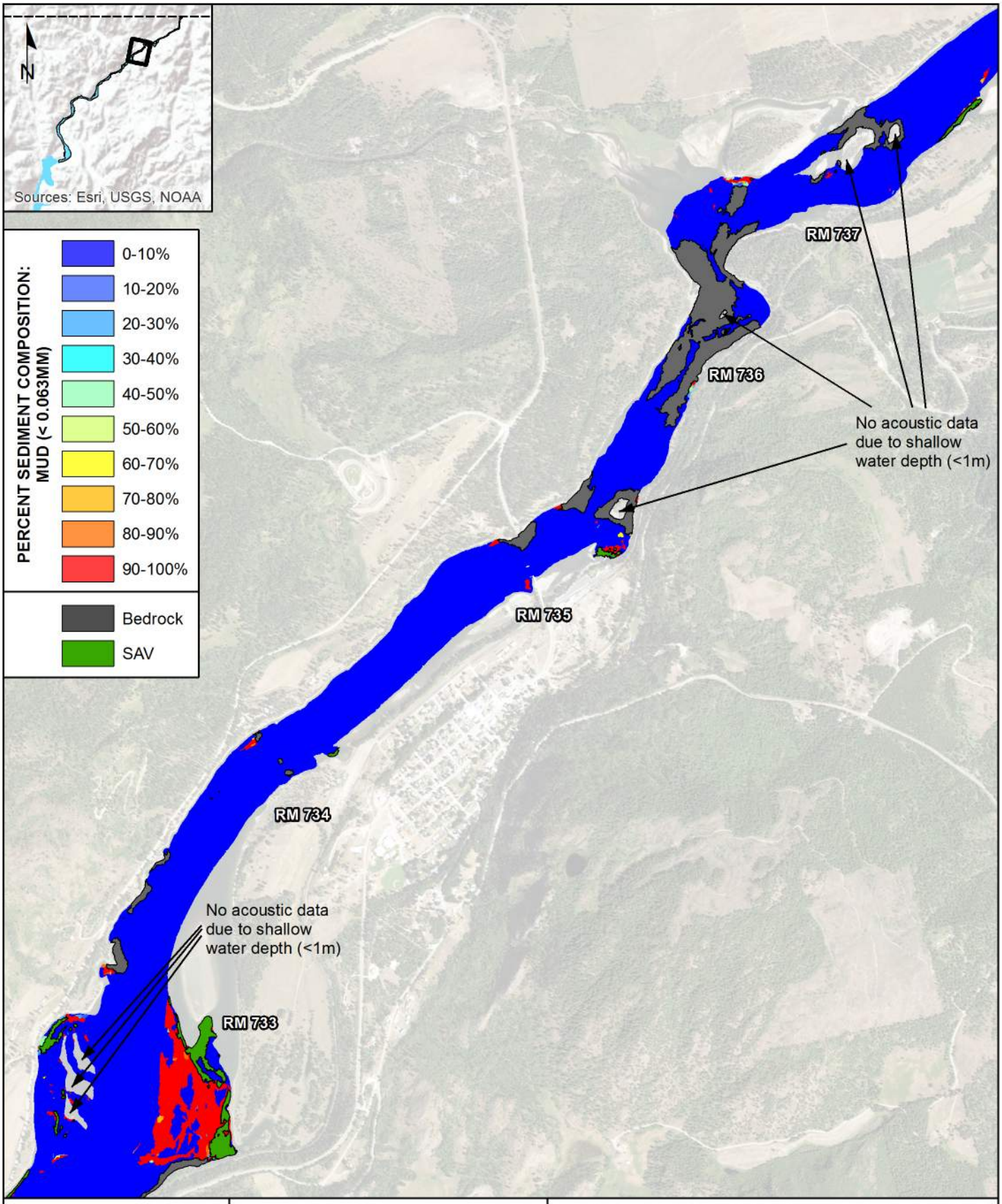
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-6e. **Sediment Facies Map for RM 725-729**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

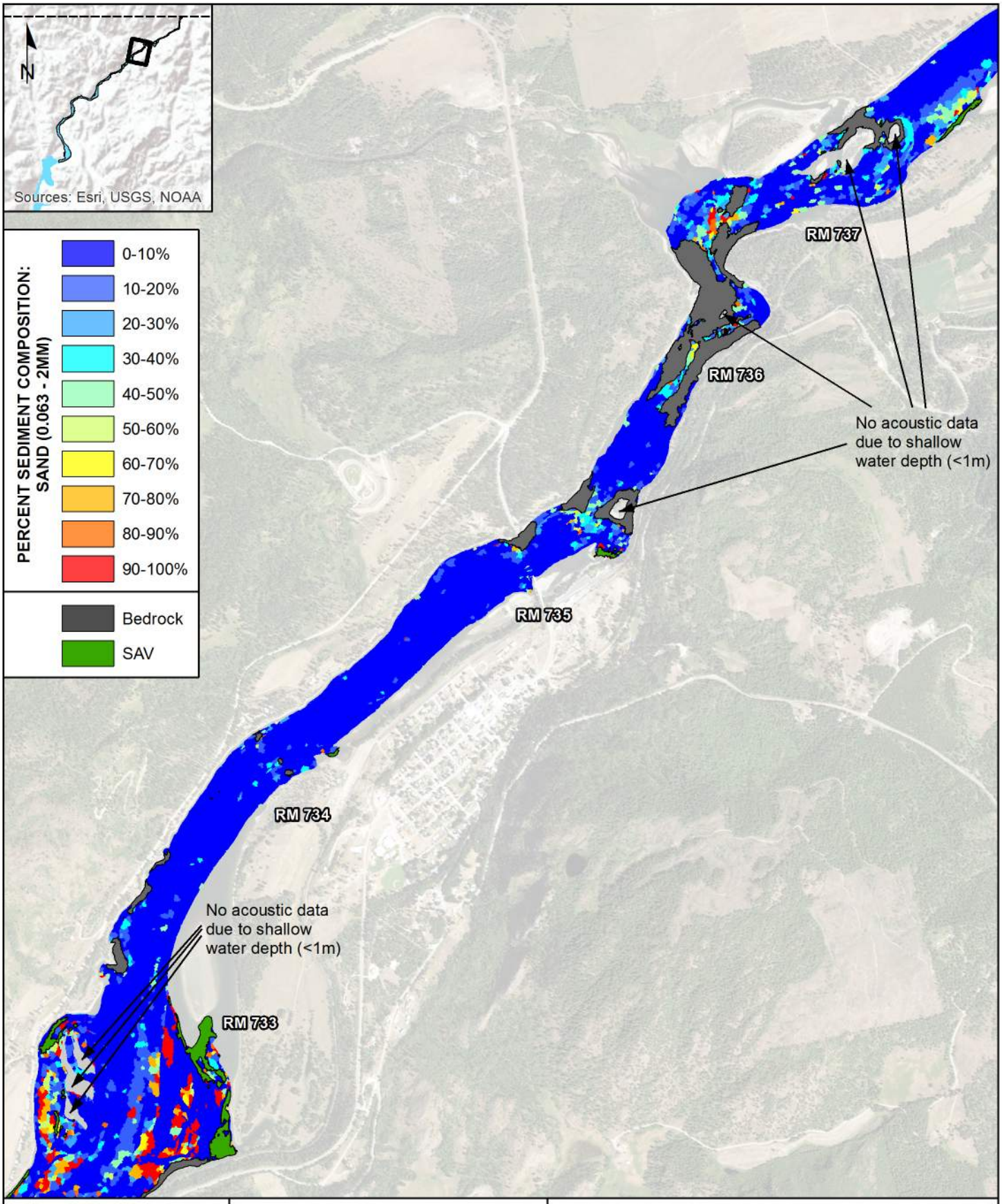
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-7a. **Percent Mud Sediment Composition for RM 733-737**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

