Appendices

Appendix 1

FIELD DESCRIPTION OF SOIL PROPERTIES

Site No.: MJD1 **Described by:** Ralph Klinger **Date:** 11/4/2008
Map Unit: Qa2 terrace **Aspect:** SW **Parent Material:** fine- to coarse-grained silty sand
Quadrangle: Boulder Butte, OR (USGS 7.5') **Coordinates:** N44°40'11.4"; W118°43'20.7" (NAD83) **Elevation:** 3590 ft
Location: Downstream margin of alluvial terrace along the right bank on the Nature Conservancy property near Road 45 and downstream of the confluence of Big Boulder Creek.

Horizon	Depth (cm)	Boundaries	Structure	Clay Films	Consistence			Texture	Gravel %	CaCO3 Morphology	Color (moist)
					Stickiness	Plasticity	Dry				
A	0-11	as	sg-1fgr	none			so		0	n/a	
BA	11-20	cs	2fgr-2msbk	none			so		0	n/a	
B1	20-40	as	m-2cgr	none			So		trace	n/a	
B2	40-66	cw	2m-csbk	1fpf			Sh		trace	n/a	
Btb	66-85+	-	3cabk	3ppf			vh		trace	n/a	

Radiocarbon/Pollen Samples:

MJD1-1 detrital charcoal from near the upper boundary of the Btb horizon at 77 cm
MJD1-2 detrital charcoal from the B1 horizon at 26 cm
MJD1-3 detrital charcoal from the B2 horizon at 57 cm
MJD1-4 detrital charcoal from near the boundary of the BA/B1 horizon at 18 cm
MJD1-5 detrital charcoal from the base of the base of the BA horizon at 16 cm
MJD1-6 detrital charcoal from the top of the B1 horizon at 22 cm
MJD1-7 detrital charcoal from the B1 horizon at 38 cm
MJD1-8 detrital charcoal from the B1 horizon at 34 cm
MJD1-9 bulk sediment for pollen from the B2 horizon at 45-60 cm
MJD1-10 bulk sediment for pollen from the B1 horizon at 25-40 cm

Miscellaneous Notes:

The surface of the terrace has been clearly disrupted by logging and agriculture (grazing); many tree stumps present on surface in growth position; irrigation ditch from diversion on Big Boulder Creek flows across the terrace. A/BA horizon may be representative of this disruption (plow horizon). A horizon is very dark; rich in organics; abundant roots. BA horizon appears transitional from overlying A to underlying B1; contains many roots. B1 horizon is mottled; contains many small (<1 mm) pores; trace of rounded gravel (<10 cm diameter). B2 horizon contains trace of rounded gravel (<10 cm) with clean white ash coatings on bottoms of clasts. Btb horizon very coarse rounded to well-rounded sand with trace of sub-rounded pebbles (<1 cm).

A
BA
B1
B2
Btb
Site MJD1

FIELD DESCRIPTION OF SOIL PROPERTIES

Site No.: MJD2A/B **Described by:** Ralph Klinger **Date:** 11/5/2008
Map Unit: Qafs **Aspect:** NW **Parent Material:** poorly-sorted, fine-grained silty sand; moderately-sorted sandy gravel
Quadrangle: Boulder Butte, OR (USGS 7.5') **UTM coordinates:** N44°39'57.8"; W118°43'00.3" (NAD83) **Elevation:** 3600 ft
Location: Natural exposure of alluvial fan deposits along the left bank opposite the mouth of Big Boulder Creek.

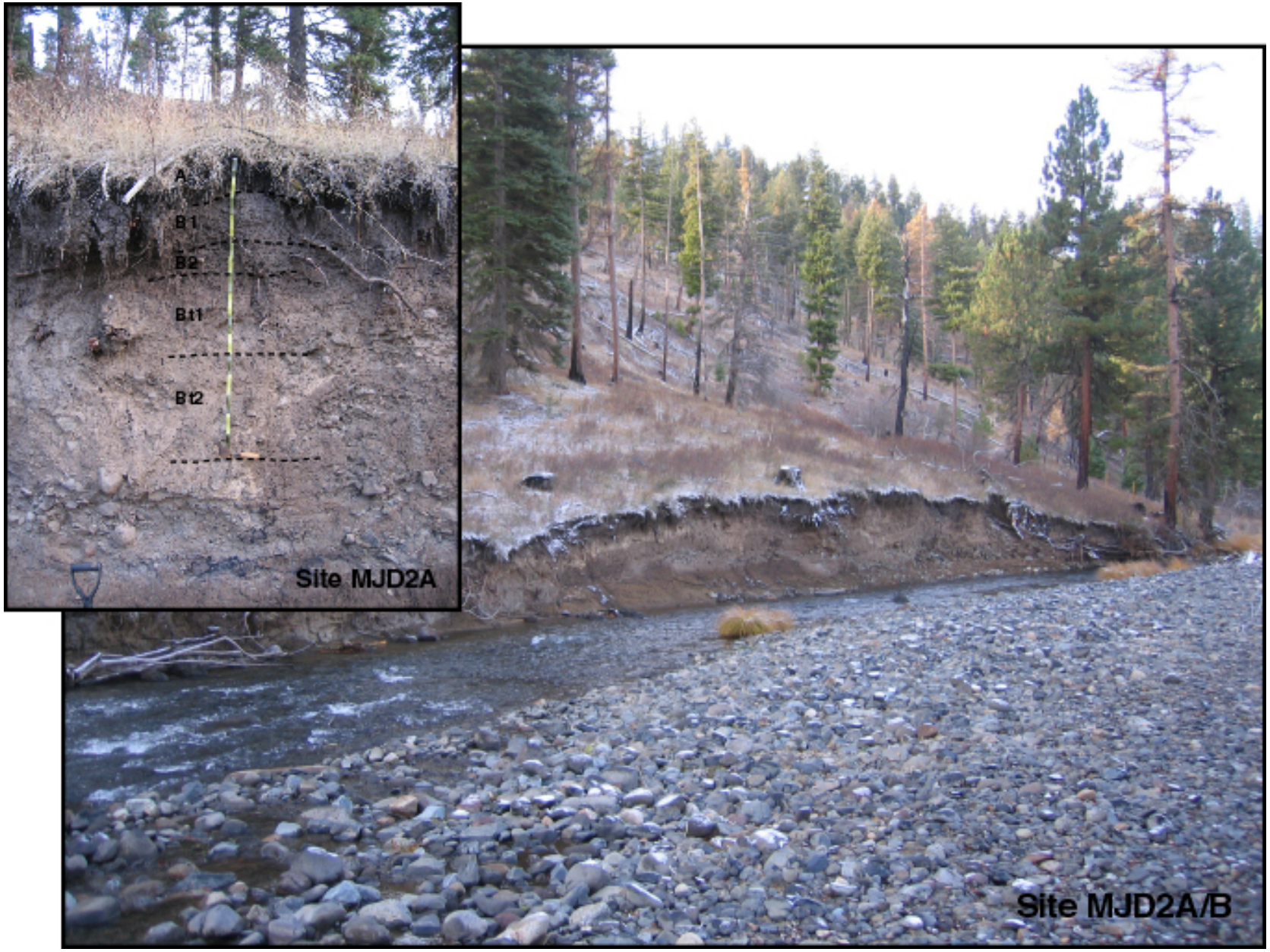
Horizon	Depth (cm)	Boundaries	Structure	Clay Films	Consistence			Texture	Gravel %	CaCO3 Morphology	Color (moist)
					Stickiness	Plasticity	Dry				
A1	0-11	cw	2mgr	none			-		0	n/a	
A2	11-18	aw	3cpl	none			so		0	n/a	
B1	18-42	aw	2cgr-1fsbk	none			so		10	n/a	
B2	42-70	aw	2csbk	none			vh		0	n/a	
Bt1	70-110	cw	2msbk	2fpf			vh		0	n/a	
Bt2	110-150	aw	3vcabk-1cpr	3ppf			eh	vc	0	n/a	

Radiocarbon Samples:

MJD2B-1 detrital charcoal from unit equivalent to Bt2 horizon at 205 cm
MJD2B-2 detrital charcoal from unit equivalent to B2 horizon at 93 cm
MJD2B-3 detrital charcoal from unit equivalent to Bt1 horizon at 135 cm
MJD2B-4 collected from the top of the 3C horizon at 50 cm
MJD2B-5 collected from the 3C horizon at 95 cm

Miscellaneous Notes:

Described composite section of alluvial fan deposits that in part contain reworked volcanic ash; -2A from surface to 150 cm, -2B down to stream-level (175 cm). Upper A horizon contains many roots; wet from recent rain/snow. All horizons below B2 transition laterally; exhibit more sedimentary structure, cross-cut by sand and gravelly sand beds indicating reworking/erosion by stream. Very thin, light-colored ashy silt bed is present between the B2 and Bt1 horizons in section MJD2A at about 70 cm. B2 horizon is composed of mottled coarse sand with is slightly more oxidized than overlying B1 horizon.


A
B1
B2
Bt1
Bt2
Site MJD2A
Site MJD2A/B

FIELD DESCRIPTION OF SOIL PROPERTIES

Site No.: MJD3 **Described by:** Ralph Klinger **Date:** 11/5/2008
Map Unit: Qa3 **Aspect:** SE **Parent Material:** fine silty sand; rounded sandy gravel
Quadrangle: Boulder Butte, OR (USGS 7.5') **UTM coordinates:** N44°40'05.4"; W118°42'44.5" (NAD83) **Elevation:** 3610 ft
Location: Natural exposure at the edge of alluvial terrace along the right bank upstream of Big Boulder Creek.

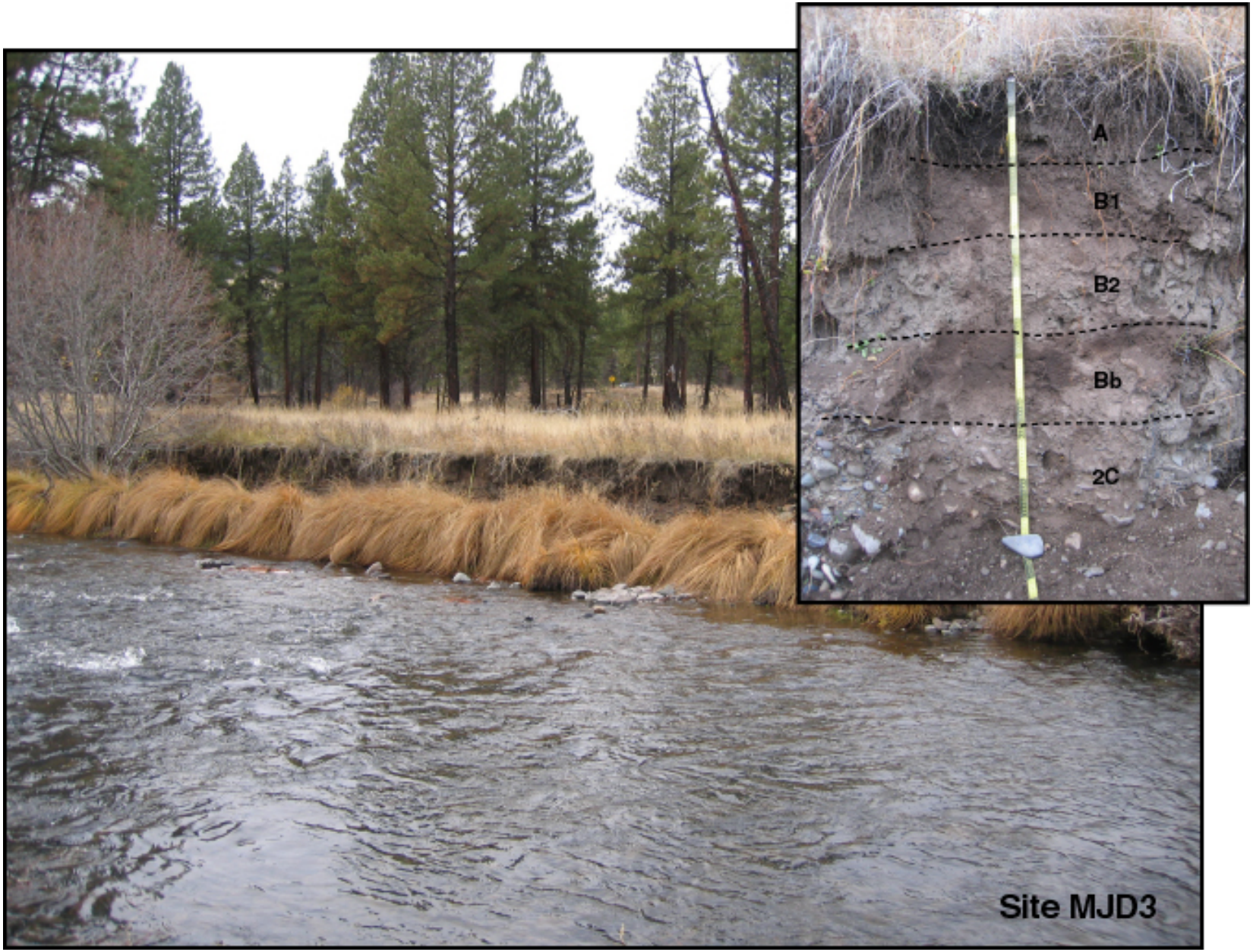
Horizon	Depth (cm)	Boundaries	Structure	Clay Films	Consistence			Texture	Gravel %	CaCO3 Morphology	Color (moist)
					Stickiness	Plasticity	Dry				
A	0-21	cw	1mgr-2csbk	none	ss-s	ps	so	fL	trace	n/a	10YR2/1
B1	21-40	cs	2msbk	none	s	p	sh	fL	trace	n/a	10YR2/2
B2	40-63	aw	2csbk	none	s	p	sh	fL	0	n/a	10YR2/2
Bb	63-87	aw	2vcsbk	none	ss	ps	H	fSL	0	n/a	10YR3/2
2C	87-118+	-	sg	None	so	po	lo	vcS	75	n/a	10YR2/2

Radiocarbon and Pollen Samples:

MJD3-1 detrital charcoal from the B2 horizon at 46 cm
MJD3-2 detrital charcoal from the base of B1 horizon at 40 cm
MJD3-3 detrital charcoal from the B2 horizon at 57 cm
MJD3-4 detrital charcoal from the Bb horizon at 68 cm
MJD3-5 detrital charcoal from the Bb horizon at 77 cm
MJD3-6 detrital charcoal from the base of Bb horizon at 87 cm
MJD3-7 bulk sediment for pollen from the Bb horizon at 65-70 cm

Miscellaneous Notes:

A and B1 horizons contain a few rounded pebbles up to about 2 cm diameter; abundant roots. Pores are common in B2 horizon. Buried B (Bb) horizon is weakly mottled. 2C horizon contains rounded to subrounded basalt pebbles to cobbles; coarse- to very coarse sand; weakly stratified.


A
B1
B2
Bb
2C
Site MJD3

FIELD DESCRIPTION OF SOIL PROPERTIES

Site No.: MJD4 **Described by:** Ralph Klinger **Date:** 11/6/2008
Map Unit: Qa1 **Aspect:** W-SW **Parent Material:** fine silty sand; angular silty gravel; very coarse sandy gravel
Quadrangle: Boulder Butte, OR (USGS 7.5') **UTM coordinates:** N44°39'17.1"; W118°40'43.3" (NAD83) **Elevation:** 3690 ft
Location: At downstream end of high alluvial terrace along right side of valley immediately downstream of confluence of Beaver Creek with Middle Fork John Day River; approximately 25 feet north of stock tank and west of Oxbow Conservation Area access road.

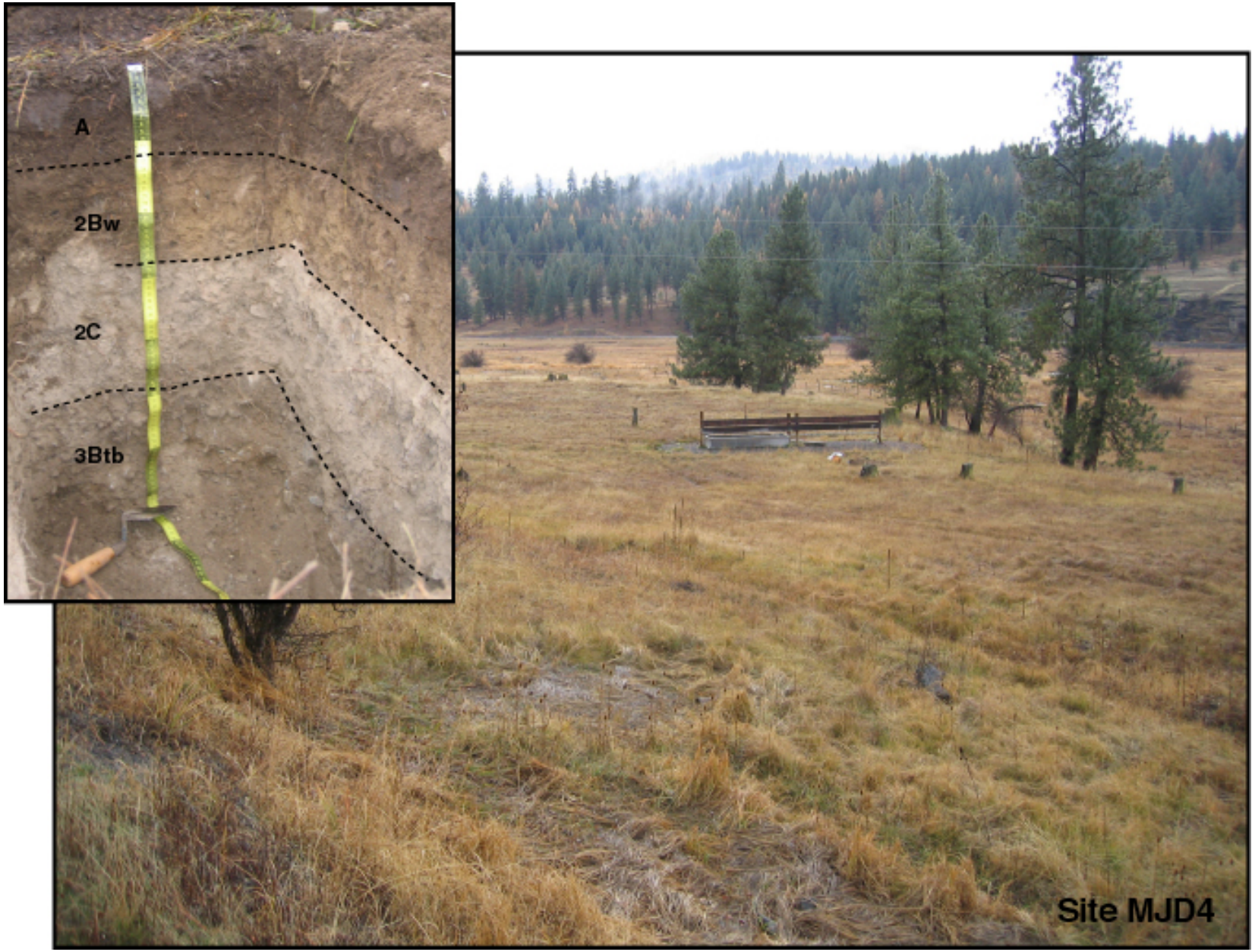
Horizon	Depth (cm)	Boundaries	Structure	Clay Films	Consistence			Texture	Gravel %	CaCO3 Morphology	Color (moist)
					Stickiness	Plasticity	Dry				
A	0-12	cs	2fgr-1msbk	none			so		trace	n/a	
2Bw	12-28	as	2csbk	none			so		25-50	n/a	
2C	28-50	cw	1csbk	none			so		50-75	n/a	
3Btb	50-80+	-	2csbk	1fbr-2dco			sh		>75	n/a	

Radiocarbon Samples:

MJD4-1 detrital charcoal from the 2Bw horizon at 21 cm
MJD4-2 detrital charcoal from the base of the 2Bw horizon at 27 cm
MJD4-3 detrital charcoal from the top of the 2C horizon at 32 cm
MJD4-4 detrital charcoal from the boundary between 2Bw/2C horizons at 28 cm
MJD4-5 detrital charcoal from the boundary between A/2Bw horizons at 13 cm

Miscellaneous Notes:

The most extensive Qa1 terrace on the Oxbow Conservation Area; the slope on the terrace surface is generally in a downstream direction but has some valleyward component. Back edge of the terrace is marked by road, which is cut into landslide deposits. Upper-most part of the profile shows input of hillslope sediment. Texture and color of 2Bw/2C horizons contains large component of volcanic ash; oxidized in 2Bw horizon.