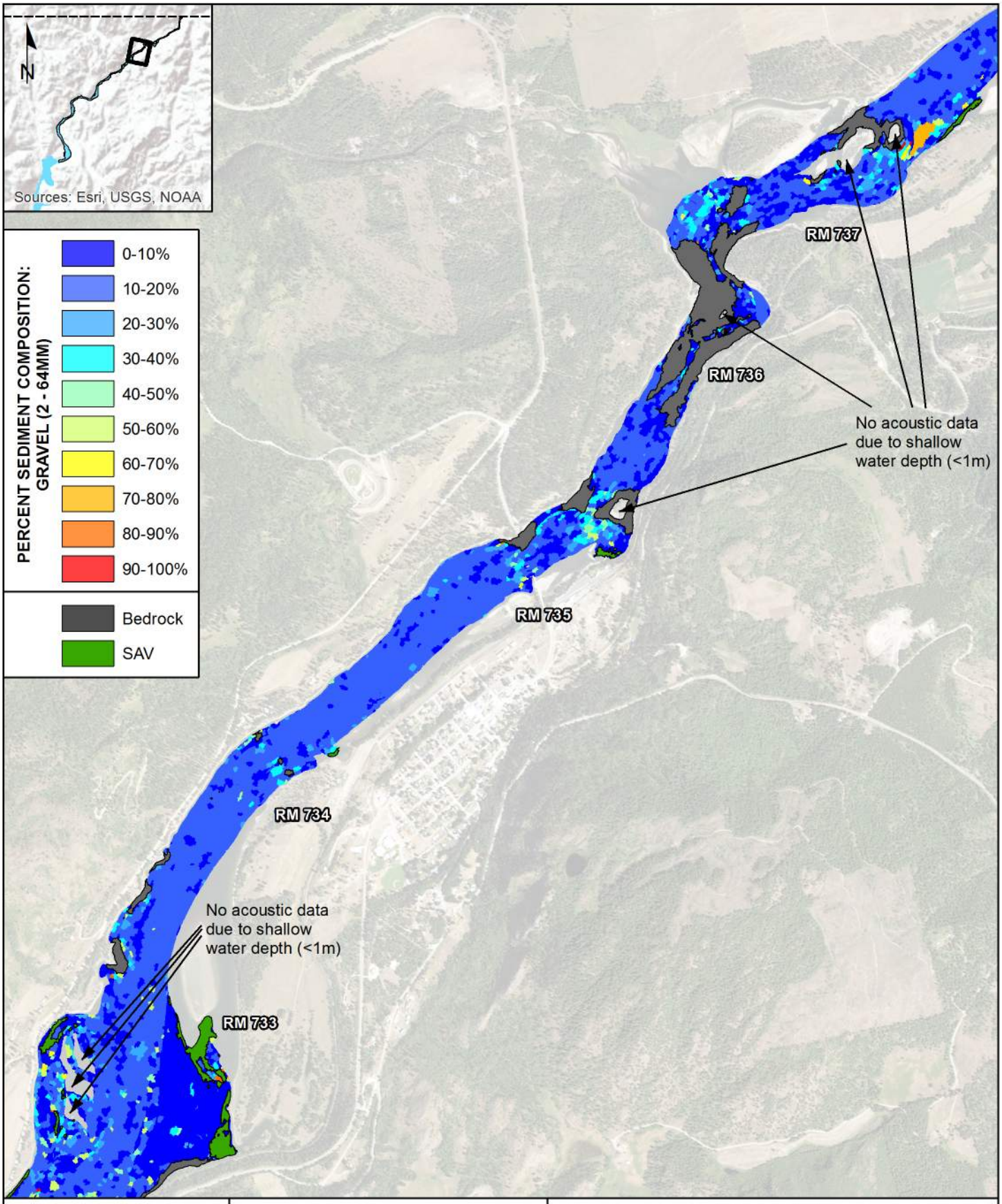
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-7b. **Percent Sand Sediment Composition for RM 733-737**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

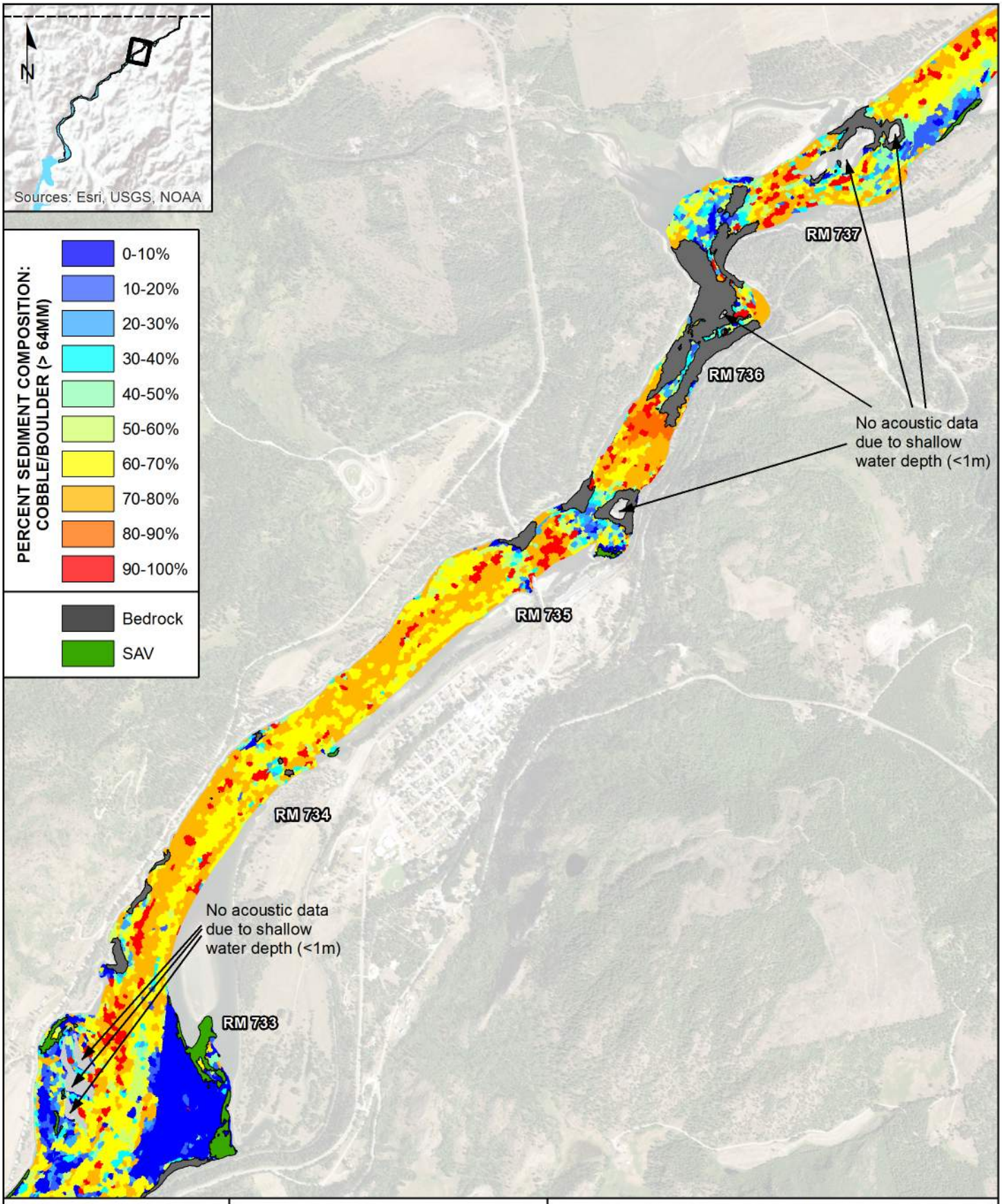
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-7c. **Percent Gravel Sediment Composition for RM 733-737**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

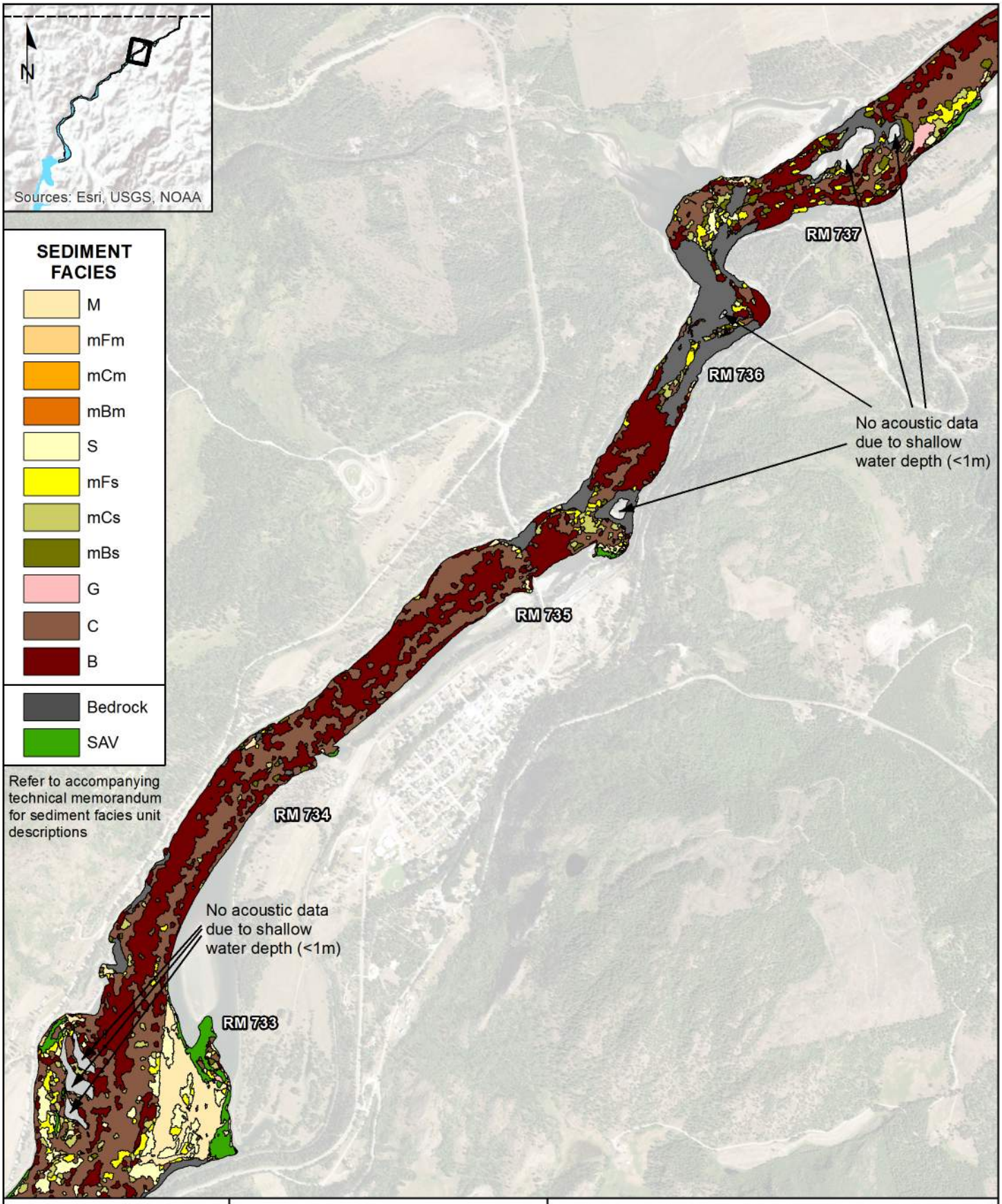
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-7d. **Percent Cobble/Boulder Sediment Composition for RM 733-737**

Upper Columbia River, WA



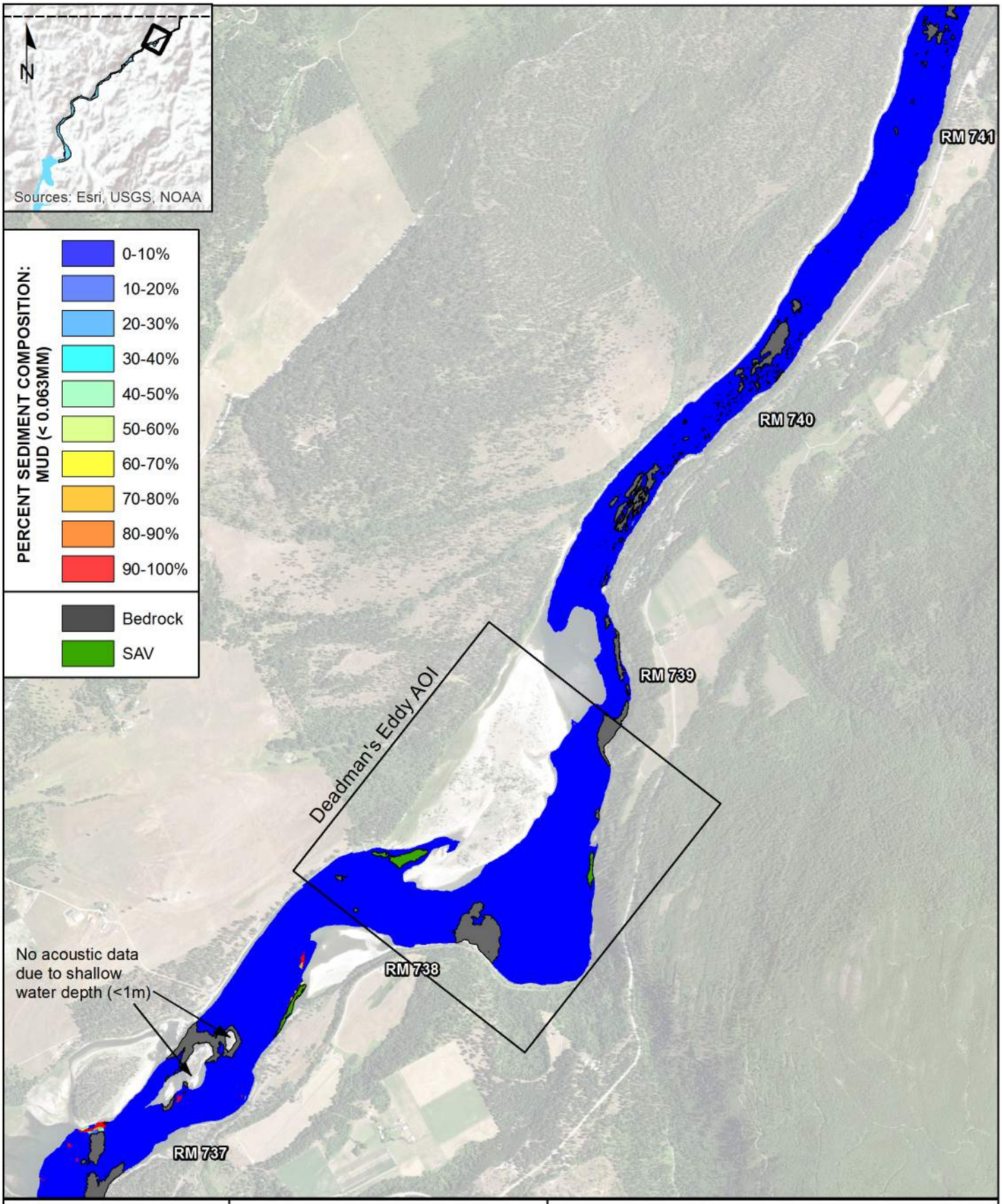
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-7e. **Sediment Facies Map for RM 733-737**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