A
2Bw
2C
3Btb
Site MJD4

Site No.: MJD5 **Described by:** Ralph Klinger **Date:** 6/18/2009
Map Unit: Qaf/Qa2 **Aspect:** NE **Parent Material:** fine silty sand; angular silty gravel; very coarse sandy gravel
Quadrangle: Bates, OR (USGS 7.5') **Coordinates:** N44°36'42.64"; W118°33'25.42" (NAD83) **Elevation:** 3983 ft
Location: In a low cut formed by an old road at the intersection of the Qa2 terrace and the distal end of an alluvial fan from an unnamed tributary along left side of valley immediately downstream of area shown in Figure 10.

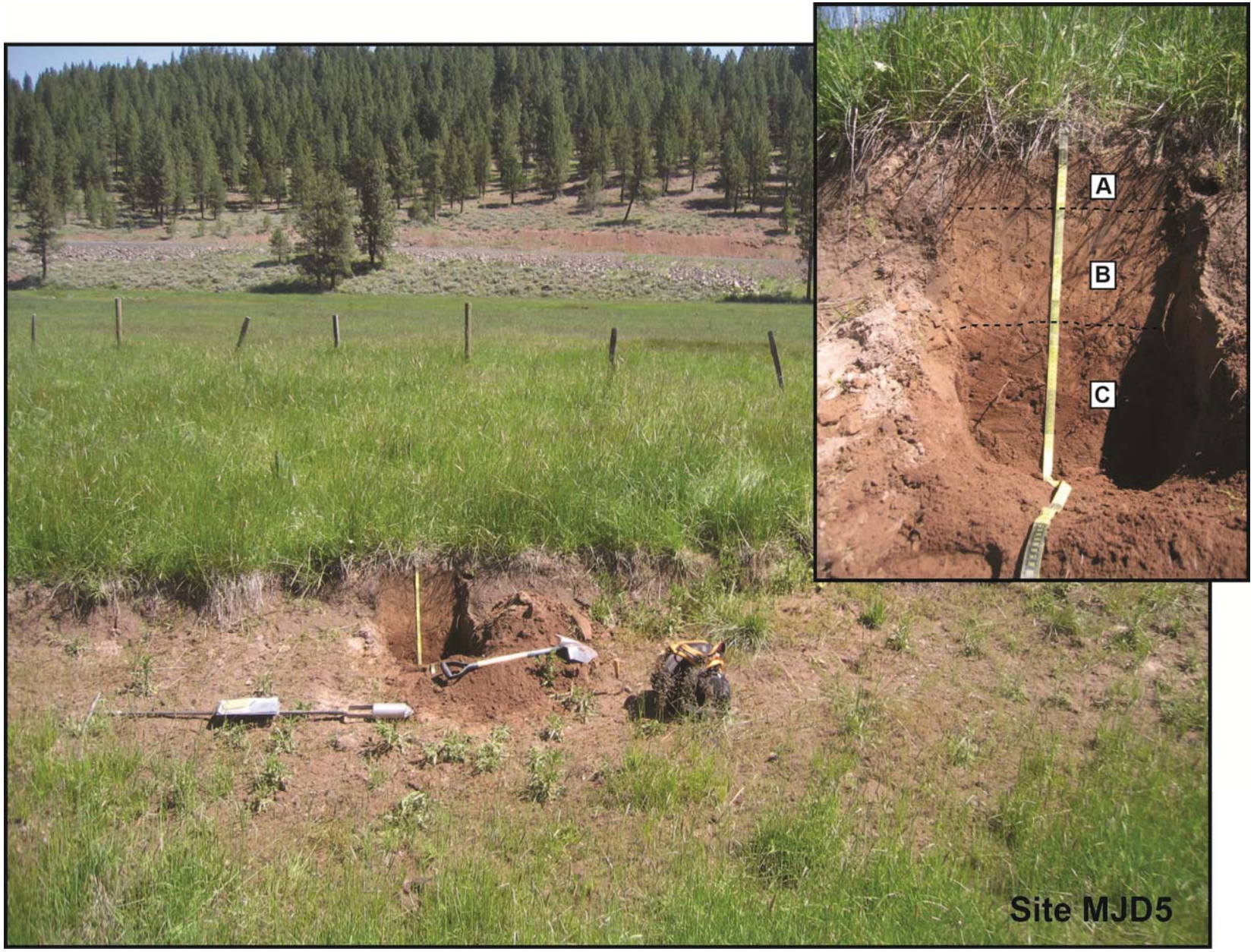
Horizon	Depth (cm)	Boundaries	Structure	Clay Films	Consistence			Texture	Gravel %	CaCO3 Morphology	Color (moist)
					Stickiness	Plasticity	Dry				
A	0-21	cs	2fgr	none			so		0	n/a	
B	21-46	as	1fsbk	none			so		trace	n/a	
C	46-80+	-	2msbk	none			so		trace	n/a	

Radiocarbon Samples:

No samples were collected at this site; charcoal was common at 27 cm depth in the top of the B horizon.

Miscellaneous Notes:

The most extensive Qa2 terrace on the Forrest Conservation Area; the slope on the terrace surface is generally in a downstream direction but has a small valley-ward component. Parent material for the soil and the entire deposit is interpreted as fluvial fine-grained, well-sorted, silty sand. The exposure at this site contained essential no gravel. B and Cox horizons show color change due to oxidation of mineral grains much greater than in soils formed on other terraces; likely due to being derived from volcanic bedrock.


A
B
C
Site MJD5

Appendix 2

POLLEN AND MACROFLORAL ANALYSIS OF BULK SOIL SAMPLES AND IDENTIFICATION OF DETRITAL CHARCOAL SAMPLES FROM ALONG THE MIDDLE FORK JOHN DAY RIVER, OREGON

By

Kathryn Puseman
and
Linda Scott Cummings

With Assistance from
R. A. Varney
and
Peter Kováčik

Paleo Research Institute
Golden, Colorado

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Reclamation Service Center
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INTRODUCTION

Samples were collected along the Middle Fork of the John Day River in east-central Oregon for a study of fluvial geomorphology. A total of 32 detrital charcoal/wood samples were submitted for identification, and 11 bulk soil samples were examined for pollen and macrofloral remains. These samples were recovered from soil pit or natural bank exposures along the river. After successful completion of this phase of the study, an additional eight pollen, eleven macrofloral, and two botanic samples were submitted to obtain additional information about the local, prehistoric vegetation. Macrofloral, including charcoal, and pollen records will be used to provide information concerning plant taxa that may have been present in this area prehistorically.

METHODS

Pollen

A chemical extraction technique based on flotation is the standard preparation technique used in this laboratory for the removal of the pollen from the large volume of sand, silt, and clay with which they are mixed. This particular process was developed for extraction of pollen from soils where preservation has been less than ideal and pollen density is lower than in peat.

Hydrochloric acid (10%) is used to remove calcium carbonates present in the soil, after which the samples are screened through 150 micron mesh. The material remaining in the pollen screen was saved and examined to recover macrofloral remains. The samples are rinsed until neutral by adding water, letting the samples stand for 2 hours, then pouring off the supernatant. A small quantity of sodium hexametaphosphate is added to each sample once it reaches neutrality, then the samples are allowed to settle according to Stoke's Law in settling columns. This process is repeated with ethylenediaminetetraacetic acid (EDTA). These steps remove clay prior to heavy liquid separation. The samples are then freeze dried. Sodium polytungstate (SPT), with a density 1.8, is used for the flotation process. The samples are mixed with SPT and centrifuged at 1500 rpm for 10 minutes to separate organic from inorganic remains. The supernatant containing pollen and organic remains is decanted. Sodium polytungstate is again added to the inorganic fraction to repeat the separation process. The supernatant is decanted into the same tube as the supernatant from the first separation. This supernatant is then centrifuged at 1500 rpm for 10 minutes to allow any silica remaining to be separated from the organics. Following this, the supernatant is decanted into a 50 ml conical tube and diluted with distilled water. These samples are centrifuged at 3000 rpm to concentrate the organic fraction in the bottom of the tube. After rinsing the pollen-rich organic fraction obtained by this separation, all samples receive a short (20-30 minute) treatment in hot hydrofluoric acid to remove any remaining inorganic particles. The samples are then acetolated for 3-5 minutes to remove any extraneous organic matter.

A light microscope is used to count the pollen to a total of approximately 30 to 100 pollen grains at a magnification of 500x. Pollen preservation in these samples varied from good to poor. Comparative reference material collected at the Intermountain Herbarium at Utah State University and the University of Colorado Herbarium was used to identify the pollen to the family, genus, and species level, where possible.

Pollen aggregates were recorded during identification of the pollen. Aggregates are clumps of a single type of pollen and may be interpreted to represent pollen dispersal over short distances or the introduction of portions of the plant represented into an archaeological setting. Aggregates were included in the pollen counts as single grains, as is customary. The presence of aggregates is noted by an "A" next to the pollen frequency on the pollen diagram. A plus (+) on the pollen diagram indicates that pollen was observed, in spite of the fact that pollen was not present in a sufficient concentration to obtain a full count. Pollen diagrams are produced using Tilia, which was developed by Dr. Eric Grimm of the Illinois State Museum. Total pollen concentrations are calculated in Tilia using the quantity of sample processed in cubic centimeters (cc), the quantity of exotics (spores) added to the sample, the quantity of exotics counted, and the total pollen counted and expressed as pollen per cc of sediment.

Indeterminate pollen includes pollen grains that are folded, mutilated, and otherwise distorted beyond recognition. These grains are included in the total pollen count since they are part of the pollen record. The microscopic charcoal frequency registers the relationship between pollen and charcoal. The total number of microscopic charcoal fragments was divided by the pollen sum, resulting in a charcoal frequency that reflects the quantity of microscopic charcoal fragments observed, normalized per 100 pollen grains.

Macrofloral

Eight of the bulk soil samples were floated using a modification of the procedures outlined by Matthews (1979). Each sample was added to approximately 3 gallons of water, then stirred until a strong vortex formed. The floating material (light fraction) was poured through a 150 micron mesh sieve. Additional water was added and the process repeated until all floating material was removed from the sample (a minimum of five times). The material that remained in the bottom (heavy fraction) was poured through a 0.5-mm mesh screen. The floated portions were allowed to dry.

The light fractions and/or the screen contents recovered from the bulk soil samples during pollen extraction were weighed, then passed through a series of graduated screens (US Standard Sieves with 2-mm, 1-mm, 0.5-mm and 0.25-mm openings) to separate charcoal debris and to initially sort the remains. The contents of each screen then were examined. Charcoal pieces were broken to expose a fresh cross section and examined under a binocular microscope at a magnification of 70x. The weights of each charcoal type were recorded. The material that remained in the 2-mm, 1-mm, 0.5-mm, and 0.25-mm sieves was scanned under a binocular stereo microscope at a magnification of 10x, with some identifications requiring magnifications of up to 70x. The material that passed through the 0.25-mm screen was not examined.

The detrital charcoal samples were water-screened through a 250 micron mesh sieve and allowed to dry. The dried water-screened samples, as well as individual charcoal/wood samples, were scanned under a binocular stereo microscope at a magnification of 10x. Charcoal fragments were separated and examined under a binocular microscope at a magnification of 70x. Macrofloral remains, including charcoal, were identified using manuals (Core, et al. 1976; Martin and Barkley 1961; Panshin and Zeeuw 1980; Petrides and Petrides 1992) and by comparison with modern and archaeological references. The term "seed" is used to represent seeds, achenes, caryopses, and other disseminules.

DISCUSSION

The study sites are located along the Middle Fork of the John Day River, near the town of John Day in east-central Oregon. The morphology of the river terraces and floodplain reflect a long history of snow melt hydrology and landslide activity. Very large landslides appear to have dammed the river for long periods of time, perhaps hundreds of years. Local vegetation in the study area is dominated by conifers and annual grasses.

Samples MJD1-9 from a depth of 45-60 cm, MJD1-10 from a depth of 25-40 cm, and MJD3-7 from a depth of 65-70 cm reflect bulk soil samples examined for pollen and macrofloral remains (Table 1). Small total pollen concentrations were obtained for each of these samples, with sample (MJ1-9) yielding the least pollen. Total pollen concentration probably reflects depositional history, with the largest concentration (MJD1-10) representing the slowest deposition and the smallest concentration (MJD1-9) representing the most rapid deposition.

The pollen record for samples MJD1-10 and MJD3-7 is dominated by *Pinus* pollen (Figure 1, Table 2), reflecting local pines. Other trees represented in this record include *Alnus*, Cupressaceae, *Larix*, and *Tsuga*, representing alder, members of the cypress family, larch, and hemlock. Hemlock does not grow in the area today, although it appears to have been an abundant tree in the local forest in the past. Pollen representing shrubby and herbaceous plants includes *Artemisia*, Low-spine Asteraceae, High-spine Asteraceae, Cheno-am, Corylaceae, Cyperaceae, Onagraceae, Poaceae, and *Symphoricarpos*, indicating local growth of sagebrush, various members of the sunflower family (including the groups that include ragweed, marshelder, cocklebur and most of the rest of this family), Cheno-ams, members of the hazel family, sedges, members of the evening primrose family, grasses, and snowberry. Interpreting the meaning of variation in pollen frequencies lies in a more thorough understanding of the depositional history of these sediments. In addition, algal and fungal spores are present. *Zygnema* spores represent a fungus that grows in the presence of oxidizing conditions. Microscopic charcoal fragments also were recorded and indicate that fires were more abundant or there was greater charcoal transport at the time MJD1-10 accumulated than at other times examined.

The macrofloral record for these bulk soil samples yielded small fragments of charcoal. Sample MJD1-9 contained one small fragment of conifer charcoal too small for further identification (Table 3, Table 4). Small fragments of conifer charcoal also were present in sample MJD1-10, including two fragments of incompletely burned conifer charcoal. In addition, three charred bark fragments were noted. Sample MJD3-7 yielded three fragments of *Pinus* charcoal, reflecting local pines. A few uncharred Poaceae leaf/stem fragments and a few uncharred rootlets represent modern grasses.

Charcoal sample MJD1-1 was recovered from the Btb horizon at a depth of 77 cm. This sample contained ten small fragments of conifer charcoal and two pieces of unidentified hardwood too small for identification.

Several fragments of vitrified probable *Larix occidentalis* charcoal were present in sample MJD1-2 from the top of the B1 horizon at a depth of 26 cm. Vitrified charcoal has a shiny, glassy appearance due to fusion by heat. A vitrified appearance may indicate that the wood had burned while “green” and fresh with a higher sap content.

Sample MJD1-3 was taken from a depth of 57 cm at the base of the B2 horizon. This sample consisted of sand and one piece of charred parenchymous tissue. "Parenchyma is the botanical term for relatively undifferentiated tissue, composed of many similar thin-walled cells...which form a ground tissue that surrounds other tissues. Parenchyma occurs in many different plant organs in varying amounts. Large fleshy organs such as ...roots and stems are composed largely of parenchyma. ...The vegetative storage parenchyma in swollen roots and stems stores starch and other carbohydrates and sugars ..." (Hather 2000:1). Recovery of parenchymous tissue reflects either burned root or stem tissue.

Sample MJD1-4 was collected from the base of the BA horizon at a depth of 18 cm. One piece of conifer charcoal was present but was too vitrified for further identification. A few uncharred rootlets represent modern plants.

Sample MJD1-5 reflects the BA horizon at a depth of 16 cm. This sample contained several fragments of *Pinus* charcoal, including three pieces that were incompletely charred. Several small fragments of *Pinus* charcoal also were present in sample MJD1-6 from the top of the B1 horizon at a depth of 22 cm.

Sample MJD1-7 was taken from a depth of 38 cm at the base of the B1 horizon. This sample yielded five fragments of *Larix occidentalis* charcoal, reflecting local western larch wood that burned. Sample MJD1-8 represents the B1 horizon at a depth of 34 cm. Several fragments of conifer charcoal too vitrified for further identification were noted in this sample.

Sample MJD2A-1 was recovered from an outcrop in the channel at a depth of 200 cm. These deposits are believed to be several thousand years old. The sample consisted of sand and one fragment of *Tsuga* charcoal, representing either western hemlock or mountain hemlock. Hemlocks currently are not found in the John Day River basin; however, recovery of *Tsuga* charcoal and pollen in these samples suggests that hemlocks grew in the area prehistorically.

Samples MJD2A-2 and MJD2A-3 were collected from the base of the bank exposure at depths of 172 and 175 cm, respectively. Sample MJD2A-2 yielded only rock/gravel and clay. Three small fragments of *Pinus* charcoal were noted in sample MJD2A-3, representing the presence of pine trees.

Sample MJD2B-1 was recovered from the Bt2 horizon at a depth of 205 cm. This sample contained a piece of *Pinus* charcoal and several fragments of conifer charcoal too small for further identification. Two pieces of charred, vitrified tissue might reflect charcoal or other charred plant tissue too vitrified for identification.

Pieces of vitrified conifer charcoal were present in sample MJD2B-2 from a depth of 93 cm in the B2 horizon. Two other fragments of charcoal were too vitrified for identification. These charcoal fragments may suggest burning of fresh, green wood.

Sample MJD2B-3 was taken from the Bt1 horizon at a depth of 135 cm. This sample yielded several fragments of *Tsuga* charcoal. One uncharred Poaceae floret represents a modern grass in the area. Pieces of *Tsuga* charcoal also were noted in sample MJD2B-4 from the base of the B2 horizon at a depth of 104 cm and in sample MJD2B-5 from a depth of 170

cm in a debris flow. These deposits appear to reflect a time when hemlocks were growing in the area.

Sample MJD3-1 was collected from the top of the B2 horizon at a depth of 46 cm. This sample contained six fragments of charcoal too small for identification. An uncharred *Amaranthus* seed and a few uncharred rootlets represent modern plants.

Sample MJD3-2 from the base of the B1 horizon at a depth of 40 cm contained three small pieces of charred bark. One charred parenchymous tissue fragment reflects burned root or stem tissue. Four pieces of conifer charcoal in sample MJD3-3 from a depth of 57 cm at the base of the B2 horizon were too small and vitrified for further identification.

Sample MJD3-4 was recovered from a depth of 68 cm in the Ab horizon. This sample contained several fragments of *Larix occidentalis* charcoal, reflecting western larch that burned. Two small fragments of charcoal in sample MJD3-5 from a depth of 77 cm in the Bb horizon were too vitrified for identification.

Sample MJD3-6 was taken from the top of the 2C horizon at a depth of 87 cm. This sample yielded seven fragments of *Alnus* charcoal, reflecting alder wood that burned. Alders are shrubs to medium-sized trees, and they are associated with water everywhere they grow. The presence of mountain alder (*A. tenuifolia*) denotes running water (Peattie 1953:396-400; Robinson 1979:17-19).

Sample MJD4-1 was collected from the 2Bw horizon at a depth of 21 cm. This sample contained seven small fragments of *Larix occidentalis* charcoal, reflecting the presence of western larch. Sample MJD4-2 from the base of the 2Bw horizon at a depth of 27 cm yielded a single piece of *Pinus* twig charcoal.

Samples MJD4-3 and MJD4-4 were recovered from the top of the 2C horizon at depths of 32 and 28 cm, respectively. Sample MJD4-3 yielded six small fragments of *Tsuga* charcoal. Several fragments of conifer charcoal too small for further identification were noted in sample MJD4-4.

Sample MJD4-5 represents the top of the 2Bw horizon at a depth of 13 cm. This sample contained eight fragments of unidentified hardwood root charcoal.

Eight additional stratigraphic samples from two pits (MFJD-017 and MFJD-019) were examined for pollen and macrofloral remains to provide information concerning vegetation succession in the area. Samples were collected with a 3" auger from older abandoned channels. Samples were taken at approximately 20 cm intervals since previous analysis indicates that sediments in this area probably accumulated rapidly. Examination of four samples from each of these profiles provides an opportunity to examine vegetation change over at least several hundreds of years. Total pollen concentration (approximately 130 pollen per cubic centimeter (cc) of sample) in the lowest sample (17-4) is similar to that obtained in samples from MJD3 and MJD1, while the total pollen concentration in sample 17-3 is higher at nearly 2000 pollen per cc of sample (Figure 2). The upper two samples, collected at 20-40 and 1-20 cm, exhibit approximately 31,000 pollen per cc of sample, indicating that they are very recent. Therefore, discussion of this pollen record will treat the lower two samples as distinct from the upper two samples.