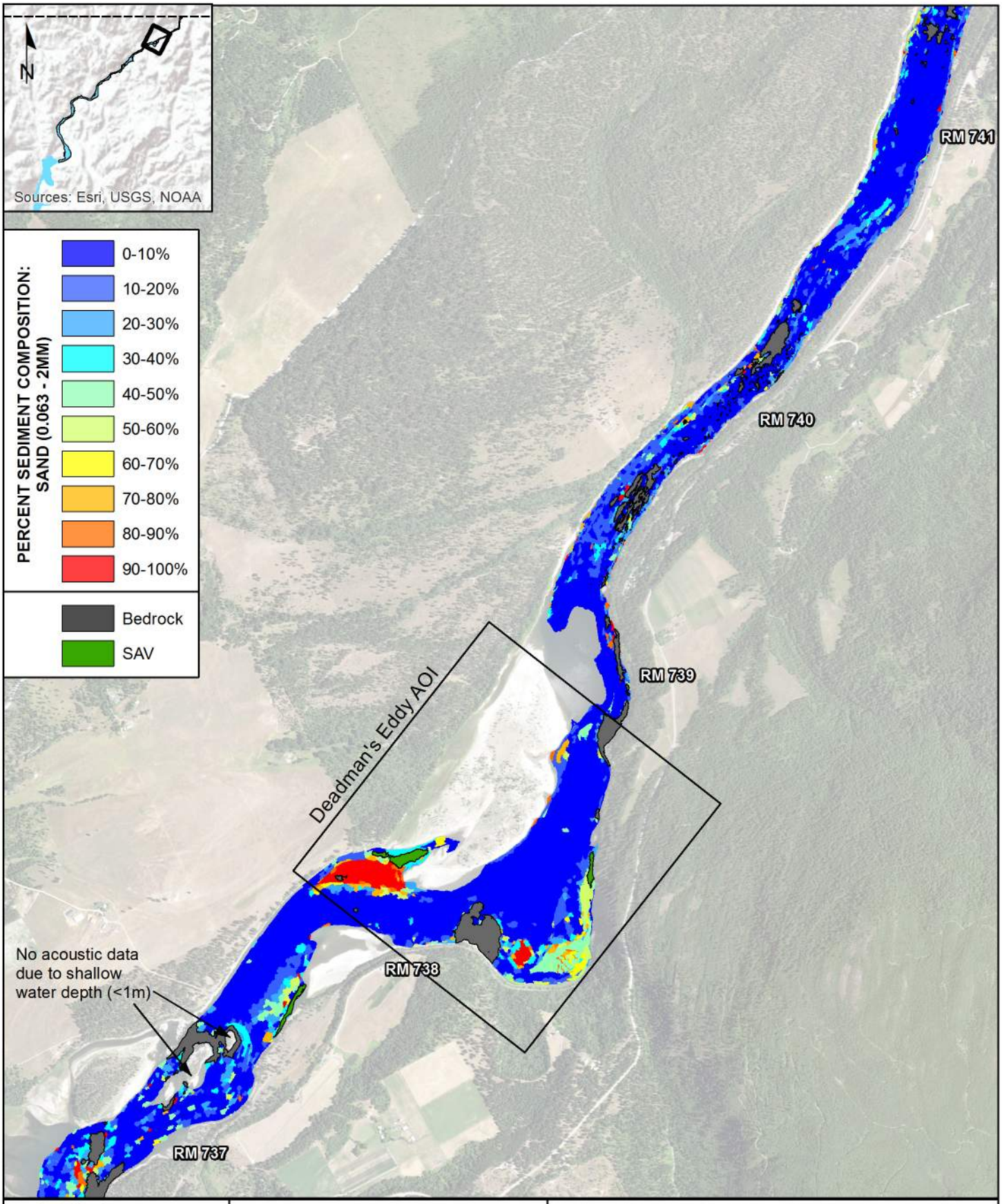
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-8a. **Percent Mud Sediment Composition for RM 737-741 Including Deadman's Eddy AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

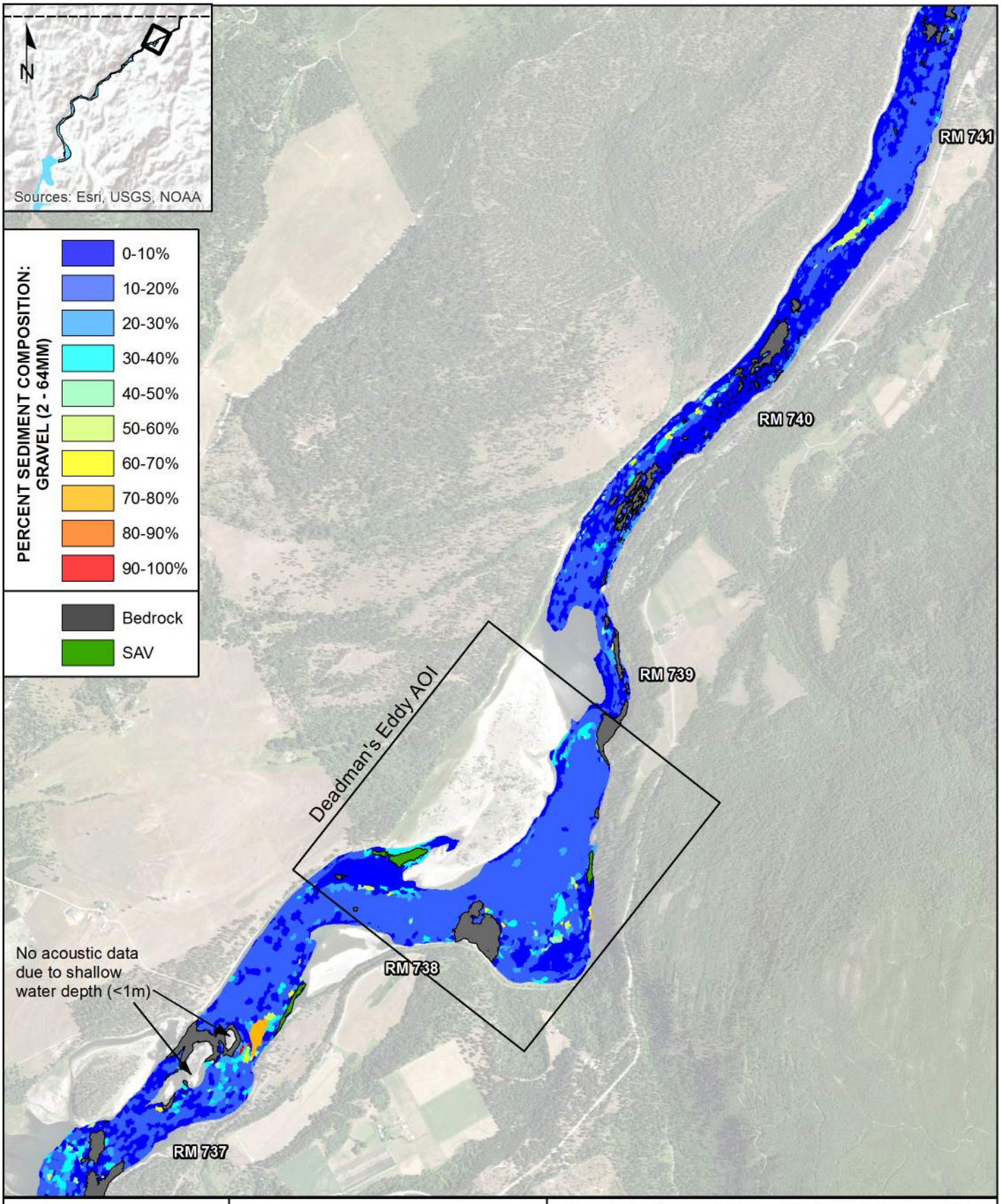
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-8b. **Percent Sand Sediment Composition for RM 737-741 Including Deadman's Eddy AOI**