The stratigraphic pollen records are dominated by *Pinus* pollen reflecting a large, local pine population. The stratigraphic record at MFJD-017 exhibits larger *Pinus* pollen frequencies in the upper two samples than in the lower two samples. This might be the result of fire suppression activities that have resulted in an increase in tree density in the forests. Microscopic charcoal was more abundant in the lowest sample, declining severely in the middle two samples, and again in the uppermost sample. These factors combine with the total pollen concentration to emphasize assignment of the upper two samples to the modern era. *Alnus*, Cupressaceae, *Abies*, *Picea*, and *Pseudotsuga* pollen recovered from many of these stratigraphic samples indicates local growth of a variety of trees including alder, red cedar and possibly others of the Cupressaceae family, fir, spruce, and Douglas fir. *Salix* pollen was noted only in the uppermost sample, indicating that willow currently grows along the John Day River.

Patterns of pollen frequencies from these four samples are instructive. *Abies* pollen is slightly more abundant in the lower two samples, suggesting that fir was more abundant locally in the past than it is today. High-spine Asteraceae, Cheno-am, and particularly Poaceae pollen also were more abundant in the lower two samples than in the upper two samples, indicating that open areas supported various members of the sunflower family, members of the Cheno-am group that probably included primarily *Chenopodium* (goosefoot), and grasses. As the forest became more dense in recent times, the grass population declined severely. It is likely that stands of trees are more dense and that openings in the forest canopy are smaller than they were a few hundred years ago. Other pollen noted in the lower two samples, representing herbaceous or shrubby plants that would have grown in openings in the forest canopy, include Low-spine Asteraceae, Brassicaceae, *Eriogonum*, Fabaceae, Onagraceae, and Rosaceae, indicating that plants in the ragweed group, mustard family, wild buckwheat, legumes, and members of the evening primrose and rose families grew in open areas or at forest margins. Recovery of small quantities of *Artemisia*, Liguliflorae, Cyperaceae, *Eriogonum*, and *Symphoricarpos* pollen in one or both of the upper two samples represent sagebrush, members of the chicory tribe of the sunflower family, sedges, wild buckwheat, and snowberry growing in open areas or along forest margins. Spores indicating the presence of ferns were noted occasionally but do not indicate that ferns were abundant in this area.

Stratigraphic samples from MFJD-019 exhibit a slightly different signature. They may still be divided into the upper two and lower two samples based on total pollen concentration and quantity of microscopic charcoal. Samples 19-1 and 19-2, the upper samples, exhibit total pollen concentrations between approximately 9,000 and 12,500 pollen per cc of sediment. While this is less than half the concentration noted in the upper samples at MFJD-017, it is still within the expected range for modern samples. Microscopic charcoal is more abundant in the lower two samples and is consistent with low level mosaic fires. The upper two samples experience a reduction by about 80% in the quantities of microscopic charcoal. The upper samples also record an increase in *Pinus* pollen, as did the upper samples from MFJD-017, indicating an increase in the density of pine trees and/or an expansion of the forest and closing of some of the previously open areas. *Alnus* pollen is more abundant in the lower two samples than the upper two, suggesting that alder was more abundant growing along the John Day River in the past than in the modern era. Recovery of small quantities of Cupressaceae, *Abies*, and *Pseudotsuga* pollen from both upper and lower samples indicates local growth of a member of the cypress family (probably western red cedar), fir, and Douglas fir in this area both prehistorically and during the modern era. *Tsuga* pollen was noted only in the lower two samples, indicating the presence of hemlock at least in the prehistoric or perhaps early historic

era. *Betula* and *Salix* pollen were observed only in sample 19-3, indicating that birch and willow grew along the John Day River at least sporadically.

This location contains Apiaceae pollen in three of the four samples, indicating that a member of the umbel family grew either along the banks of the John Day River or perhaps along the forest margin in the modern and perhaps prehistoric eras. *Artemisia* pollen is more abundant in the lower two samples suggesting that, in this area, sagebrush was more abundant in the past than in the modern era. Quantities of High-spine Asteraceae pollen are slightly larger in the middle two than the lowermost and uppermost samples, suggesting fluctuating populations of members of the sunflower family through time. Liguliflorae pollen is more abundant in the more modern samples, especially the uppermost sample, indicating a recent increase in plants in the chicory tribe of the sunflower family. Brassicaceae pollen is noted in the three lower samples, reflecting past growth of weedy plants in the mustard family in open areas. As at MFJD-017, Cheno-am pollen is slightly more abundant in the lower two samples, probably reflecting growth of goosefoot in open areas, as well. Cyperaceae pollen was observed only in the lowest sample, indicating that sedges grew with grasses in open areas. *Eriogonum* and Fabaceae pollen are noted in three of the four samples, each, indicating that wild buckwheat and legumes have been part of the plant community in open areas. Lamiaceae pollen is present only in sample 19-4, indicating local growth of a member of the mint family, again in an open area. Onagraceae pollen was observed only in sample 19-3, placing a member of the evening primrose family as part of the vegetation in an open area at the time those sediments accumulated. Poaceae pollen is not as variable in these samples as at MFJD-017 suggesting that, in the area sampled, the grass population has been more stable. Recovery of small quantities of Rosaceae and *Fragaria* pollen in sample 19-4 represents local growth of at least two members of the rose family including wild strawberries. *Symphoricarpos* pollen was noted only in sample 19-3, documenting local growth of snowberry. Fern spores are more abundant in the lowest sample, indicating that ferns were more abundant as a forest margin plant in late prehistory than in the modern era. Total pollen concentration of the lower two samples (approximately 6000 and 2500 pollen per cc) suggests that they might be slightly more recent than the lowest sample from MFJD-017. Continued decline of total pollen concentration in these samples is typical of these sediments and suggests that sample 19-4 may be more similar in age to sample 17-3 than to sample 17-4.

A variety of macrofloral remains were present in these stratigraphic samples. Sample MFJD-017-1 from a depth of 0-20 cm contained a charred *Carex* seed and a charred *Polygonum* - triangular seed, indicating the presence of sedge and smartweed/knotweed plants in the area. Uncharred *Carex* seeds and an uncharred *Polygonum* - triangular seed fragment note the continued presence of sedges and smartweed/knotweed in this area. *Carex* seeds, as well as uncharred Cyperaceae seed fragments, a *Scirpus* seed, *Juncus* seeds, and a *Ranunculus* seed, represent plants typical of riparian habitats. Other types of uncharred seeds indicate that components of the modern vegetation community in this area include members of the sunflower family, tansy mustard and another member of the mustard family, goosefoot, probable St. Johnswort, and clover. The charcoal record was dominated by *Larix occidentalis*, reflecting western larch trees. In addition, the sample contained smaller fragments of conifer charcoal, incompletely charred conifer charcoal, and a charred bark scale fragment. Numerous insect chitin fragments and a few insect eggs reflect insect activity in the area.

All eight stratigraphic samples yielded uncharred roots, rootlets, and varying amounts of sclerotia. Sclerotia are commonly called "carbon balls". They are small, black, solid or hollow

spheres that can be smooth or lightly sculpted. These forms range from 0.5 to 4 mm in size. Sclerotia are the resting structures of mycorrhizae fungi, such as *Cenococcum graniforme*, that have a mutualistic relationship with tree roots. Many trees are noted to depend heavily on mycorrhizae and may not be successful without them. "The mycelial strands of these fungi grow into the roots and take some of the sugary compounds produced by the tree during photosynthesis. However, mycorrhizal fungi benefit the tree because they take in minerals from the soil, which are then used by the tree" (Kricher and Morrison 1988:285). Sclerotia appear to be ubiquitous and are found with coniferous and deciduous trees including *Abies* (fir), *Juniperus communis* (common juniper), *Larix* (larch), *Picea* (spruce), *Pinus* (pine), *Pseudotsuga* (Douglas fir), *Alnus* (alder), *Betula* (birch), *Populus* (poplar, cottonwood, aspen), *Quercus* (oak), and *Salix* (willow). These forms originally were identified by Dr. Kristiina Vogt, Professor of Ecology in the School of Forestry and Environmental Studies at Yale University (McWeeney 1989:229-230) (Trappe 1962).

A few charred Poaceae C (linear) caryopses were present in sample MFJD-017-2 from a depth of 20-40 cm. Poaceae C caryopses reflect grasses with small seeds, such as *Agrostis* (bentgrass), *Muhlenbergia* (muhly grass), *Poa* (bluegrass), etc. One piece of charred vitrified tissue may reflect charcoal or other charred plant tissue. A variety of uncharred seeds from modern plants were present, including at least four species of *Carex*. *Larix occidentalis* dominated the charcoal record, with fewer fragments of *Pinus* charcoal and vitrified conifer charcoal present. Only a few insect chitin fragments and a single insect egg were noted.

Sample MFJD-017-3 from a depth of 40-60 cm contained a charred *Polygonum* - triangular seed, again noting the presence of smartweed/knotweed seeds. A charred unidentified seed and seed fragments, a piece of charred bark, and several vitrified tissue fragments also were recovered. An uncharred *Ranunculus* seed represents modern buttercups. The charcoal record consisted if several small fragments of *Larix occidentalis* and charcoal too vitrified for identification, as well as a few small pieces of conifer, *Pinus*, and vitrified unidentified hardwood charcoal. A single charred monocot/herbaceous dicot stem fragment also was noted.

Sample MFJD-017-4 was taken from a depth of 60-80 cm. This sample contained small fragments of *Artemisia*, conifer, and *Pinus* charcoal, reflecting sagebrush, pine, and possibly another type of conifer.

Sample MFJD-019-1 from a depth of 10-25 cm yielded two charred Poaceae C caryopses, again indicating the presence of small-seeded grasses. A charred *Pinus* bark scale fragment, a charred unidentified seed, and a few fragments of charred, vitrified tissue also were noted. The charcoal record consisted of several small fragments of *Pinus* charcoal, as well as fewer pieces of *Larix occidentalis*, conifer, *Alnus*, and charcoal too vitrified for identification. In addition, the sample contained several uncharred fragments of *Pinus* wood, a few uncharred seeds from modern plants, a few insect chitin fragments, and a few worm casts.

A charred *Lonicera* seed was present in sample MFJD-019-2 from a depth of 25-40 cm, reflecting honeysuckle plants. Three charred fruit fragments might reflect a *Lonicera* berry or possibly another type of fruit/berry that burned. A few charred bark fragments and numerous small pieces of charred, vitrified tissue also were noted, as were uncharred seeds from modern plants, roots, rootlets, and sclerotia. The charcoal record yielded a few fragments of *Alnus*, Asteraceae root, conifer (including root and twig), *Pinus*, *Larix occidentalis*, and unidentified

hardwood charcoal. In addition, the sample contained several pieces of uncharred *Pinus* wood. Non-floral remains include three calcined bone fragments and several insect chitin fragments.

Sample MFJD-019-3 from a depth of 40-55 cm contained six charred *Carex* seeds, a charred *Arctostaphylos* seed fragment, a charred Asteraceae seed, a charred possible Fabaceae seed fragment, and two charred Poaceae C caryopses, reflecting the presence of sedge, manzanita, a member of the sunflower family, possibly a member of the bean family, and grasses with small seeds. Two charred fruit fragments represent a dry, capsule-like fruit. The sample also yielded three charred unidentified seed fragments, charred bark, and numerous small pieces of charred, vitrified tissue. The charcoal record was dominated by *Larix occidentalis*, with fewer fragments of *Arctostaphylos*, conifer, *Pinus*, unidentified hardwood, and charcoal too vitrified for identification. A few pieces of *Pinus* wood, a few uncharred seeds, a few roots, numerous rootlets, and numerous sclerotia complete the record.

Sample MFJD-019-4 was collected from a depth of 55-70 cm. This sample yielded eight fragments of charred *Pinus* cone scale weighing 0.02 g, reflecting a pine cone that burned. A few charred Poaceae C caryopses represent small-seeded grasses. The sample also contained three charred unidentified seeds, several fragments of charred bark, numerous small fragments of vitrified tissue, a few uncharred roots, numerous rootlets, and numerous sclerotia. Charcoal in this sample included several fragments of conifer and *Larix occidentalis* charcoal, with fewer fragments of *Pinus*, Salicaceae, *Alnus*, unidentified hardwood, and charcoal too vitrified for identification also present. In addition, the sample yielded a few unburned pieces of probable *Pinus* wood and a few insect chitin fragments.

Samples MFJD-015-1 and MFJD-018-1 represent stumps in growth position on older terrace deposits. They are believed to be victims of late-1800s logging, as they represent very large trees, some approaching 4 or 5 feet in diameter (Ralph Klinger, personal communication, June 30, 2009). Sample MFJD-015-1 consisted of a large chunk of *Larix occidentalis* wood weighing 251.51 g, while sample MFJD-018-1 yielded several smaller pieces of *Larix occidentalis* wood.

Charcoal samples MFJD-016-1, MFJD-016-2, and MFJD-016-3 were collected from a natural exposure of Qa2 alluvium immediately adjacent to the river. Sample MFJD-016-1 from a depth of 42 cm yielded three fragments of slightly vitrified *Larix occidentalis* charcoal weighing 0.09 g. Sample MFJD-016-2 from a depth of 27 cm contained two pieces of slightly vitrified *Larix occidentalis* charcoal weighing 0.005 g, as well as thirteen fragments of *Pinus* twig charcoal weighing 0.01 g. Several small fragments of *Pinus* charcoal weighing 0.01 g were present in sample MFJD-016-3 from a depth of 57 cm.

SUMMARY AND CONCLUSIONS

Pollen analysis of the initial three bulk soil samples from along the Middle Fork John Day River in east-central Oregon suggests rapid deposition of sediments and provides evidence of local and/or regional fires. The largest quantity of microscopic charcoal corresponds with the largest total pollen concentration, suggesting a slower deposition for sediment represented by sample MJD1-10 than MJD3-7. Sediment represented by sample MJD1-9 appears to have accumulated much faster than either of the other two layers. The pollen record indicates the

presence of a wooded or forested area either at the area sampled or within a very short distance of the area sampled.

Stratigraphic pollen analysis of additional samples from MFJD-017 and MFJD-019 provides additional information for interpreting the past vegetation record, although some trends are very similar. At MFJD-017, the lowest sample (17-4), collected at a depth of 60-80 cm, yielded a very low total pollen concentration (approximately 130 pollen per cc of sediment), suggesting rapid sediment accumulation. In addition, this sample yielded a larger quantity of microscopic charcoal than was visible in the upper samples, suggesting an interval of fire. The lower portion of the record represents a more open environment supporting grasses and clearings, although a pine forest is evident in the area. The upper two samples exhibit both increases in pine pollen and a reduction in grass pollen, indicating that openings probably were smaller and less numerous. At MFJD-019, the trends were not as obvious, as quantities of grass pollen did not fluctuate significantly. Microscopic charcoal was more abundant in the lower two samples, as it was in the lowest sample from MFJD-017, suggesting that both records contain evidence of regional fires in these deposits. The other obvious differences between the lower and upper samples at this location are the greater abundance of *Alnus* and *Artemisia* pollen in the lower samples indicating local growth of alder along John Day river and sagebrush in open areas on the terrace above the river. Finally, *Tsuga* pollen was noted only in the lower two samples, documenting the presence of hemlock in the local forest at that time.

Macrofloral analysis, including charcoal identification, resulted in recovery of charcoal and other charred botanic material. Conifers appear to have been common in this area and included pine, western larch, and hemlock. Conifer charcoal not further identified to genus was noted in nine of the original twenty-seven samples examined, while *Pinus* charcoal was noted in six samples. Four samples contained *Larix occidentalis* charcoal, and five samples yielded *Tsuga* charcoal. Although hemlocks are not noted to grow in the John Day River basin today, recovery of *Tsuga* pollen and charcoal in these samples suggests that hemlocks grew in the area prehistorically. Charcoal representative of riparian plants is rare, represented by *Alnus* charcoal in sample MJD3-6. Unidentified hardwood charcoal in two other samples might also reflect alder or another type of hardwood such as willow or cottonwood.

Additional macrofloral analysis of eight stratigraphic samples again yielded abundant charcoal evidence for conifers, including pine and western larch. Two wood samples from stumps on older terrace deposits also note the presence of western larch trees in the area, while pine and western larch trees are reflected in three additional charcoal samples from Qa2 colluvium adjacent to the river. Alder and another type of hardwood charcoal were noted in three of the four stratigraphic samples from MFJD-109, while unidentified hardwood charcoal also was noted in sample MFJD-107-3. Charcoal types noted in single occurrences include a piece of *Artemisia* charcoal in sample MFJD-107-4, Asteraceae root charcoal in sample MFJD-109-2, *Arctostaphylos* charcoal in sample MFJD-109-3, and Salicaceae charcoal in sample MFJD-109-4. Charred seeds from the stratigraphic samples indicate the presence of smartweed/knotweed, small-seeded grasses, sedges, manzanita, huckleberry, a member of the sunflower family, and possibly a member of the bean family such as clover. Uncharred seeds reflect a variety of modern plants in the area, including riparian plants such as sedges, bulrush, rush, and buttercup.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM MIDDLE FORK JOHN DAY RIVER, OREGON

Sample No.	Depth (cmbs)	Provenience/ Description	Analysis
MJD1-1	77	Charcoal; Btb horizon	Charcoal ID
MJD1-2	26	Charcoal; Top of B1 horizon	Charcoal ID
MJD1-3	57	Charcoal; Base of B2 horizon	Charcoal ID
MJD1-4	18	Charcoal; Base of BA horizon	Charcoal ID
MJD1-5	16	Charcoal; BA horizon	Charcoal ID
MJD1-6	22	Charcoal; Top of B1 horizon	Charcoal ID
MJD1-7	38	Charcoal; Base of B1 horizon	Charcoal ID
MJD1-8	34	Charcoal; B1 horizon	Charcoal ID
MJD1-9	45-60	Bulk soil sample	Pollen Charcoal ID
MJD1-10	25-40	Bulk soil sample	Pollen Charcoal ID
MJD2A-1	200	Charcoal; Outcrop in channel (sand bed)	Charcoal ID
MJD2A-2	172	Charcoal; Bank of base exposure	Charcoal ID
MJD2A-3	175	Charcoal; Bank of base exposure	Charcoal ID
MJD2B-1	205	Charcoal; Bt2 horizon	Charcoal ID
MJD2B-2	93	Charcoal; B2 horizon	Charcoal ID
MJD2B-3	135	Charcoal; Bt1 horizon	Charcoal ID
MJD2B-4	104	Charcoal; B2 horizon	Charcoal ID
MJD2B-5	170	Charcoal; Debris flow deposit	Charcoal ID
MJD3-1	46	Charcoal; Top of B2 horizon	Charcoal ID
MJD3-2	40	Charcoal; Base of B1 horizon	Charcoal ID
MJD3-3	57	Charcoal; Base of B2 horizon	Charcoal ID
MJD3-4	68	Charcoal; Ab horizon	Charcoal ID
MJD3-5	77	Charcoal; Bb horizon	Charcoal ID
MJD3-6	87	Charcoal; Top of 2C horizon	Charcoal ID
MJD3-7	65-70	Bulk soil sample	Pollen Charcoal ID
MJD4-1	21	Charcoal; 2Bw horizon	Charcoal ID

TABLE 1 (Continued)

Sample No.	Depth (cmbs)	Provenience/ Description	Analysis
MJD4-2	27	Charcoal; Base of 2Bw horizon	Charcoal ID
MJD4-3	32	Charcoal; Top of 2C horizon	Charcoal ID
MJD4-4	28	Charcoal; Top of 2C horizon	Charcoal ID
MJD4-5	13	Charcoal; Top of 2Bw horizon	Charcoal ID
MFJD-017-1	0-20	Bulk soil sample	Pollen Macrofloral
MFJD-017-2	20-40	Bulk soil sample	Pollen Macrofloral
MFJD-017-3	40-60	Bulk soil sample	Pollen Macrofloral
MFJD-0 017-4	60-80	Bulk soil sample	Pollen Macrofloral
MFJD-0 19-1	10-25	Bulk soil sample	Pollen Macrofloral
MFJD-019-2	25-40	Bulk soil sample	Pollen Macrofloral
MFJD-019-3	40-55	Bulk soil sample	Pollen Macrofloral
MFJD-019-4	55-70	Bulk soil sample	Pollen Macrofloral
MFJD-015-1		Wood sample	Wood ID
MFJD-018-1		Wood sample	Wood ID
MFJD-016-1	42	Charcoal; top of C horizon	Charcoal ID
MFJD-016-2	27	Charcoal; B horizon	Charcoal ID
MFJD-016-3	57	Charcoal; bottom of C horizon	Charcoal ID

TABLE 2
POLLEN TYPES OBSERVED IN SAMPLES FROM MIDDLE FORK JOHN DAY RIVER, OREGON

Scientific Name	Common Name
ARBOREAL POLLEN:	
Betulaceae	Birch/Hazel family
Alnus	Alder
Betula	Birch
Cupressaceae	Cypress family
Pinaceae:	Pine family
Abies	Fir
Larix	Western Larch
Picea	Spruce
Pinus	Pine
Pseudotsuga/*Larix*	Douglas fir/Larch
Tsuga	Hemlock
Salix	Willow
NON-ARBOREAL POLLEN:	
Apiaceae	Umbel family
Asteraceae:	Sunflower family
Artemisia	Sagebrush
Low-spine	Includes ragweed, cocklebur, sumpweed
High-spine	Includes aster, rabbitbrush, snakeweed, sunflower, etc.
Liguliflorae	Chicory tribe of the sunflower family
Brassicaceae	Mustard family
Cheno-am	Includes the goosefoot family and amaranth
Corylaceae	Hazel family
Cyperaceae	Sedge family
Ephedra torreyana-type	Ephedra or Mormon tea
Eriogonum	Wild buckwheat
Fabaceae	Legume family
Lamiaceae	Mint family

TABLE 2 (Continued)

Scientific Name	Common Name
Onagraceae (*Gaura*)	Evening primrose family
Poaceae	Grass family
Rosaceae	Rose family
cf. *Fragaria*	Wild strawberry
Symphoricarpos	Western snowberry
Indeterminate	Too badly deteriorated to identify
SPORES:	
Monolete smooth	Fern spores
Trilete smooth	Fern spores
ALGAE:	
Algal Spore	Algal spore
Zygnema-type	Algal body
FUNGAL SPORES:	
Fungal Spore	Fungal spore
OTHER:	
Microscopic Charcoal	Microscopic charcoal
Total pollen concentration	Quantity of pollen per cubic centimeter (cc) of sediment

TABLE 3
MACROFLORAL REMAINS FROM ALONG THE MIDDLE FORK JOHN DAY RIVER, OREGON

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MJD1-9	Pollen Screen Weight						19.65 g
45-60 cm	FLORAL REMAINS:						
Bulk soil	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Conifer	Charcoal		1			<0.001 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD1-10	Pollen Screen Weight						12.84 g
25-40 cm	FLORAL REMAINS:						
Bulk soil	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Conifer	Charcoal		4			0.003 g
	Conifer	Charcoal		2ic			0.005 g
	Bark	Charcoal		3			0.006 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	Few
	Sand					X	
MJD3-7	Pollen Screen Weight						19.13 g
65-70 cm	FLORAL REMAINS:						
Bulk soil	Poaceae	Leaf/Stem				X	Few
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Pinus	Charcoal		3			0.04 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	
	Sand					X	Few
MJD1-1	Water-screened Sample Weight						0.34 g
77 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Conifer	Charcoal		10			0.002 g
	Unidentified hardwood - small	Charcoal		2			<0.001 g
	NON-FLORAL REMAINS:						
	Sand					X	

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MJD1-2	Water-screened Sample Weight						0.82 g
26 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	cf. *Larix occidentalis* - vitrified	Charcoal		12			0.11 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD1-3	Water-screened Sample Weight						0.39 g
57 cm	FLORAL REMAINS:						
	Parenchymous tissue			1			0.007 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD1-4	Water-screened Sample Weight						3.31 g
18 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Conifer - vitrified	Charcoal		1			0.87 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD1-5	Water-screened Sample Weight						2.29 g
16 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Pinus	Charcoal		11			0.06 g
	Pinus	Charcoal		1 ic			0.03 g
	NON-FLORAL REMAINS:						
	Clay					X	
MJD1-6	Water-screened Sample Weight						1.47 g
22 cm	CHARCOAL/WOOD:						
	Pinus	Charcoal		9			0.04 g
	NON-FLORAL REMAINS:						
	Sand					X	

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MJD1-7	Water-screened Sample Weight						0.22 g
38 cm	CHARCOAL/WOOD:						
	Larix occidentalis	Charcoal		5			
	NON-FLORAL REMAINS:						
	Sand					X	
MJD1-8	Water-screened Sample Weight						0.19 g
34 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Conifer - vitrified	Charcoal		10			0.02 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD2A-1	Water-screened Sample Weight						4.78 g
200 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Tsuga	Charcoal		1			0.04 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD2A-2	Water-screened Sample Weight						2.15 g
172 cm	NON-FLORAL REMAINS:						
	Clay					X	
	Rock/Gravel					X	
MJD2A-3	Water-screened Sample Weight						0.85 g
175 cm	CHARCOAL/WOOD:						
	Pinus	Charcoal		3			0.05 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD2B-1	Water-screened Sample Weight						18.18 g
205 cm	FLORAL REMAINS:						
	Vitrified tissue			2			0.01 g
	Roots					X	Few
	CHARCOAL/WOOD:						
	Conifer	Charcoal		15			0.047 g
	Pinus	Charcoal		1			0.005 g

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MJD2B-1	NON-FLORAL REMAINS:						
205 cm	Rock/Gravel					X	
MJD2B-2	Water-screened Sample Weight						
93 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Conifer - vitrified	Charcoal		6			0.01 g
	Unidentified - vitrified	Charcoal		2			0.01 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD2B-3	Water-screened Sample Weight						2.03 g
135 cm	FLORAL REMAINS:						
	Poaceae	Floret			1		
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Tsuga	Charcoal		19			0.21 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD2B-4	Water-screened Sample Weight						3.10 g
104 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Tsuga	Charcoal		8			0.09 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD2B-5	Water-screened Sample Weight						12.59 g
170 cm	CHARCOAL/WOOD:						
	Tsuga	Charcoal		20			
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	
	Sand					X	
MJD3-1	Water-screened Sample Weight						0.71 g
46 cm	FLORAL REMAINS:						
	Amaranthus	Seed			1		
	Rootlets					X	Few

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MJD3-1	CHARCOAL/WOOD:						
46 cm	Unidentifiable - small	Charcoal		6			<0.001 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD3-2	Water-screened Sample Weight						2.49 g
40 cm	FLORAL REMAINS:						
	Bark			3			0.008 g
	Parenchymous tissue			1			0.002 g
	Rootlets					X	
	NON-FLORAL REMAINS:						
	Sand					X	
MJD3-3	Water-screened Sample Weight						0.45 g
57 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Conifer - vitrified	Charcoal		4			0.05 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD3-4	Water-screened Sample Weight						0.25 g
08-144	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Larix occidentalis	Charcoal		17			0.011 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD3-5	Water-screened Sample Weight						
77 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Unidentified - vitrified	Charcoal		2			0.03 g
	NON-FLORAL REMAINS:						
	Sand					X	

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MJD3-6	Water-screened Sample Weight						1.10 g
87 cm	CHARCOAL/WOOD:						
	Alnus	Charcoal		7			0.006 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD4-1	Water-screened Sample Weight						0.26 g
21 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Larix occidentalis	Charcoal		7			
	NON-FLORAL REMAINS:						
	Sand					X	
MJD4-2	Water-screened Sample Weight						0.17 g
27 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Pinus twig	Charcoal		1			0.05 g
	NON-FLORAL REMAINS:						
	Sand					X	
MJD4-3	Water-screened Sample Weight						2.57 g
32 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Tsuga	Charcoal		6			0.01 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	Few
	Sand					X	
MJD4-4	Water-screened Sample Weight						0.004 g
28 cm	CHARCOAL/WOOD:						
	Conifer	Charcoal		41			0.0013 g
	NON-FLORAL REMAINS:						
	Sand					X	Few

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MJD4-5	Water-screened Sample Weight						1.07 g
13 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Unidentified hardwood root	Charcoal		8			0.102 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	Few
	Sand					X	
MFJD-017-1	Light Fraction Weight						17.12 g
0-20 cm	FLORAL REMAINS:						
	Carex	Seed	1				
	Polygonum - triangular	Seed	1			1	
	Asteraceae	Seed			1		
	Brassicaceae	Seed			3		
	Descurainia	Seed			3		
	Chenopodium	Seed				4	
	Cyperaceae	Seed				7	
	Carex Z	Seed			8	3	
	Scirpus	Seed			1		
	cf. *Hypericum*	Seed			8		
	Juncus	Seed			12		
	Ranunculus	Seed			1		
	Trifolium	Seed			1		
	Unidentified Y	Seed				3	
	Roots					X	Few
	Rootlets					X	Numerous
	Sclerotia				16		
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.79 g
	Conifer	Charcoal		2			0.01 g
	Conifer	Charcoal		lic			0.03 g
	Larix occidentalis			17			0.56 g
	Bark scale			1			0.01 g
	Wood					X	

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MFJD-017-1	NON-FLORAL REMAINS:						
0-20 cm	Insect	Chitin				X	Numerous
	Insect	Egg			X		Few
	Rock/Gravel					X	Few
MFJD-017-2	Light Fraction Weight						21.01 g
20-40 cm	FLORAL REMAINS:						
	Poaceae C (linear)	Caryopsis	4*				
	Vitrified tissue			1			< 0.01 g
	Brassicaceae	Seed			4*		
	Carex W	Seed			4*		
	Carex X	Seed			8*	24*	
	Carex Y	Seed			4*		
	Carex Z	Seed			48*		
	cf. *Hypericum*	Seed				8*	
	Juncus	Seed			12*		
	Poaceae C (oblong)	Caryopsis			4*		
	Roots					X	Moderate
	Rootlets					X	Numerous
	Sclerotia					X	Few
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						3.41 g
	Conifer - vitrified	Charcoal		1			0.21 g
	Larix occidentalis	Charcoal		30			0.75 g
	Pinus	Charcoal		6			0.91 g
	Pinus twig	Charcoal		3			0.07 g
	Wood					X	
	NON-FLORAL REMAINS:						
	Insect	Chitin				8	
	Insect	Egg				1	
	Rock/Gravel					X	Few

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MFJD-017-3	Light fraction Weight						12.08 g
40-60 cm	FLORAL REMAINS:						
	Polygonum - triangular	Seed	1				
	Unidentified P	Seed	1	1			
	Bark		1				< 0.01 g
	Vitrified tissue			20			0.02 g
	Ranunculus	Seed		1			
	Roots					X	Few
	Rootlets					X	Moderate
	Sclerotia				8		Few
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.33 g
	Conifer	Charcoal		2			0.01 g
	Larix occidentalis	Charcoal		7			0.05 g
	Pinus	Charcoal		3			0.06 g
	Unidentified hardwood - vitrified	Charcoal		1			0.02 g
	Unidentified hardwood - twig	Charcoal		2			0.07 g
	Unidentifiable - vitrified	Charcoal		6			0.10 g
	Monocot/Herbaceous dicot stem			1			0.01 g
	NON-FLORAL REMAINS:						
	Rocks/Gravel					X	Moderate
MFJD-017-4	Light fraction Weight						0.82 g
60-80 cm	FLORAL REMAINS:						
	Roots					X	Few
	Rootlets					X	Numerous
	Sclerotia				13		
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.01 g
	Artemisia	Charcoal		1			< 0.01 g
	Conifer	Charcoal		3			< 0.01 g
	Pinus	Charcoal		1			< 0.01 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	Moderate

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MFJD-019-1	Light Fraction Weight						15.74 g
0-25 cm	FLORAL REMAINS:						
	Pinus	Bark scale		1			< 0.01 g
	Poaceae C	Caryopsis	2				
	Unidentified	Seed	1				
	Vitrified tissue < 1 mm			X			Few
	Calandrinia	Seed			1		
	Carex Z	Seed			1		
	Montia	Seed			1	1	
	Polygonum pennsylvanicum-type	Seed			1		
	Rootlets					X	Moderate
	Roots					X	Numerous
	Sclerotia				X		Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.23 g
	Alnus	Charcoal		1			0.01 g
	Conifer	Charcoal		4			0.03 g
	Conifer - vitrified	Charcoal		4			0.06 g
	Larix occidentalis	Charcoal		4			0.04 g
	Pinus	Charcoal		7			0.07 g
	Unidentifiable - vitrified	Charcoal		4			0.02 g
	Total wood ≥ 2 mm						2.19 g
	Pinus	Wood				20	0.95 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				8	
	Rock/Gravel					X	Few
	Worm casts					X	Few

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MFJD-019-2	Light Fraction Weight						8.57 g
25-40 cm	FLORAL REMAINS:						
	Lonicera	Seed	1				
	Unidentified	Fruit		3			
	Bark			X			Few
	Vitrified tissue ≥ 2 mm			8			0.01 g
	Vitrified tissue < 2 mm			X			Few
	Carex W	Seed			1		
	Carex Z	Seed			2		
	Poaceae	Floret				1	
	Polygonum - triangular	Seed			1		
	Trifolium	Seed			1		
	Unidentified	Seed				1	
	Roots					X	Few
	Rootlets					X	Numerous
	Sclerotia				X		Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.39 g
	Alnus	Charcoal		4			0.01 g
	Asteraceae root	Charcoal		1			0.01 g
	Conifer	Charcoal		2			0.01 g
	Conifer - vitrified	Charcoal		7			0.05 g
	Conifer - twig	Charcoal		1			< 0.01 g
	Conifer - root	Charcoal		1			0.02 g
	Larix occidentalis	Charcoal		5			0.09 g
	Pinus	Charcoal		6			0.08 g
	Unidentified hardwood	Charcoal		2			0.01 g
	Unidentified hardwood - root	Charcoal		1			0.02 g
	Total wood ≥ 2 mm						0.22 g
	Pinus	Wood				20	0.20 g
	NON-FLORAL REMAINS:						
	Bone - calcined ≥ 1 mm			3			
	Insect	Chitin				31	
	Rock/Gravel					X	Few

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MFJD-019-3	Light fraction Weight						10.66 g
40-55 cm	FLORAL REMAINS:						
	Carex	Seed	6				
	Arctostaphylos	Seed		1			
	Asteraceae	Seed	1				
	cf. Fabaceae	Seed		1			
	Poaceae C	Caryopsis	2				
	Unidentified	Fruit		2			
	Unidentified	Seed		2			
	Bark			2			
	Vitrified tissue ≥ 2 mm			2			0.01 g
	Vitrified tissue < 2 mm			X			0.05 g
	Carex Z	Seed			2		
	Montia	Seed				1	
	Roots					X	Few
	Rootlets					X	Numerous
	Sclerotia				X	X	Abundant
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.71 g
	Arctostaphylos	Charcoal		1			0.01 g
	Conifer	Charcoal		5			0.05 g
	Conifer - vitrified	Charcoal		1			0.01 g
	Pinus	Charcoal		6			0.06 g
	Larix occidentalis	Charcoal		30			0.27 g
	Unidentifiable hardwood	Charcoal		1			0.01 g
	Unidentifiable - vitrified	Charcoal		2			0.13 g
	Total wood weight > 2 mm						0.04 g
	Pinus	Wood				7	0.04 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	Few

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MFJD-019-4	Light Fraction Weight						4.60 g
55-70 cm	FLORAL REMAINS:						
	Conifer	Cone scale		8			0.02 g
	Poaceae C	Caryopsis	2	1			
	Unidentified	Seed	3				
	Bark			28			0.02 g
	Vitrified tissue ≥ 2 mm			5			< 0.01 g
	Vitrified tissue < 2 mm			X			Numerous
	Roots					X	Few
	Rootlets					X	Numerous
	Sclerotia				X	X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.17 g
	Alnus	Charcoal		1			< 0.01 g
	Conifer	Charcoal		1			< 0.01 g
	Conifer - vitrified	Charcoal		8			0.04 g
	Conifer - twig	Charcoal		1			0.01 g
	Larix occidentalis	Charcoal		6			0.05 g
	Pinus	Charcoal		4			0.03 g
	Salicaceae	Charcoal		2			< 0.01 g
	Unidentifiable - hardwood	Charcoal		1			< 0.01 g
	Unidentifiable - vitrified	Charcoal		1			< 0.01 g
	Total wood ≥ 2 mm						0.01 g
	Conifer - cf. *Pinus*	Wood				4	0.01 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				5	
	Rock/Gravel					X	Few
MFJD-015-1	CHARCOAL/WOOD:						
	Larix occidentalis	Wood				1	251.51 g
MFJD-018-1	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						3.50 g
	Larix occidentalis	Wood				20	2.51 g

TABLE 3 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
MFJD-016-1	Water-screened Sample Weight						0.17 g
42 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						
	Larix occidentalis - slightly vitrified	Charcoal		3			0.09 g
	NON-FLORAL REMAINS:						
	Sand					X	
MFJD-016-2	Water-screened Sample Weight						0.59 g
27 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						
	Larix occidentalis - slightly vitrified	Charcoal		2			0.005 g
	Pinus twig	Charcoal		13			0.01 g
	NON-FLORAL REMAINS:						
	Rock/Gravel						
MFJD-016-3	Water-screened Sample Weight						1.40 g
57 cm	FLORAL REMAINS:						
	Rootlets					X	Few
	CHARCOAL/WOOD:						
	Pinus	Charcoal	15				0.01 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	Few

W = Whole
F = Fragment
X = Presence noted in sample
g = grams
ic= Incompletely charred

TABLE 4
INDEX OF MACROFLORAL REMAINS RECOVERED FROM
ALONG THE MIDDLE FORK JOHN DAY RIVER, OREGON

Scientific Name	Common Name
FLORAL REMAINS:	
Amaranthus	Pigweed, Amaranth
Arctostaphylos	Bearberry, Manzanita, Kinnikinnick
Asteraceae	Sunflower family
Brassicaceae	Mustard family
Descurainia	Tansy mustard, Flixweed
Calandrinia	Calandrinia, Red maids
Chenopodium	Goosefoot, Pigweed
Conifer	Cone-bearing, gymnospermous trees and shrubs, mostly evergreens, including the pine, spruce, fir, juniper, cedar, yew, hemlock, redwood, and cypress
Pinus	Pine
Cyperaceae	Sedge family
Carex	Sedge
Scirpus	Bulrush, Threesquares
Fabaceae	Bean family
Trifolium	Clover
Hypericum	St. Johnswort
Juncus	Rush
Lonicera	Honeysuckle
Montia	Miners lettuce
Poaceae	Grass family
Poaceae C	Members of the grass family with small caryopses, such as *Agrostis* (bentgrass), *Muhlenbergia* (muhly grass), *Poa* (bluegrass), etc.
Polygonum - triangular (includes *P. argyrocoleon*, *P. aviculare, P. cilinode, P. convolvulus, P. douglasii, P. dumetorum, P. erectum, P. hydropiper, P. hydropiperoides, P. punctatum, P. ramosissimum, P. sagittatum, P. scandens*)	Smartweed; Knotweed (seeds are triangular in cross-section)
Polygonum pennsylvanicum-type	Smartweed; Knotweed

TABLE 4 (Continued)

Scientific Name	Common Name
Ranunculus	Buttercup
Unidentified	
Parenchymous tissue	Relatively undifferentiated tissue composed of many similar thin-walled cells–occurs in different plant organs in varying amounts, especially large fleshy organs such as roots and stems
Vitrified tissue	Charred material with a shiny, glassy appearance due to fusion by heat
Sclerotia	Resting structures of mycorrhizae fungi
CHARCOAL/WOOD:	
Alnus	Alder
Arctostaphylos	Bearberry, Manzanita, Kinnikinnick
Asteraceae	Sunflower family
Artemisia	Sagebrush
Conifer	Cone-bearing, gymnospermous trees and shrubs, mostly evergreens, including the pine, spruce, fir, juniper, cedar, yew, hemlock, redwood, and cypress
Larix occidentalis	Western larch
Pinus	Pine
Tsuga	Hemlock
Monocot/Herbaceous dicot	A member of the Monocotyledonae class of Angiosperms, which include grasses, sedges, lilies, and palms/A non-woody member of the Dicotyledonae class of Angiosperms
Salicaceae	Willow family
Unidentified hardwood	Wood from a broad-leaved flowering tree or shrub
Unidentified hardwood - small	Wood from a broad-leaved flowering tree or shrub, fragments too small for further identification
Unidentified hardwood - vitrified	Wood from a broad-leaved flowering tree or shrub, exhibiting a shiny, glassy appearance due to fusion by heat
Unidentifiable - vitrified	Charcoal exhibiting a shiny, glassy appearance due to fusion by heat

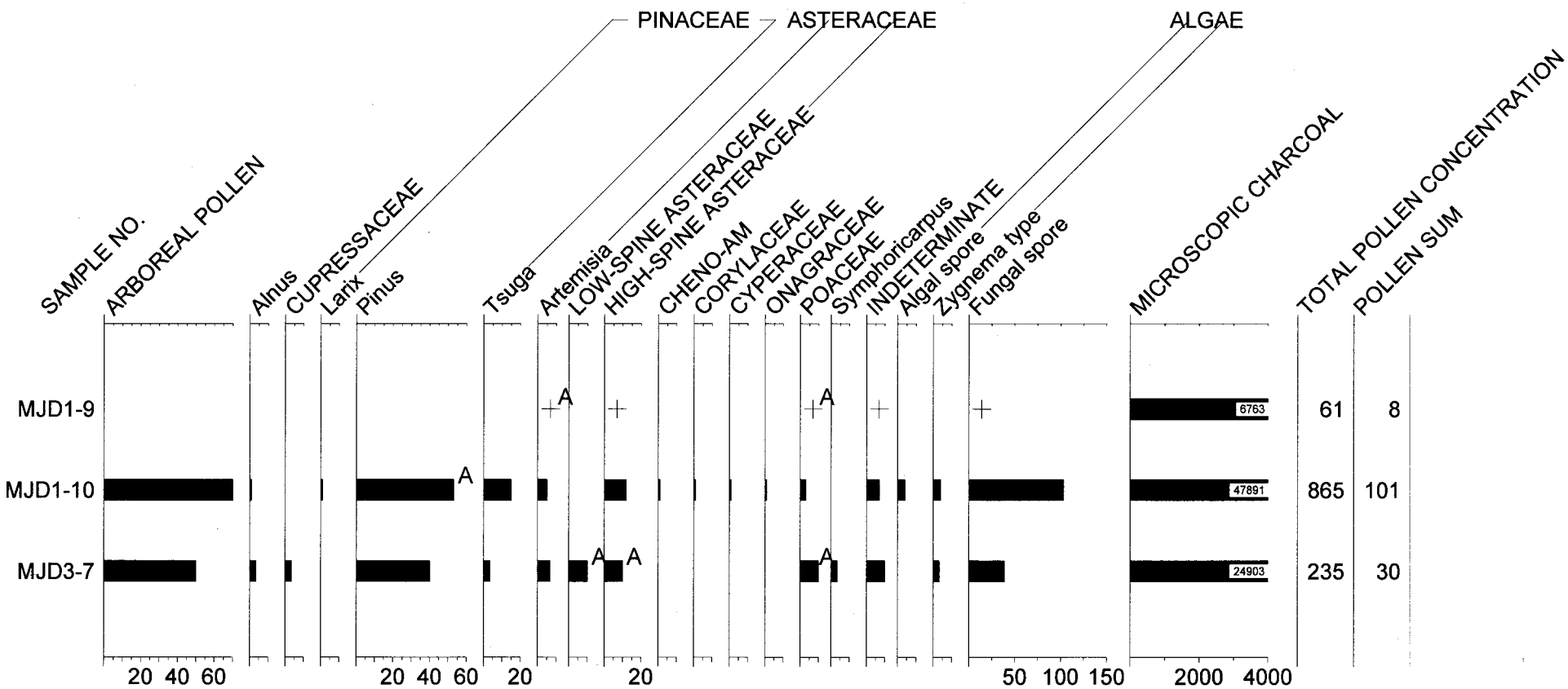

FIGURE 1. POLLEN DIAGRAM FOR MIDDLE FORK JOHN DAY, OREGON.