Upper Columbia River, WA



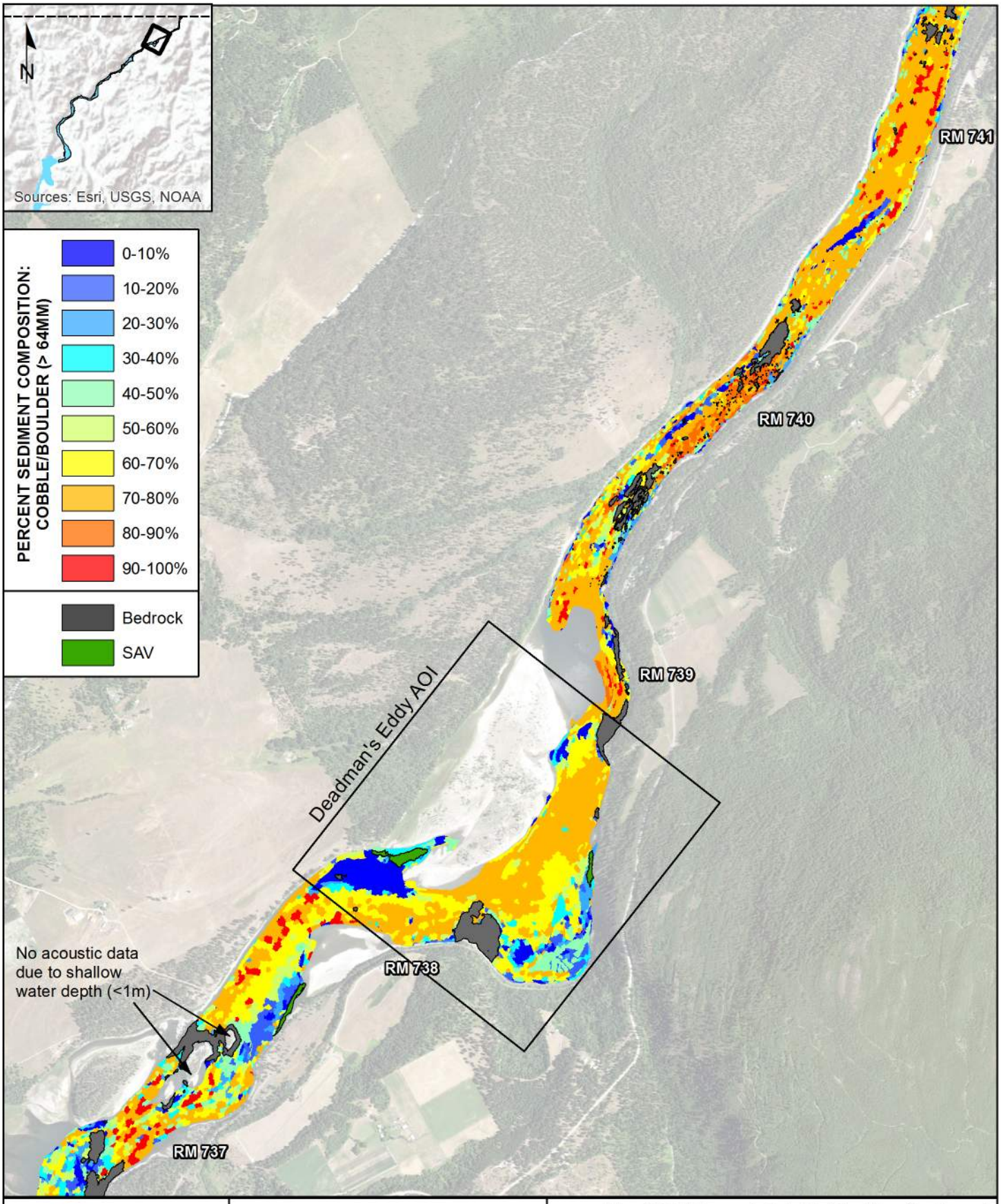
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-8c. **Percent Gravel Sediment Composition for RM 737-741 Including Deadman's Eddy AOI**