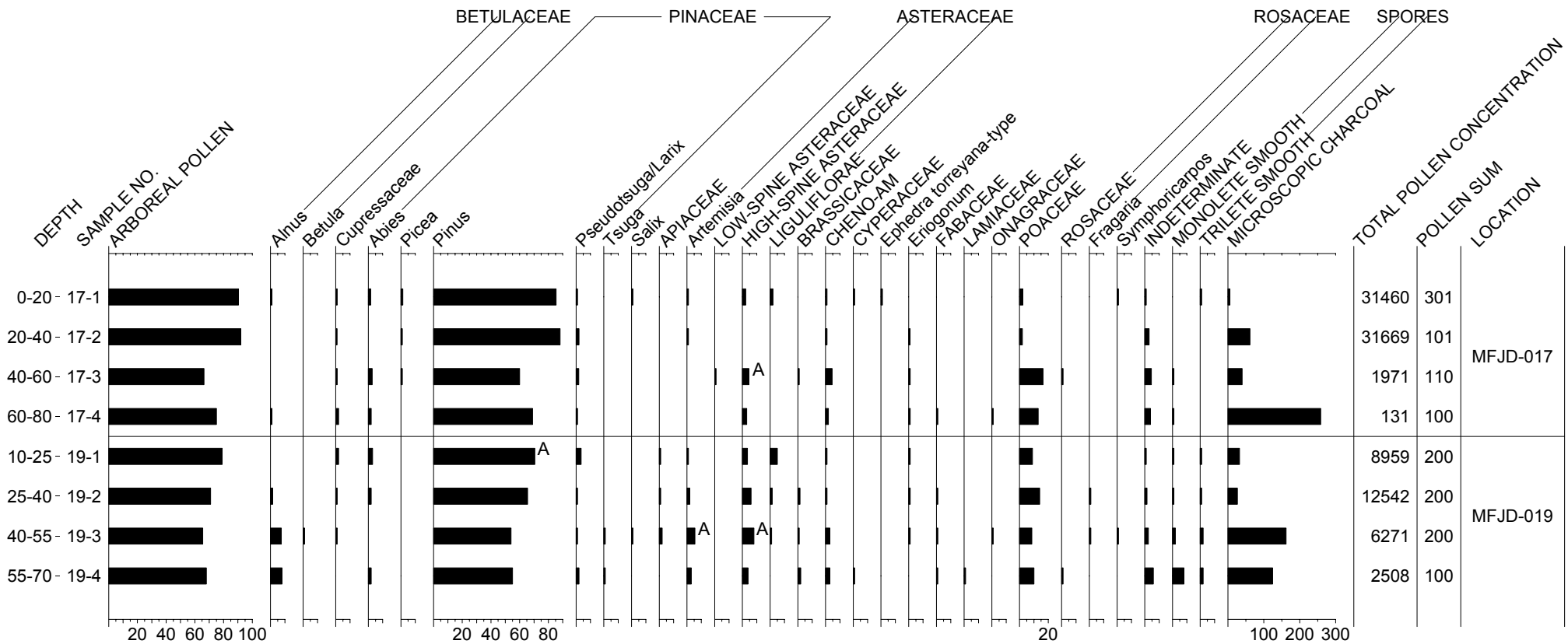

FIGURE 2. POLLEN DIAGRAM FOR MIDDLE FORK JOHN DAY RIVER, OREGON.

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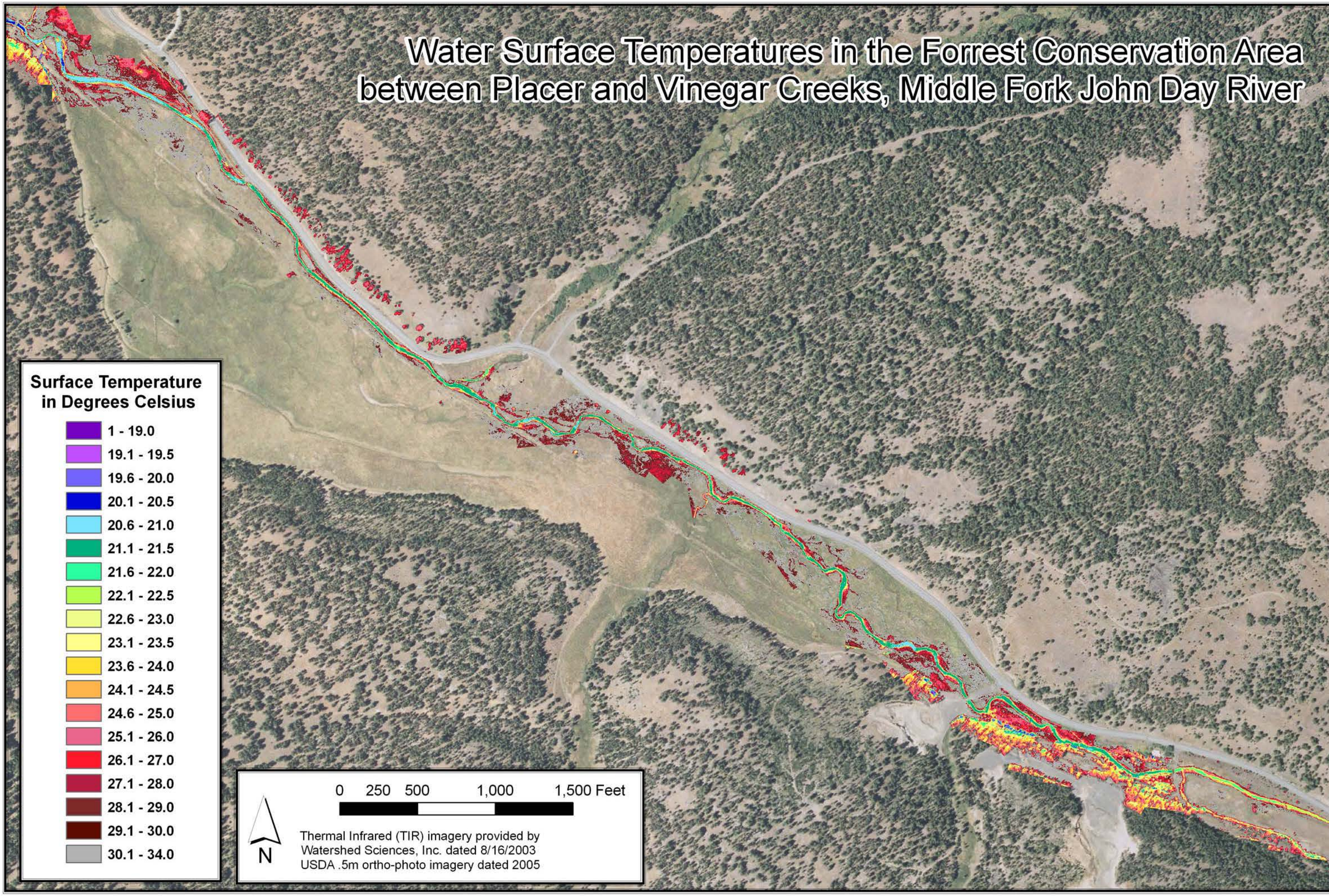
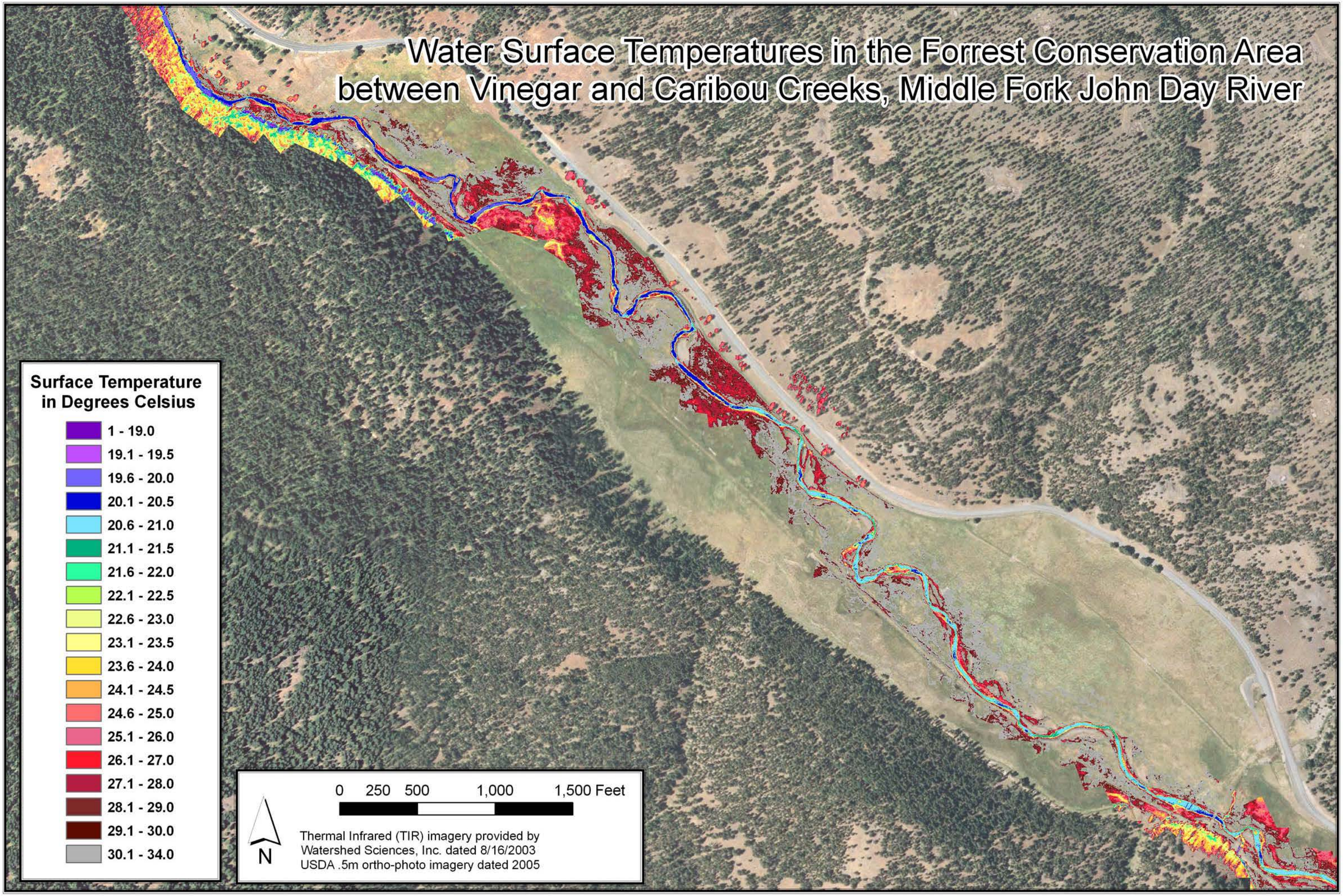
Appendix 3

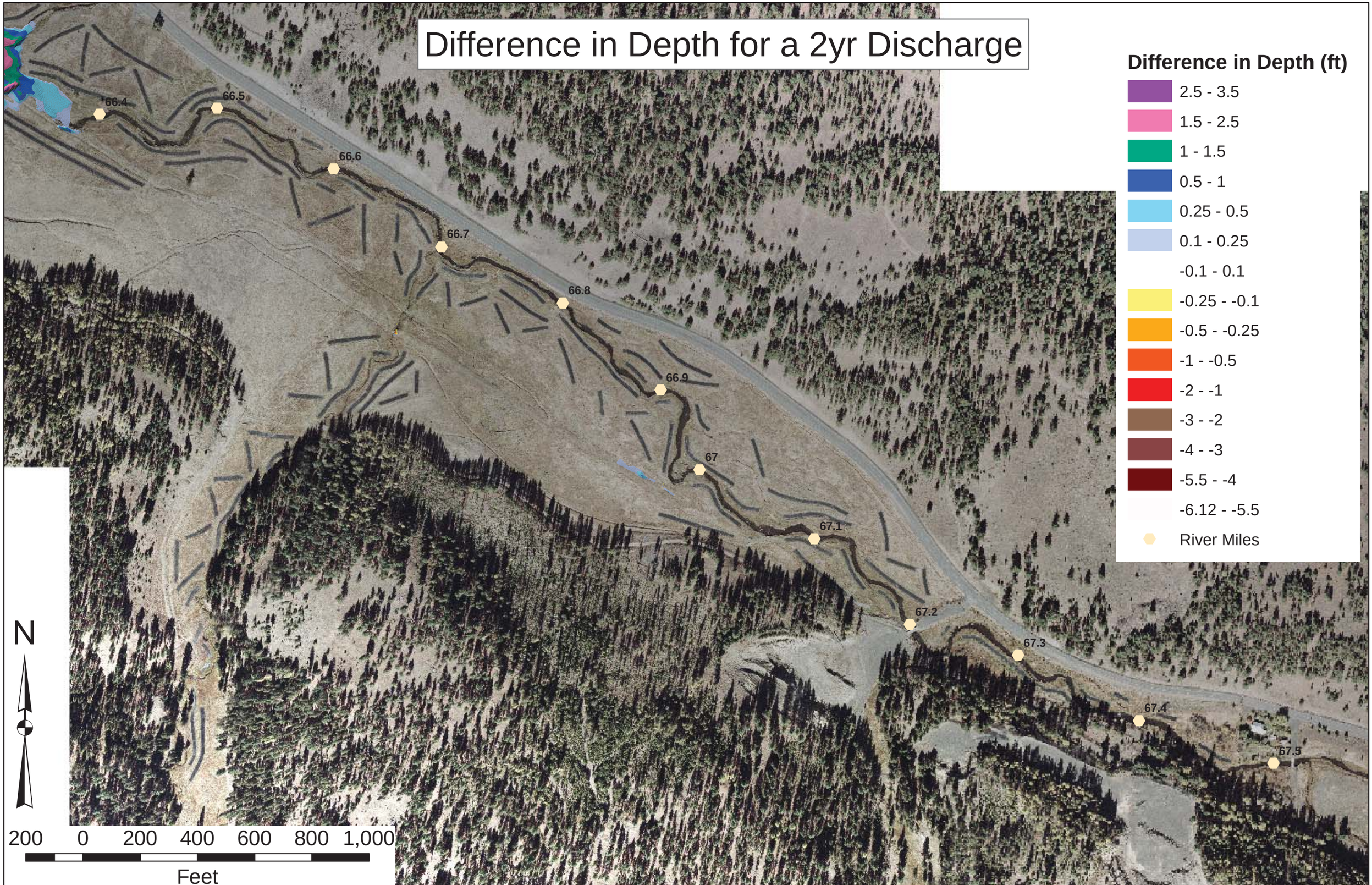
Water Surface Temperatures in the Forrest Conservation Area between Placer and Vinegar Creeks, Middle Fork John Day River