Upper Columbia River, WA



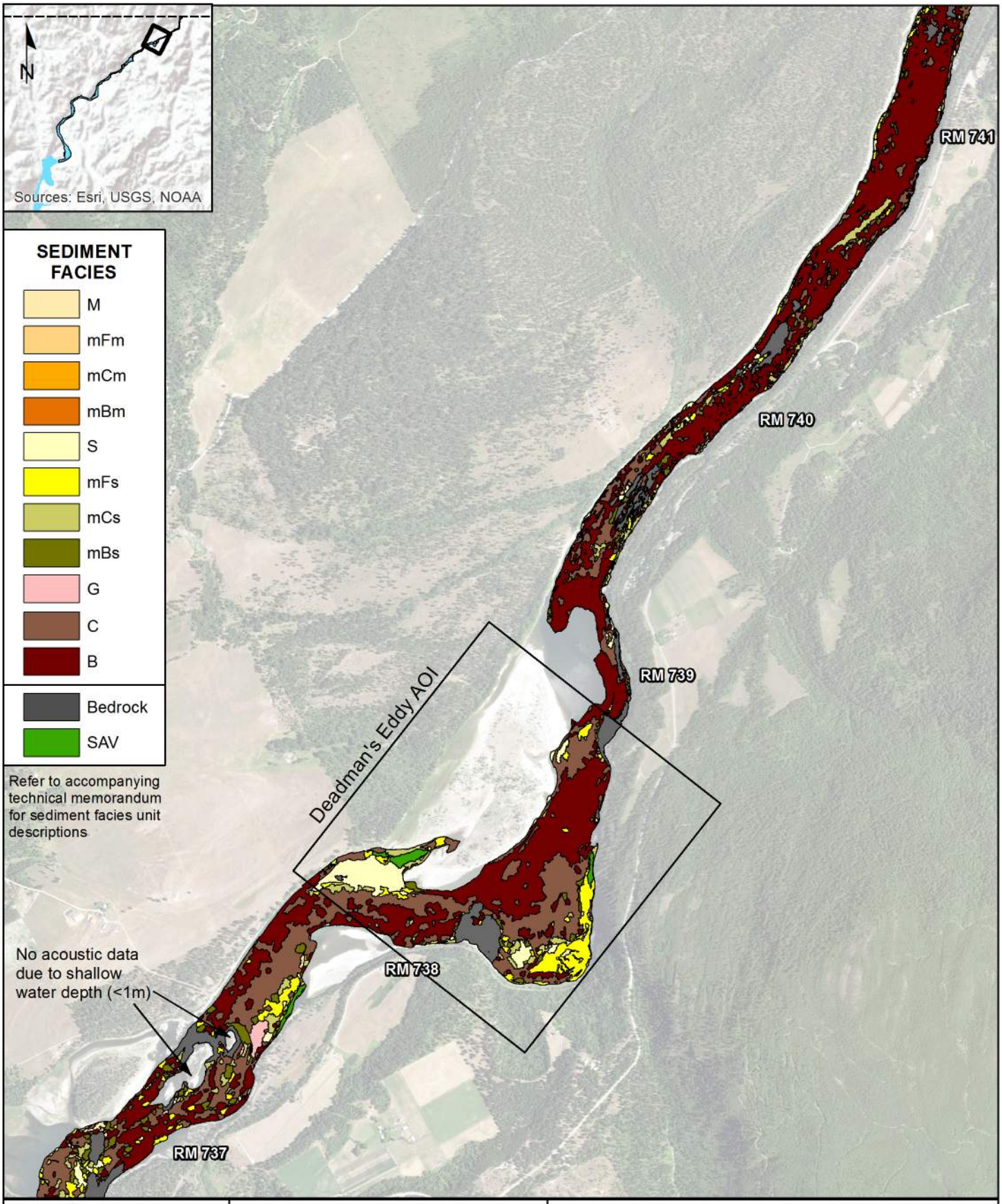
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-8d. **Percent Cobble/Boulder Sediment Composition for RM 737-741 Including Deadman's Eddy AOI**

Upper Columbia River, WA



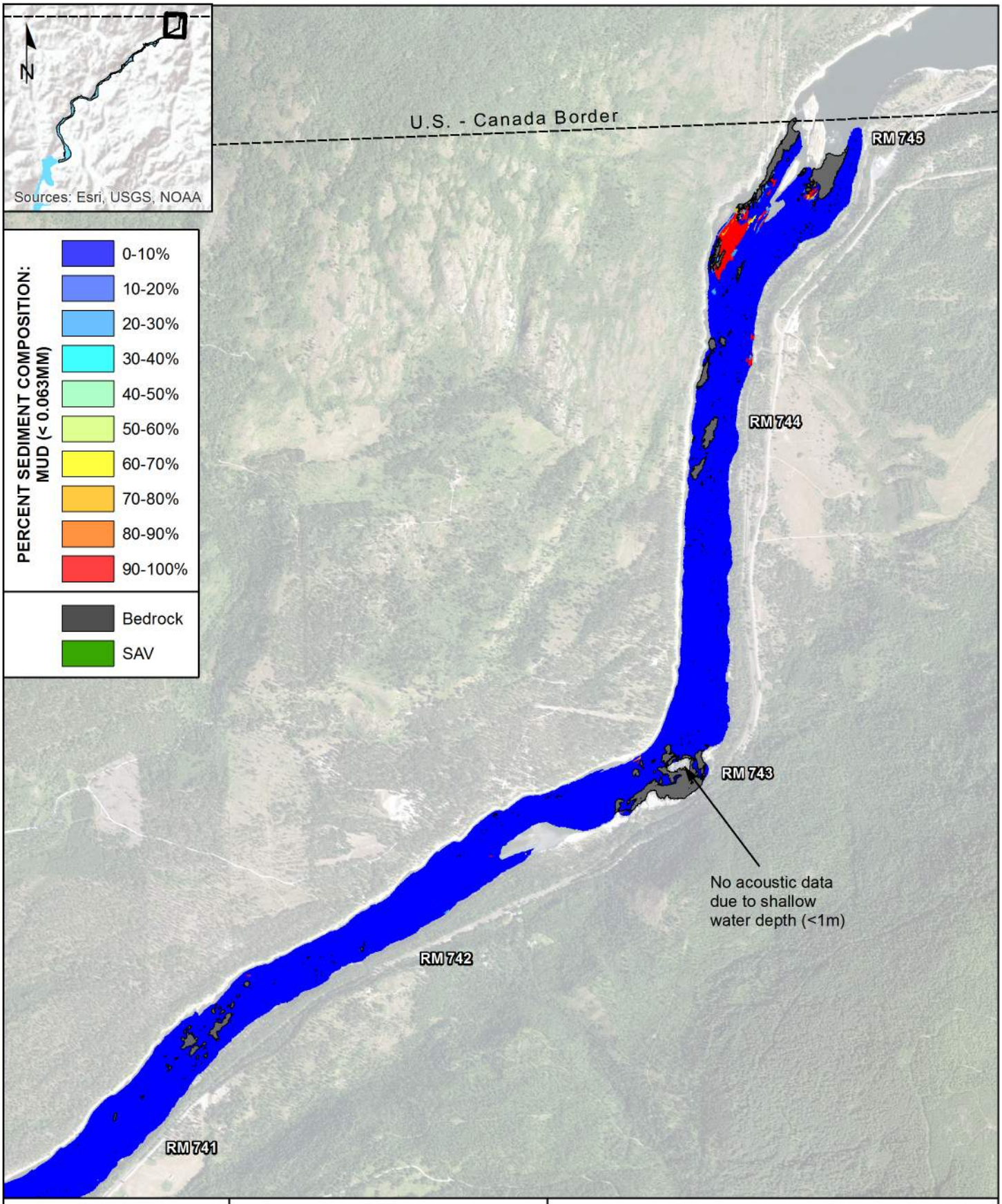
DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 3-8e. **Sediment Facies Map for RM 737-741 Including Deadman's Eddy AOI**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

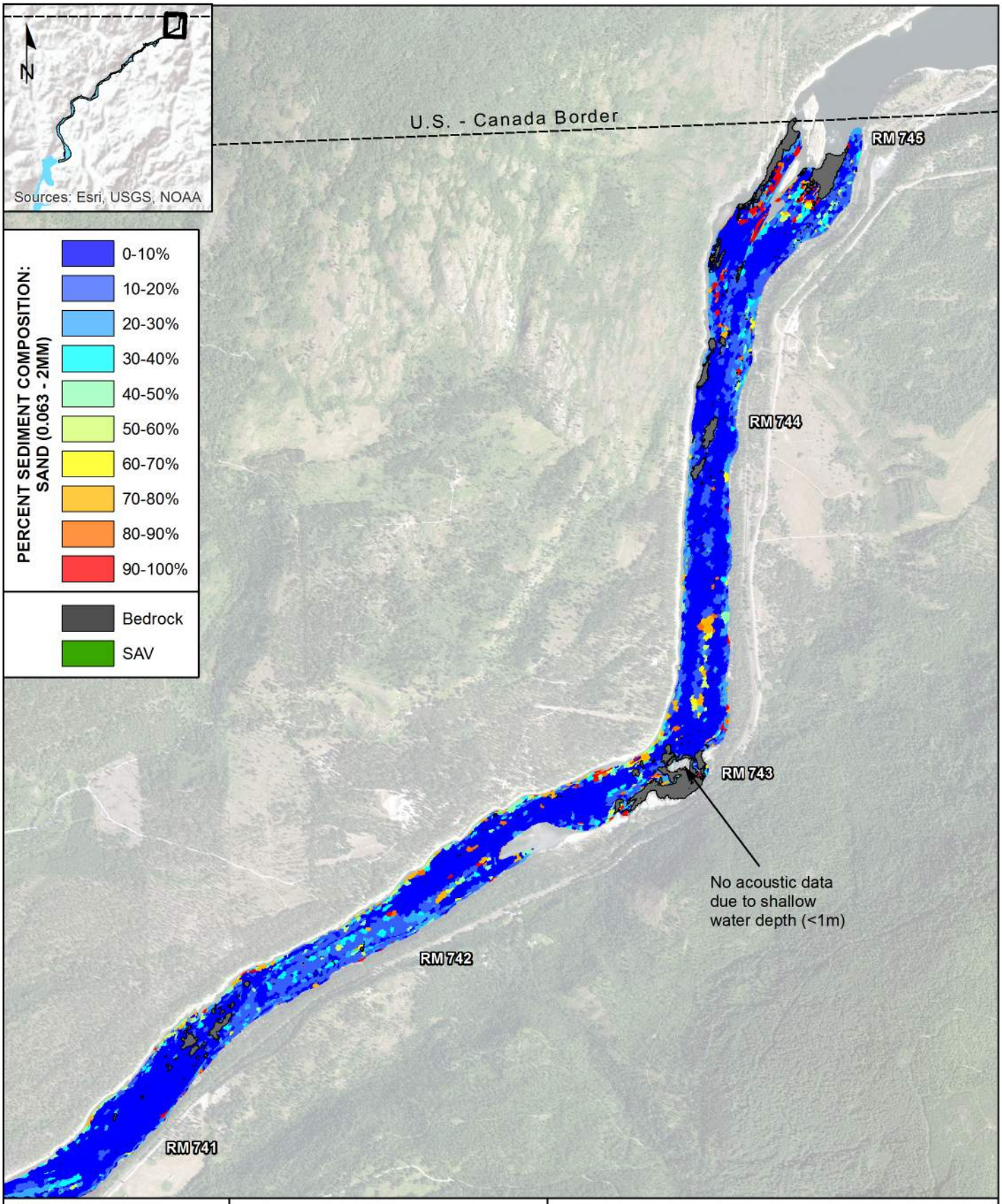
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-9a. **Percent Mud Sediment Composition for RM 741-745**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

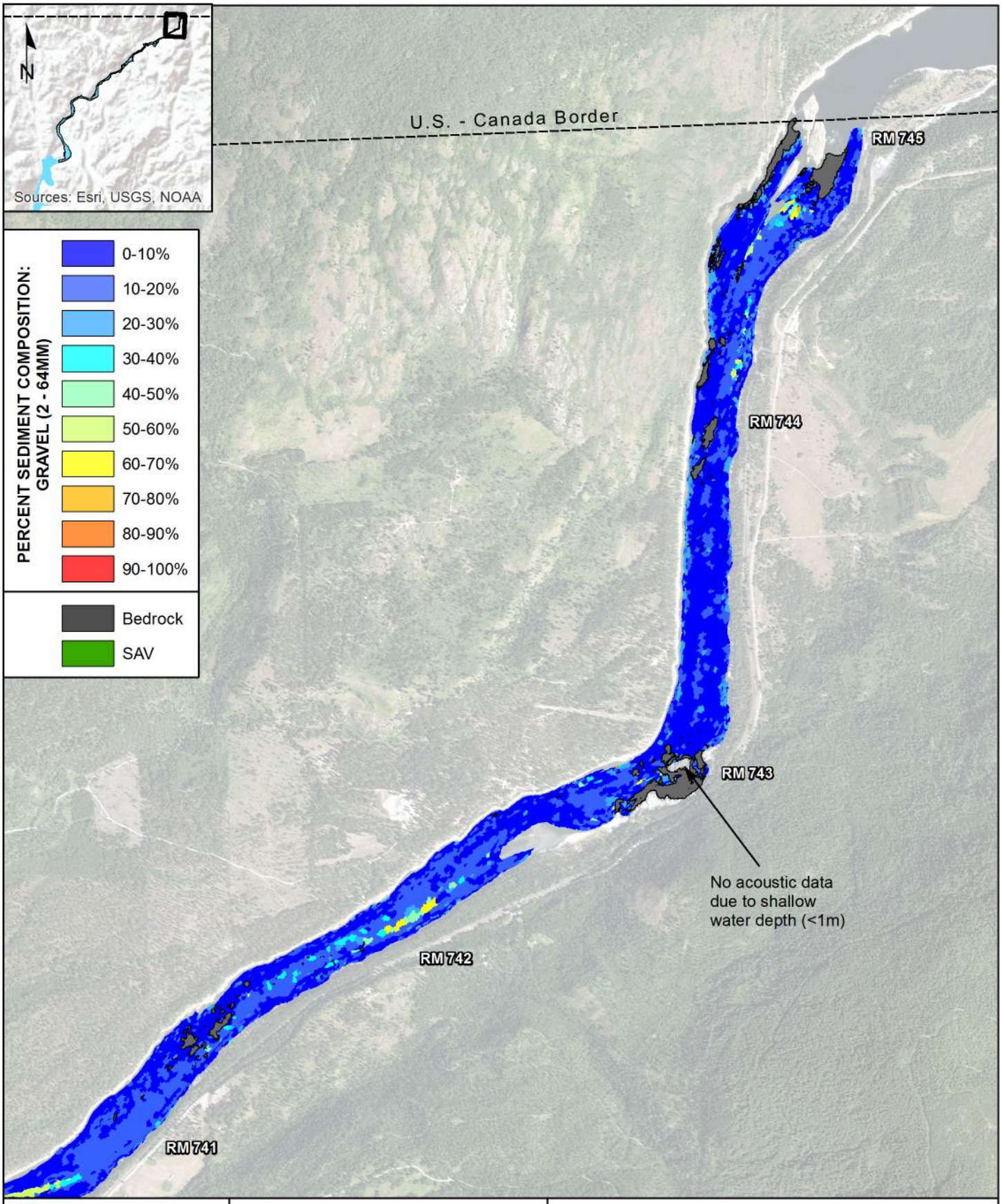
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-9b. **Percent Sand Sediment Composition for RM 741-745**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