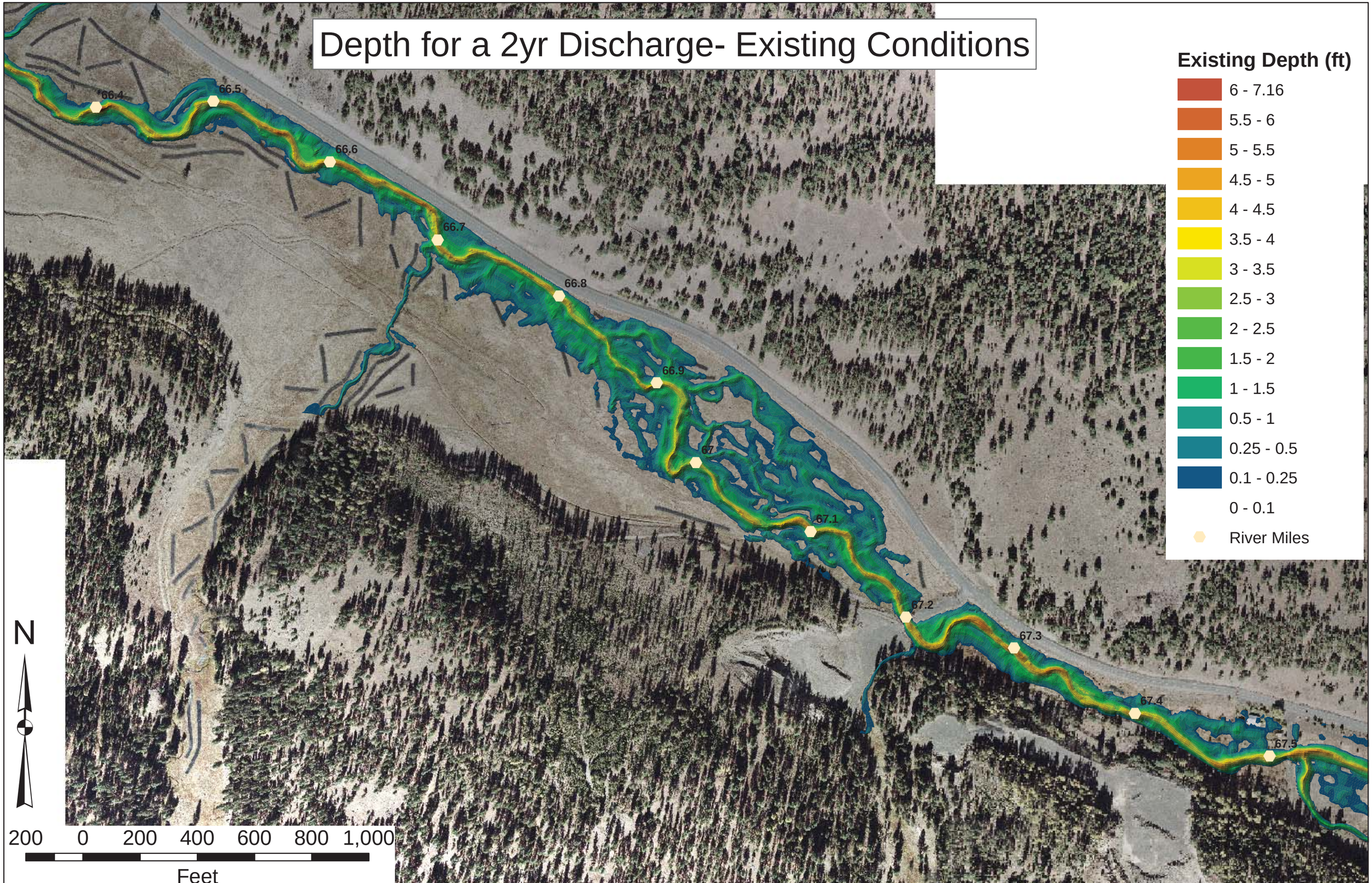


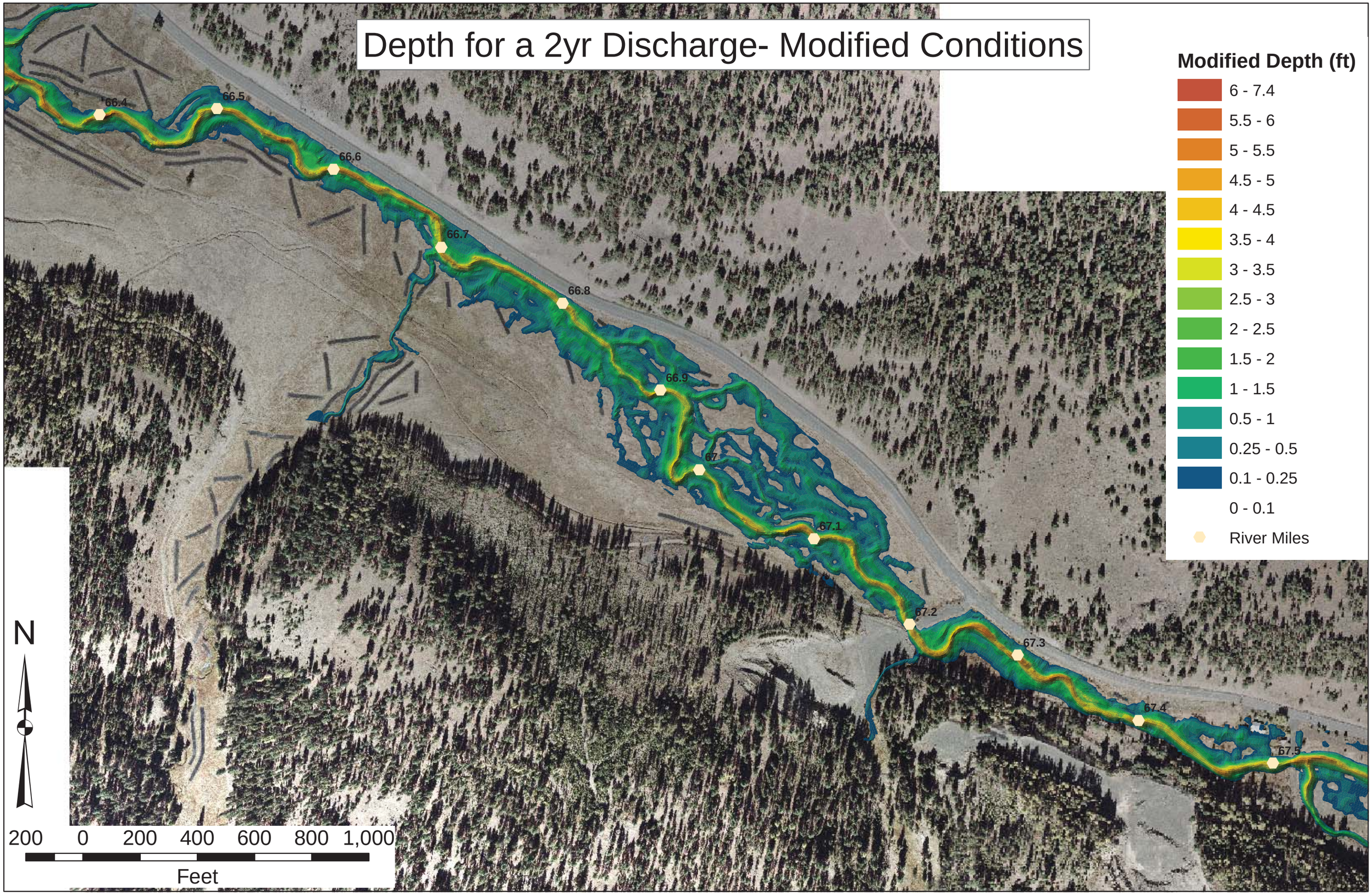

Water Surface Temperatures in the Forrest Conservation Area
between Vinegar and Caribou Creeks, Middle Fork John Day River
Surface Temperature
in Degrees Celsius
1 - 19.0
19.1 - 19.5
19.6 - 20.0
20.1 - 20.5
20.6 - 21.0
21.1 - 21.5
21.6 - 22.0
22.1 - 22.5
22.6 - 23.0
23.1 - 23.5
23.6 - 24.0
24.1 - 24.5
24.6 - 25.0
25.1 - 26.0
26.1 - 27.0
27.1 - 28.0
28.1 - 29.0
29.1 - 30.0
30.1 - 34.0
0 250 500 1,000 1,500 Feet
N
Thermal Infrared (TIR) imagery provided by
Watershed Sciences, Inc. dated 8/16/2003
USDA .5m ortho-photo imagery dated 2005

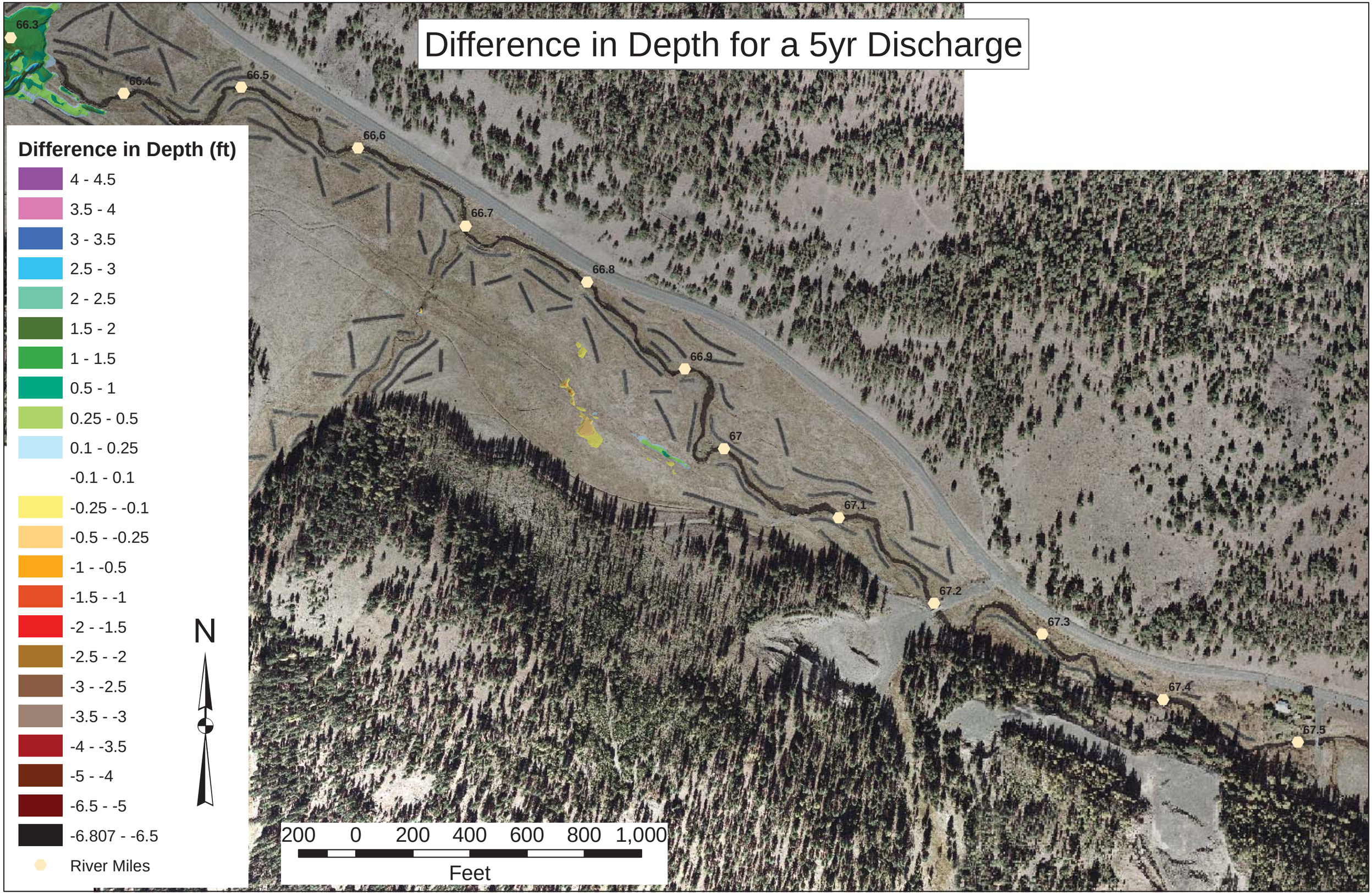
Appendix 4

Bridge Creek to Vinegar Creek

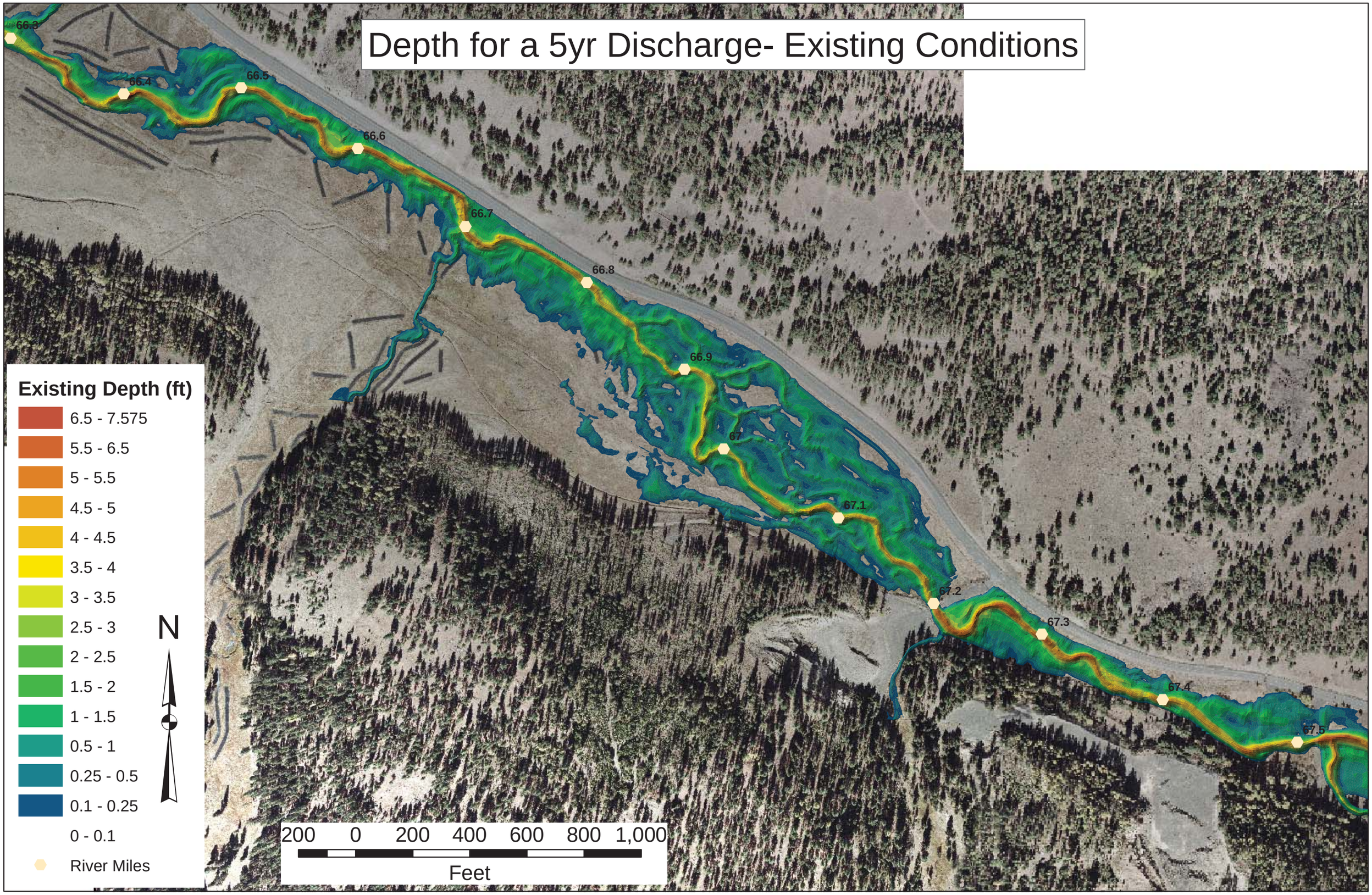

Difference in Depth for a 2yr Discharge
Difference in Depth (ft)
2.5 - 3.5
1.5 - 2.5
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-2 - -1
-3 - -2
-4 - -3
-5.5 - -4
-6.12 - -5.5
River Miles
66.4
66.5
66.6
66.7
66.8
66.9
67
67.1
67.2
67.3
67.4
67.5
N
200 0 200 400 600 800 1,000
Feet


Depth for a 2yr Discharge- Existing Conditions
Existing Depth (ft)
6 - 7.16
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
0 - 0.1
River Miles
66.4
66.5
66.6
66.7
66.8
66.9
67
67.1
67.2
67.3
67.4
67.5
N
200 0 200 400 600 800 1,000
Feet

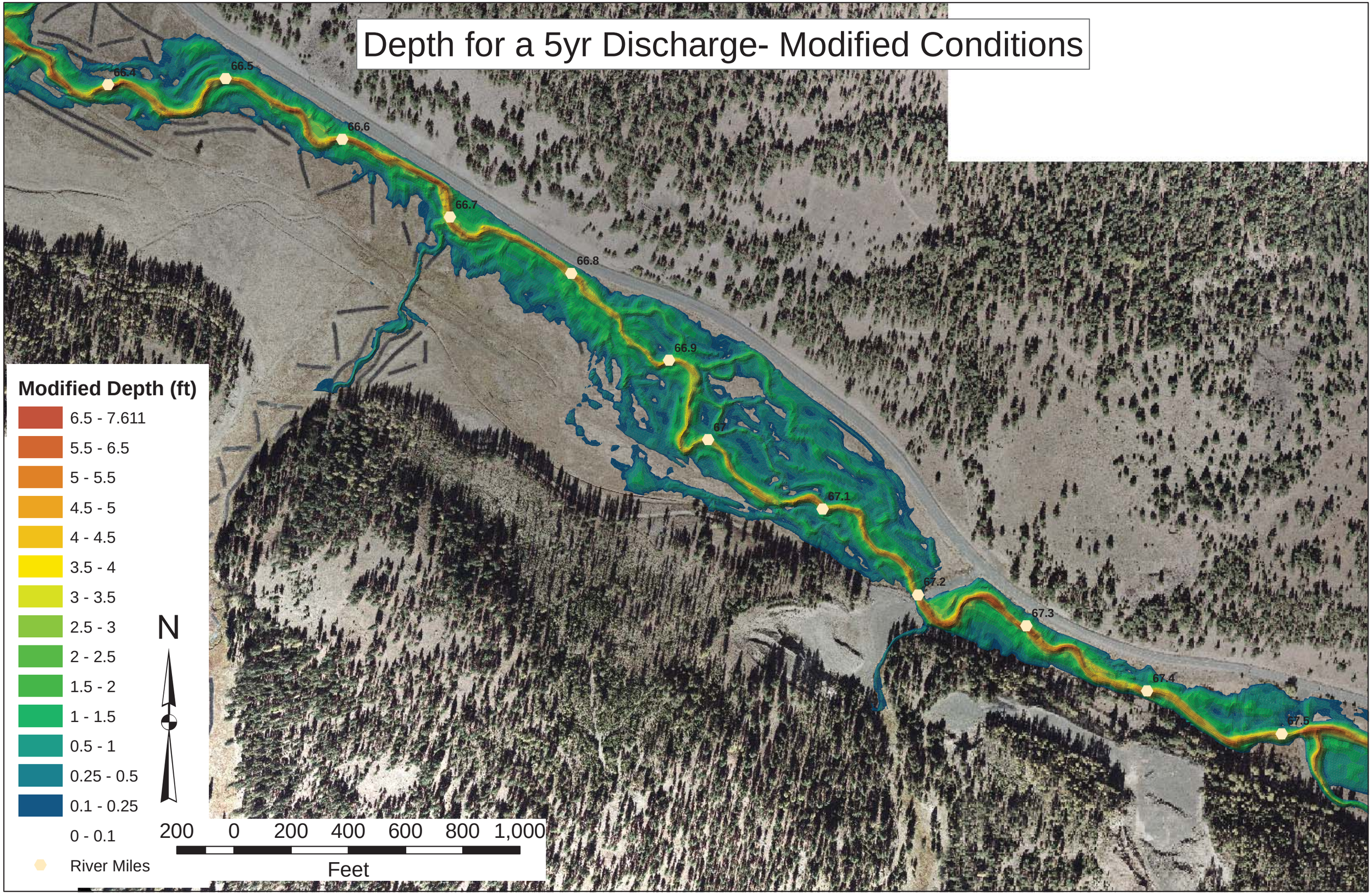

Depth for a 2yr Discharge- Modified Conditions
Modified Depth (ft)
6 - 7.4
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
0 - 0.1
River Miles
66.4
66.5
66.6
66.7
66.8
66.9
67
67.1
67.2
67.3
67.4
67.5
N
200 0 200 400 600 800 1,000
Feet

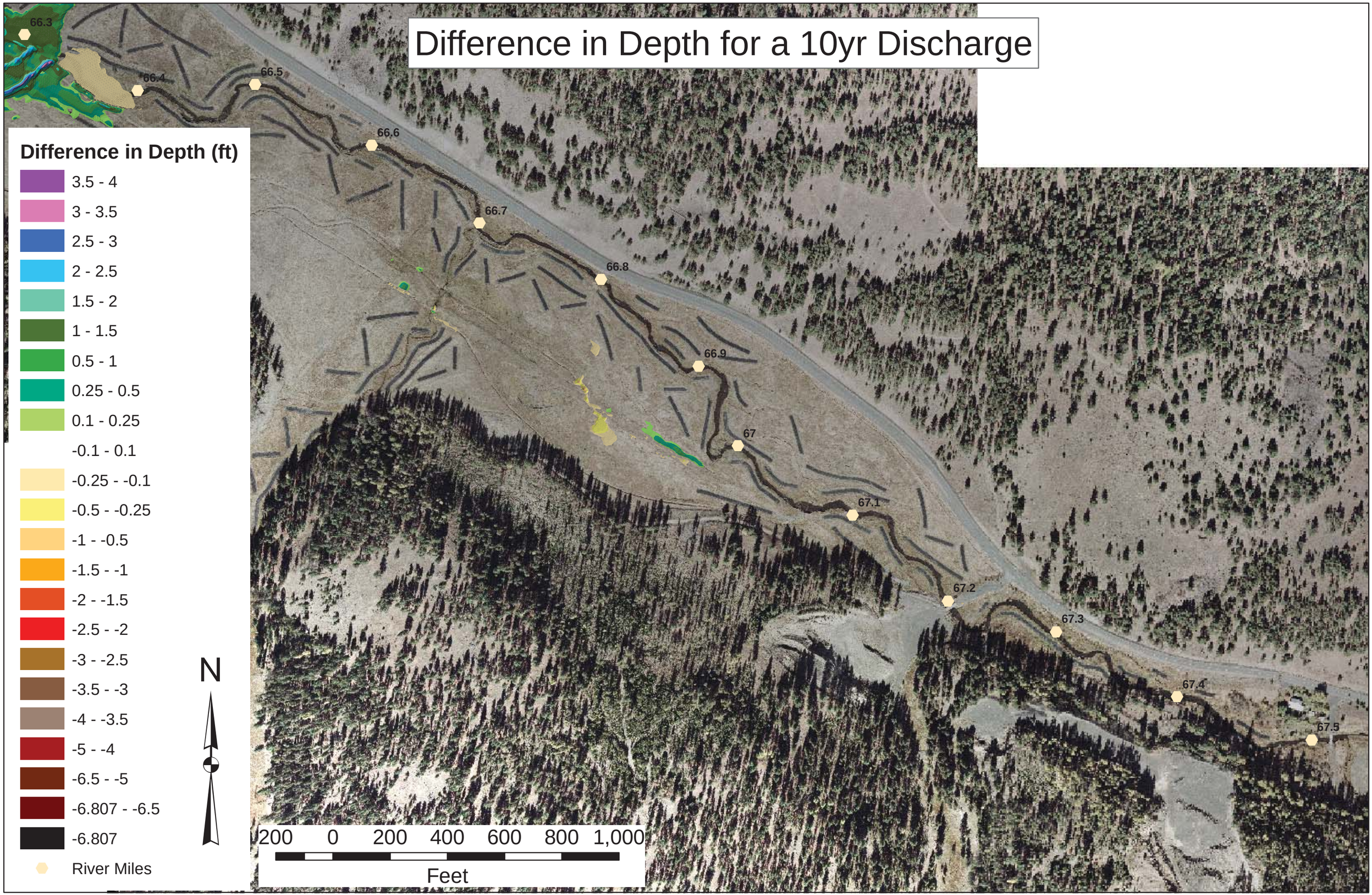

Difference in Depth for a 5yr Discharge
Difference in Depth (ft)
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
River Miles
N
200 0 200 400 600 800 1,000
Feet
66.3
66.4
66.5
66.6
66.7
66.8
66.9
67
67.1
67.2
67.3
67.4
67.5