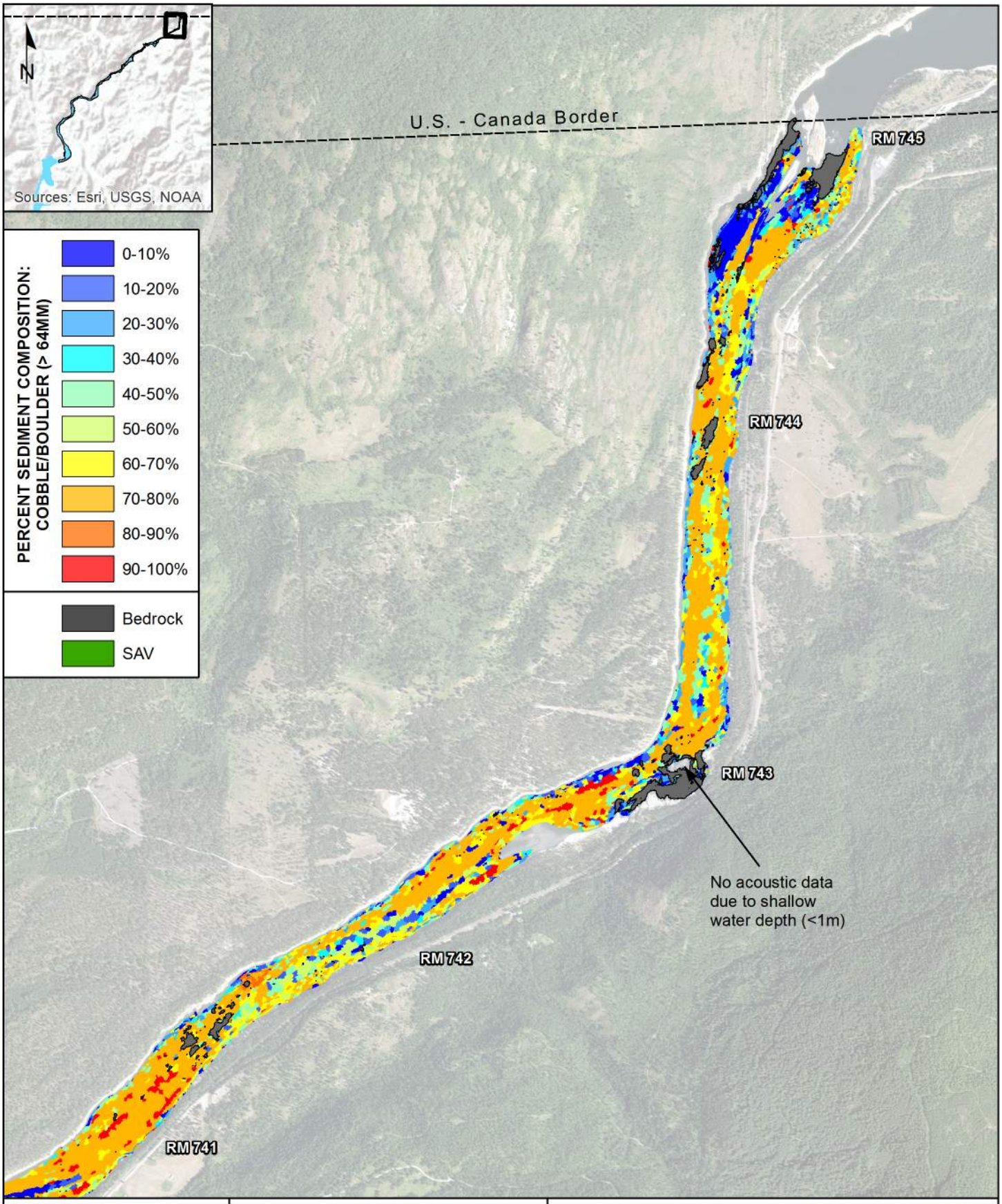
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-9c. **Percent Gravel Sediment Composition for RM 741-745**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

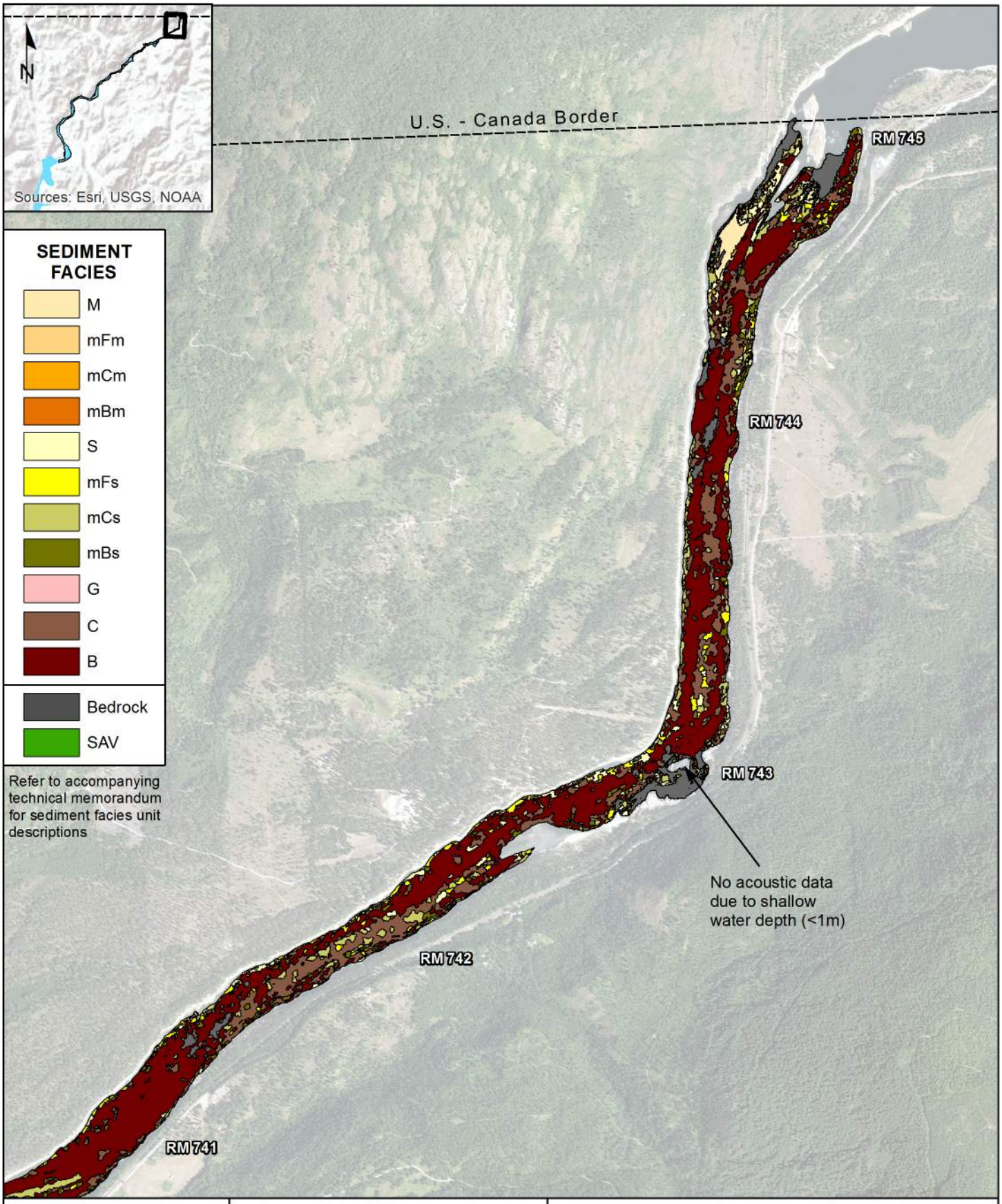
0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-9d. **Percent Cobble/Boulder Sediment Composition for RM 741-745**

Upper Columbia River, WA



DAVID EVANS AND ASSOCIATES INC.

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

N

Map 3-9e. **Sediment Facies Map for RM 741-745**

Upper Columbia River, WA