Depth for a 5yr Discharge- Existing Conditions

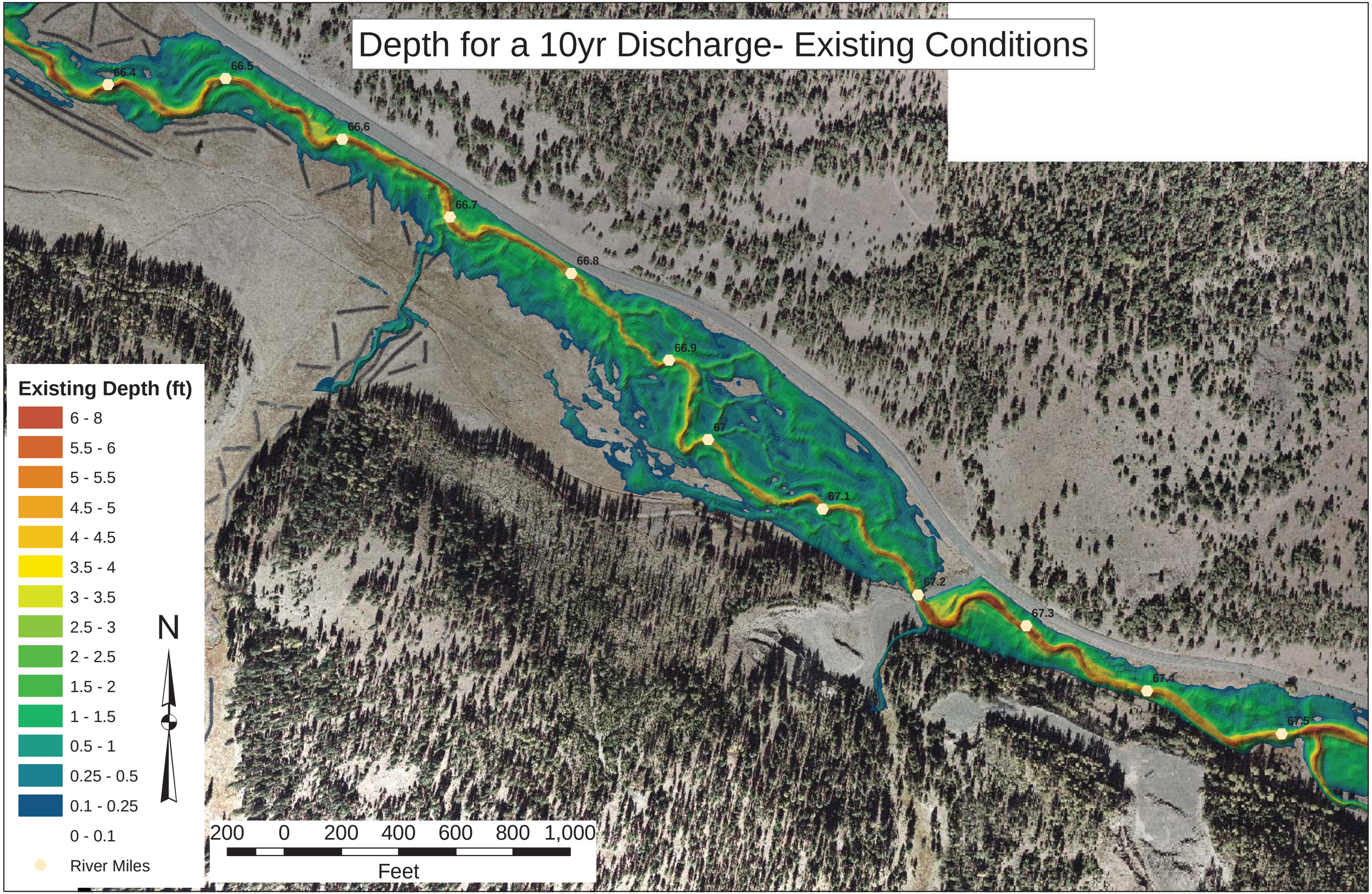


Depth for a 5yr Discharge- Modified Conditions

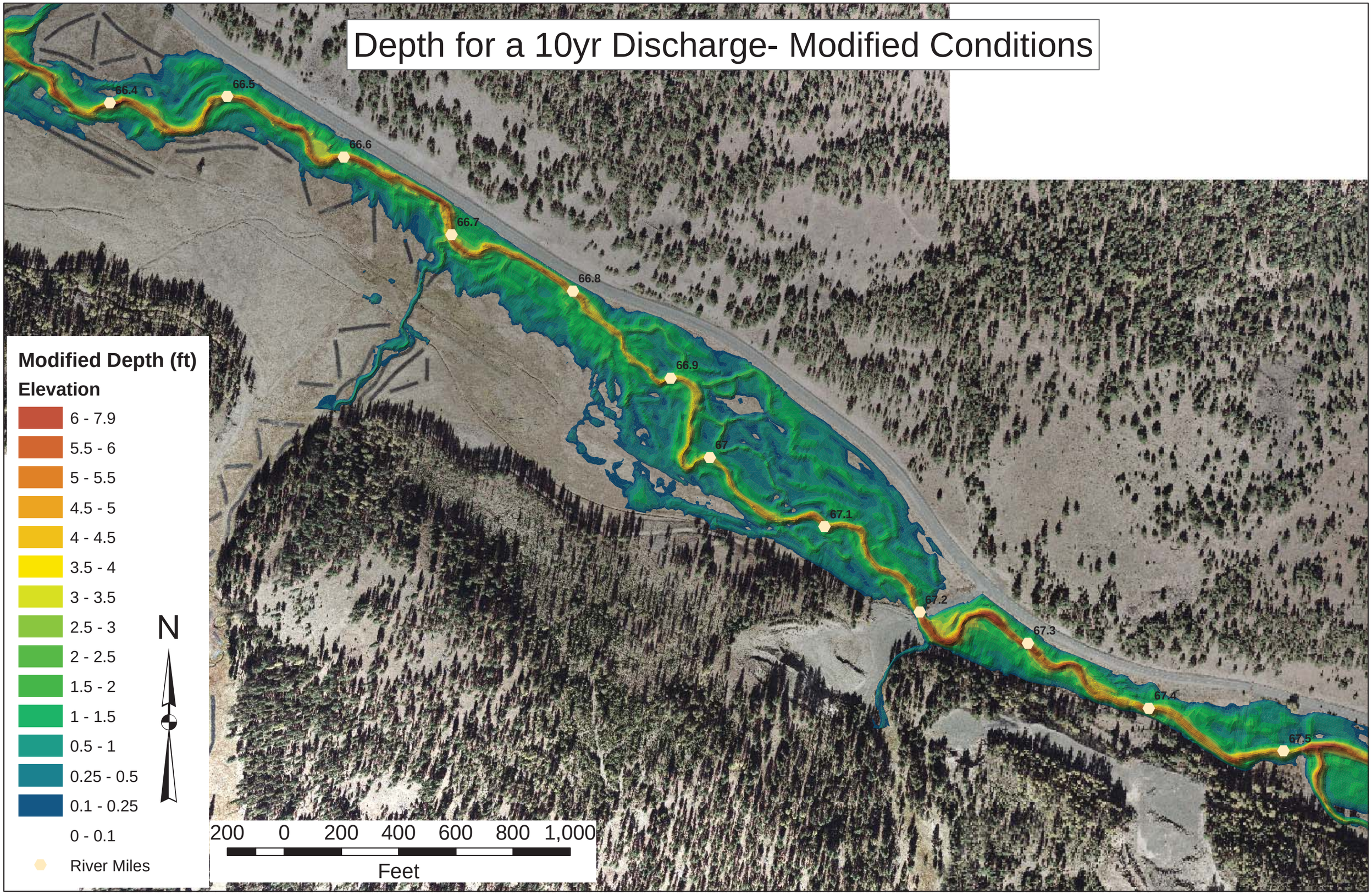


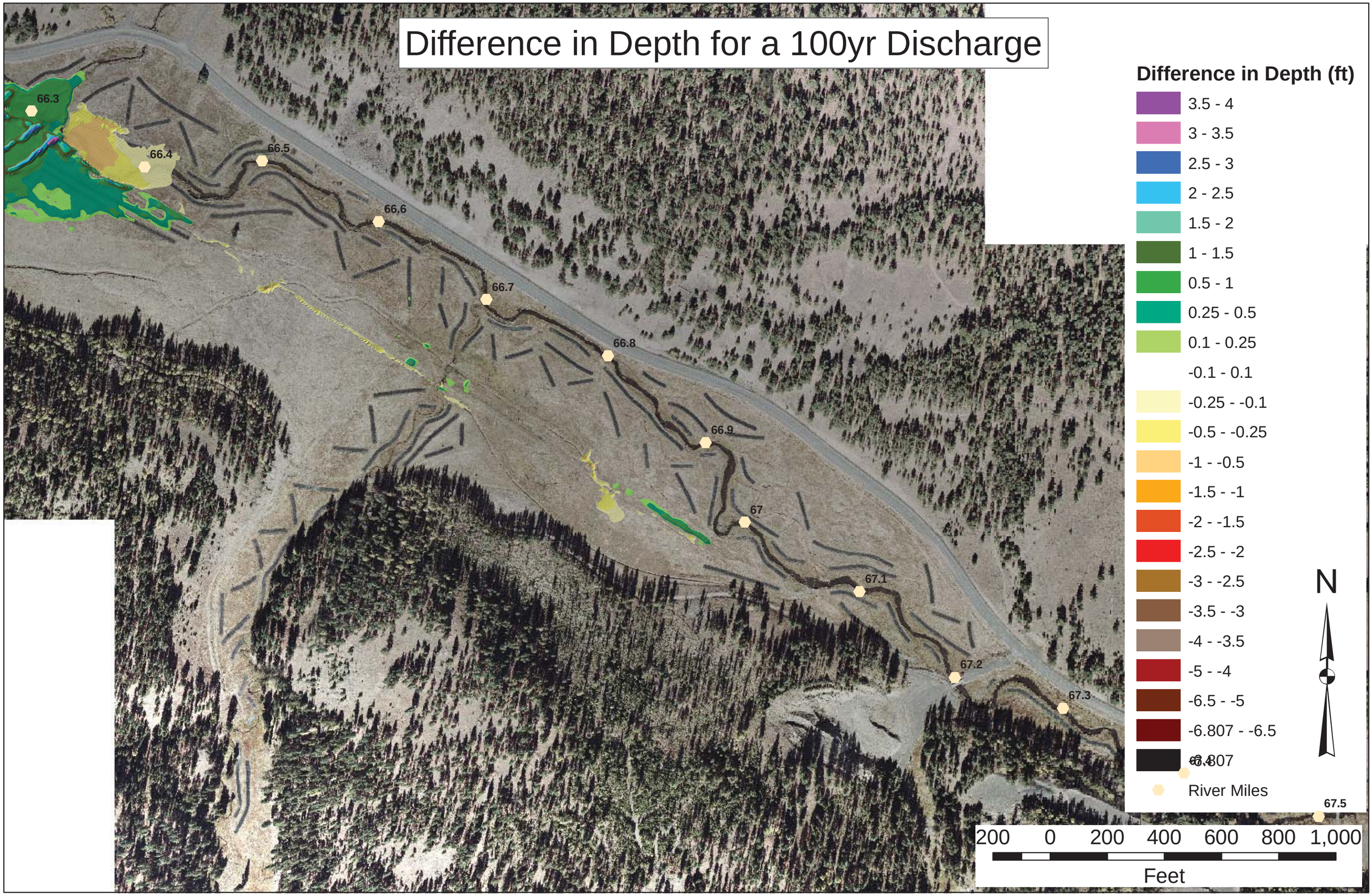

Difference in Depth for a 10yr Discharge
Difference in Depth (ft)
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
-6.807
River Miles
N
200 0 200 400 600 800 1,000
Feet
66.3
66.4
66.5
66.6
66.7
66.8
66.9
67
67.1
67.2
67.3
67.4
67.5

Depth for a 10yr Discharge- Existing Conditions

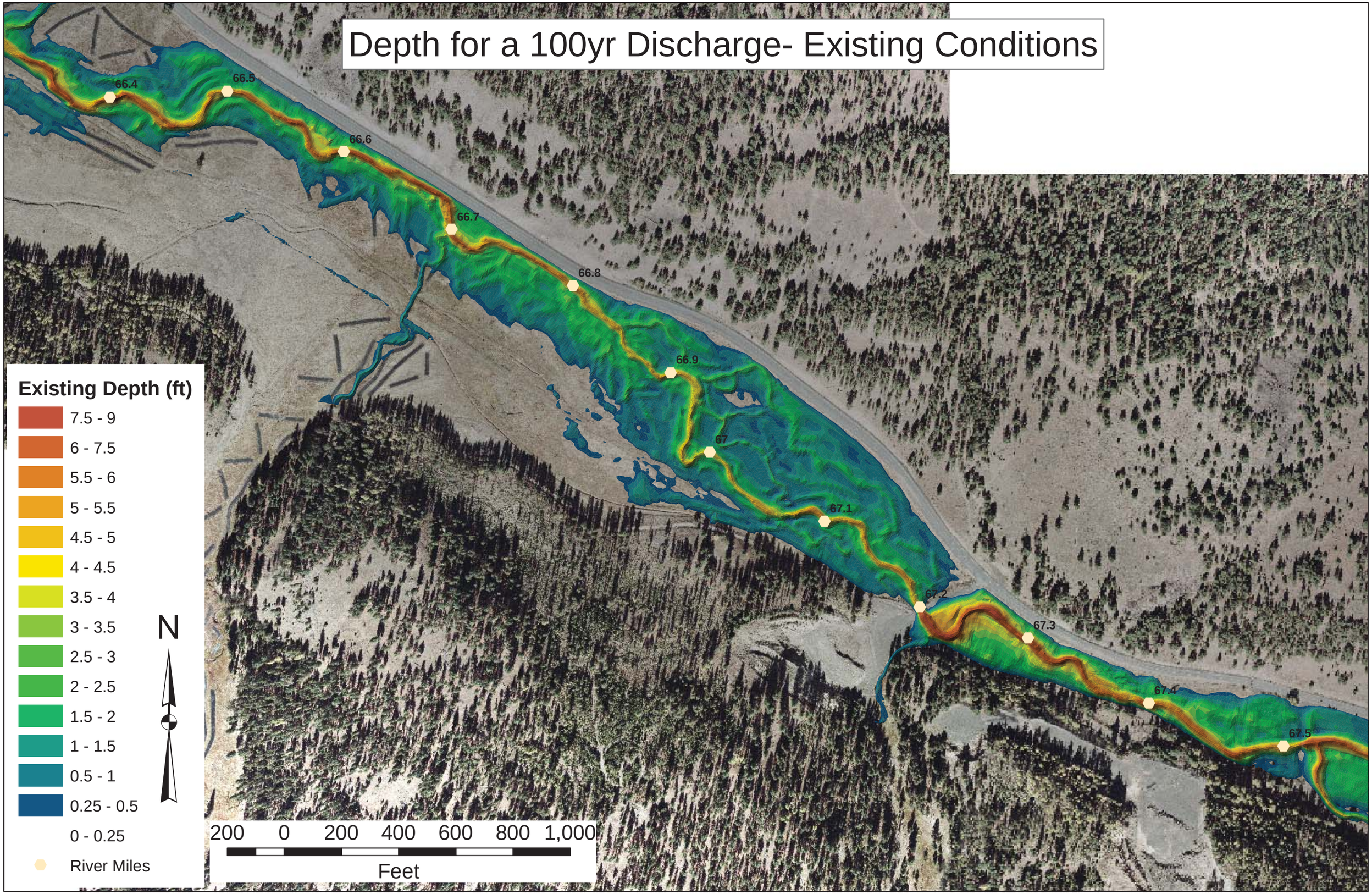


Depth for a 10yr Discharge- Modified Conditions

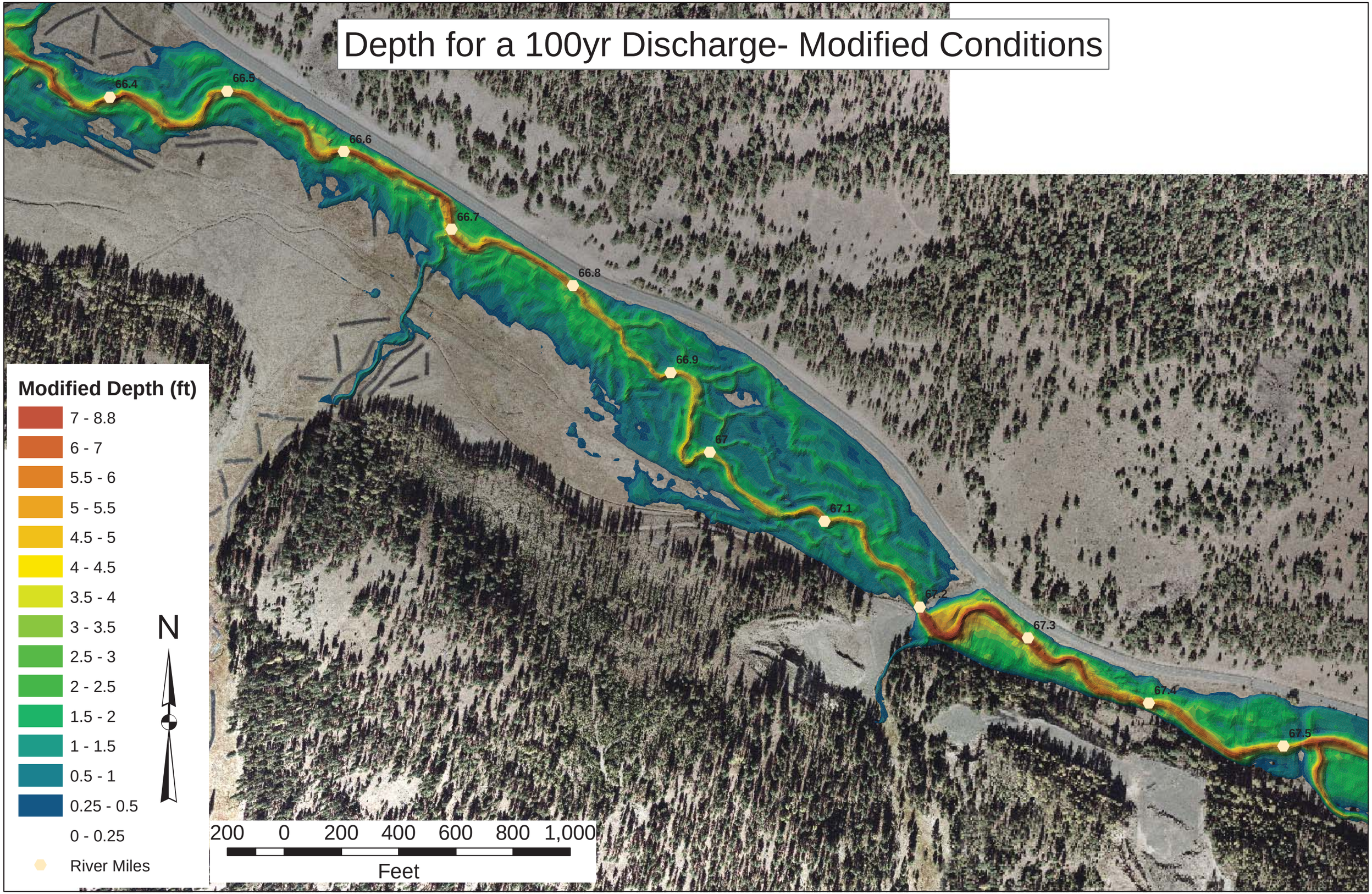



Difference in Depth for a 100yr Discharge
Difference in Depth (ft)
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
-6.807
River Miles
N
200 0 200 400 600 800 1,000
Feet
66.3
66.4
66.5
66.6
66.7
66.8
66.9
67
67.1
67.2
67.3
67.4
67.5

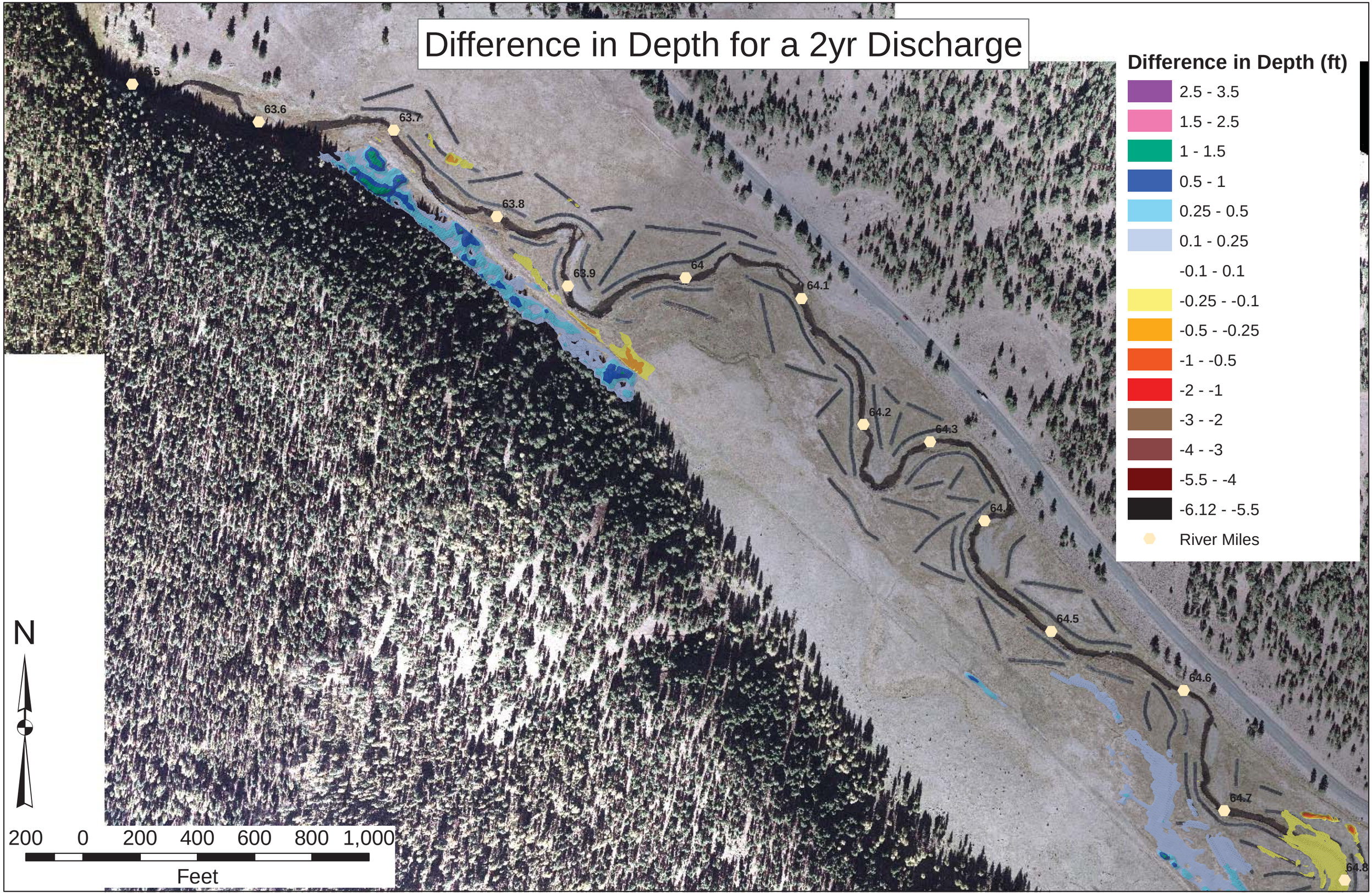
Depth for a 100yr Discharge- Existing Conditions



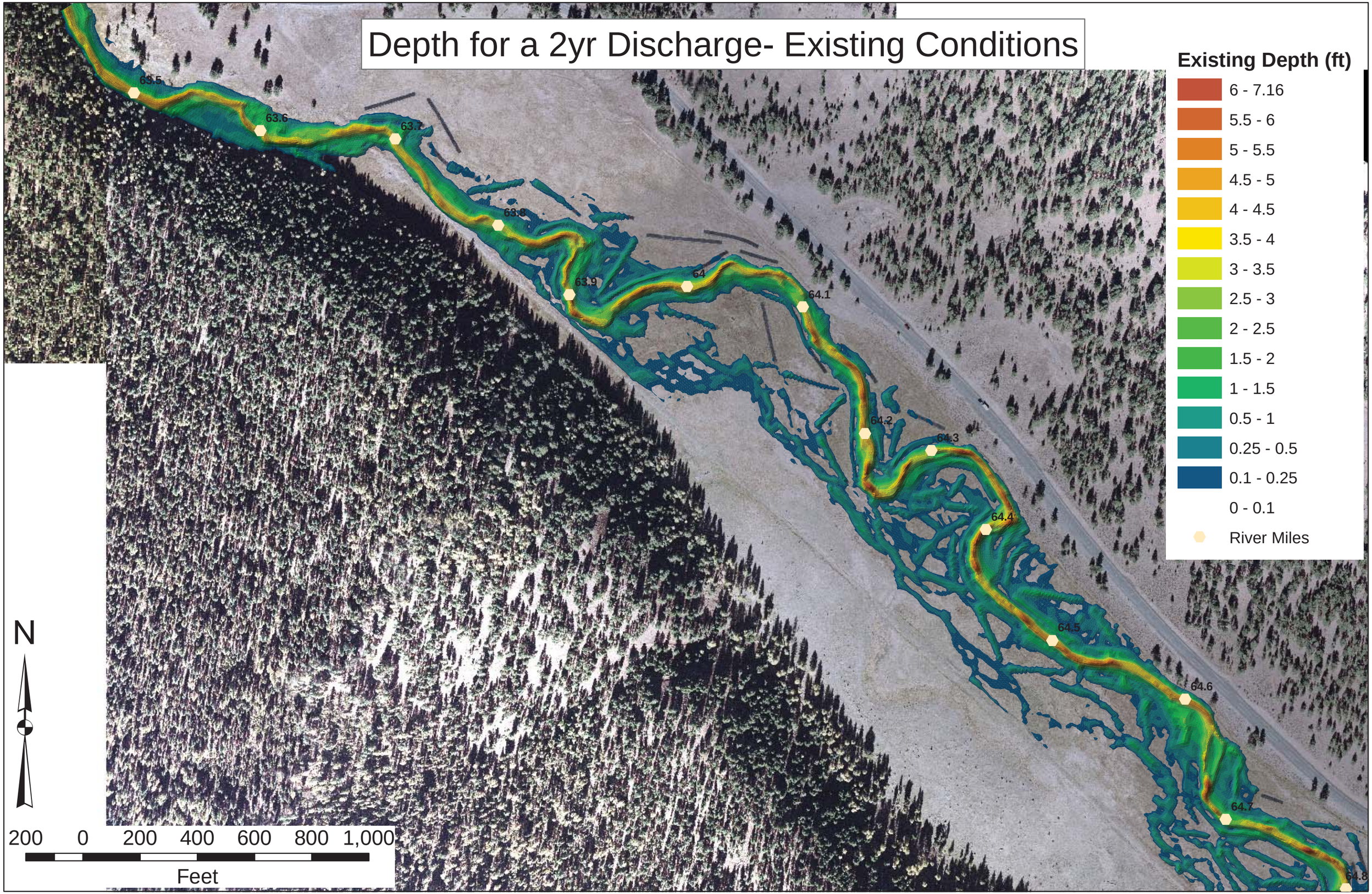
Depth for a 100yr Discharge- Modified Conditions



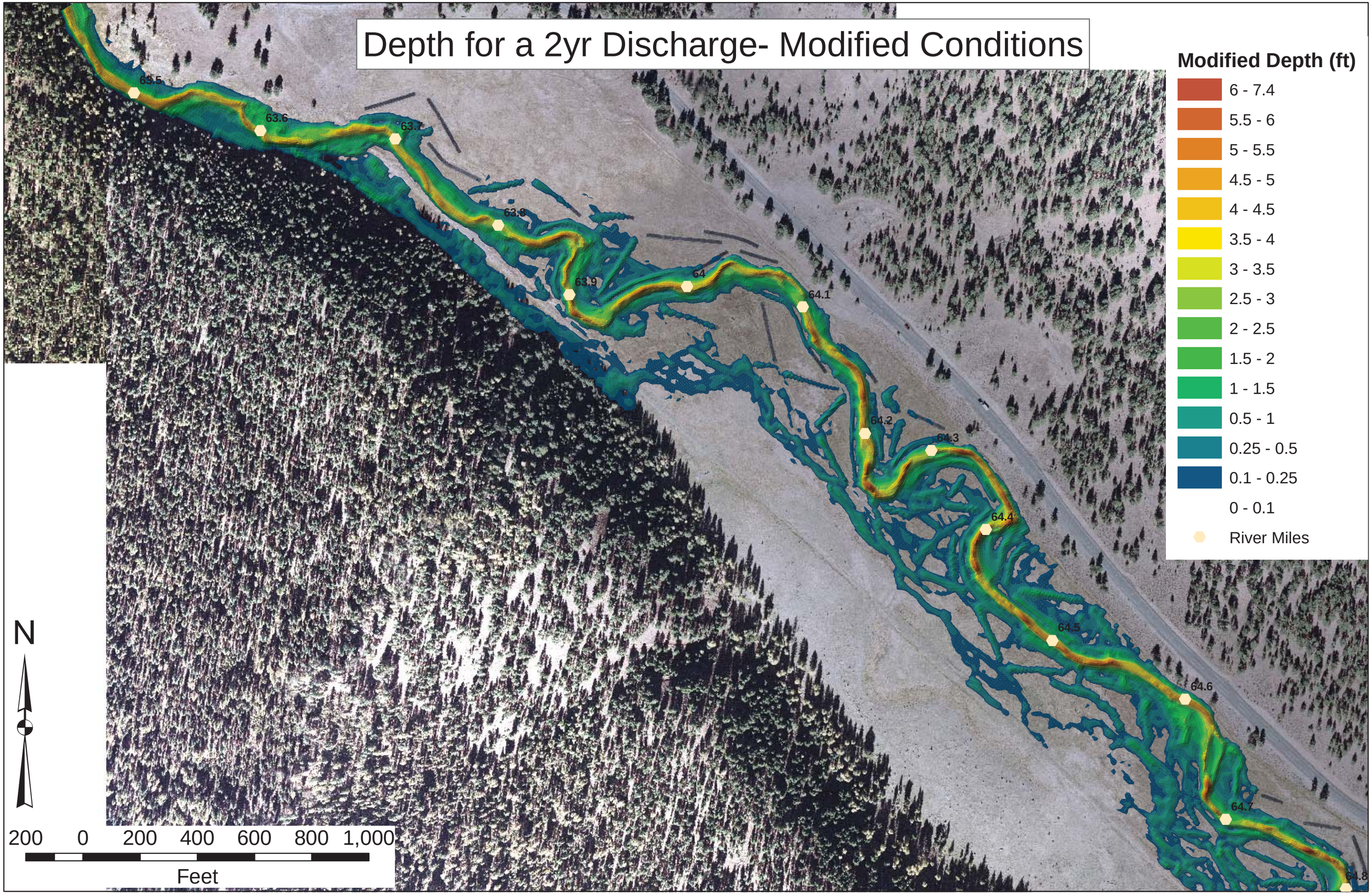
River Mile 65 to Downstream Boundary


Difference in Depth for a 2yr Discharge
Difference in Depth (ft)
2.5 - 3.5
1.5 - 2.5
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-2 - -1
-3 - -2
-4 - -3
-5.5 - -4
-6.12 - -5.5
River Miles
63.6
63.7
63.8
63.9
64
64.1
64.2
64.3
64.5
64.6
64.7
64.8
N
200 0 200 400 600 800 1,000
Feet

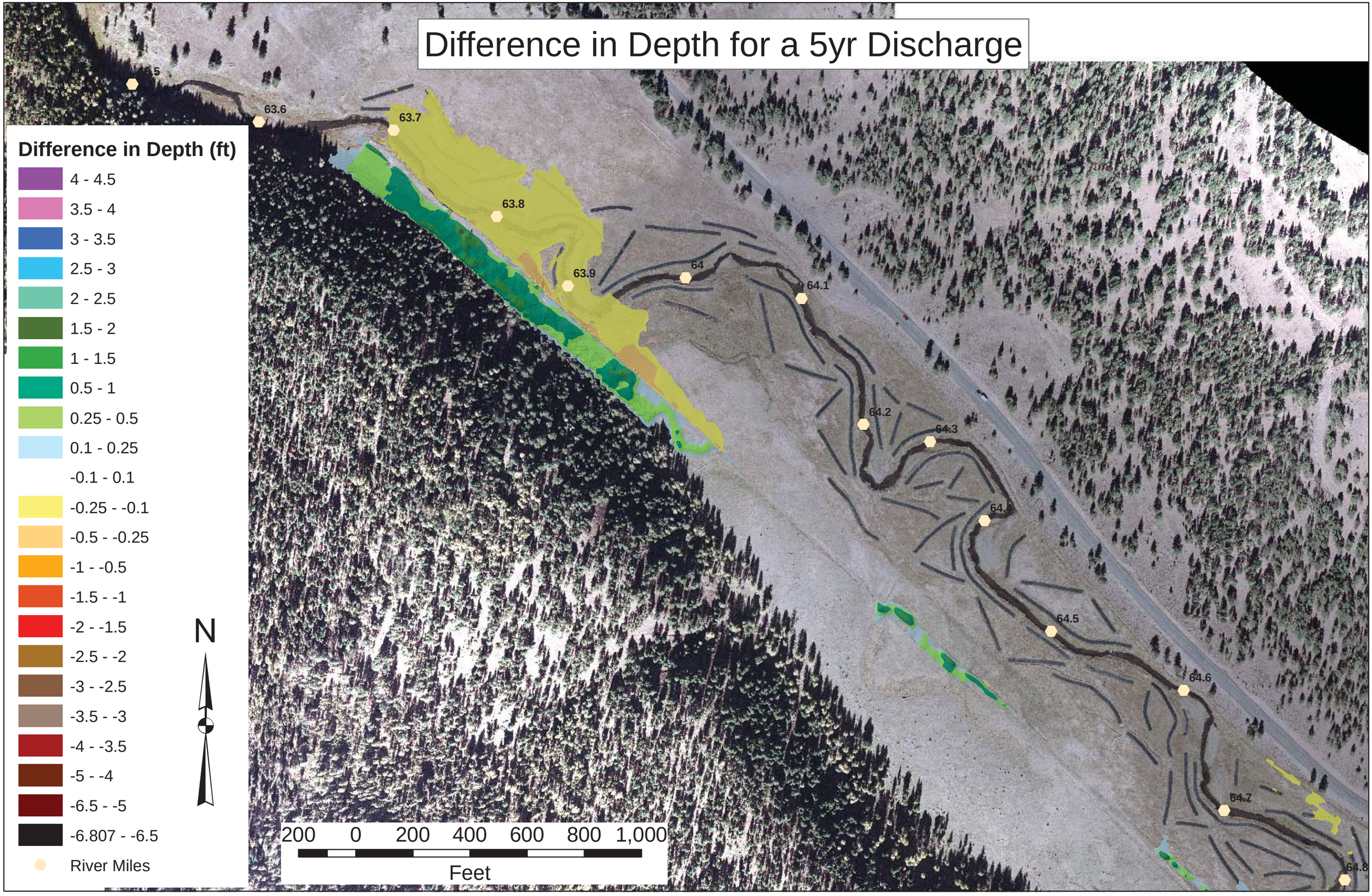
Depth for a 2yr Discharge- Existing Conditions



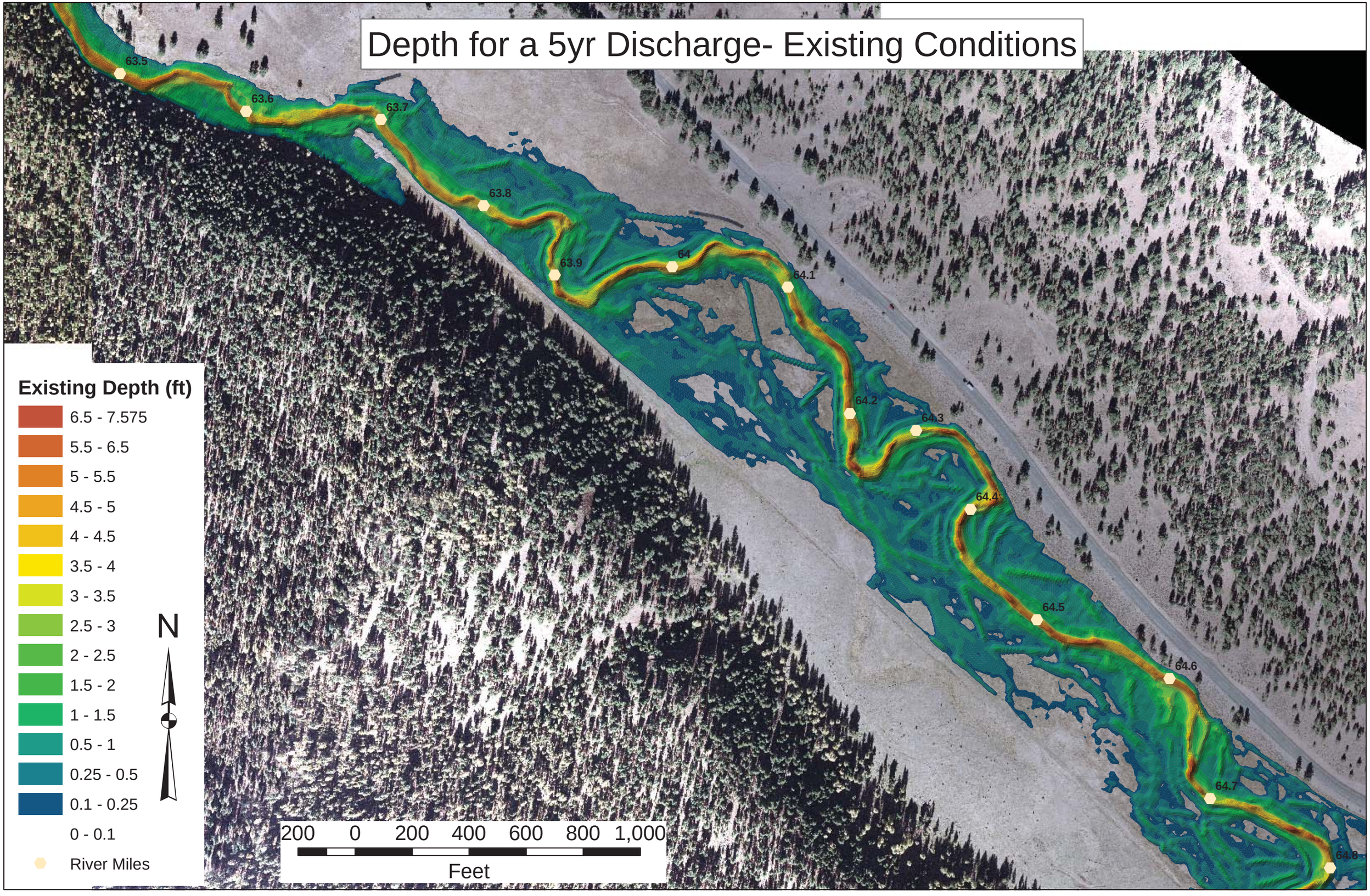
Depth for a 2yr Discharge- Modified Conditions



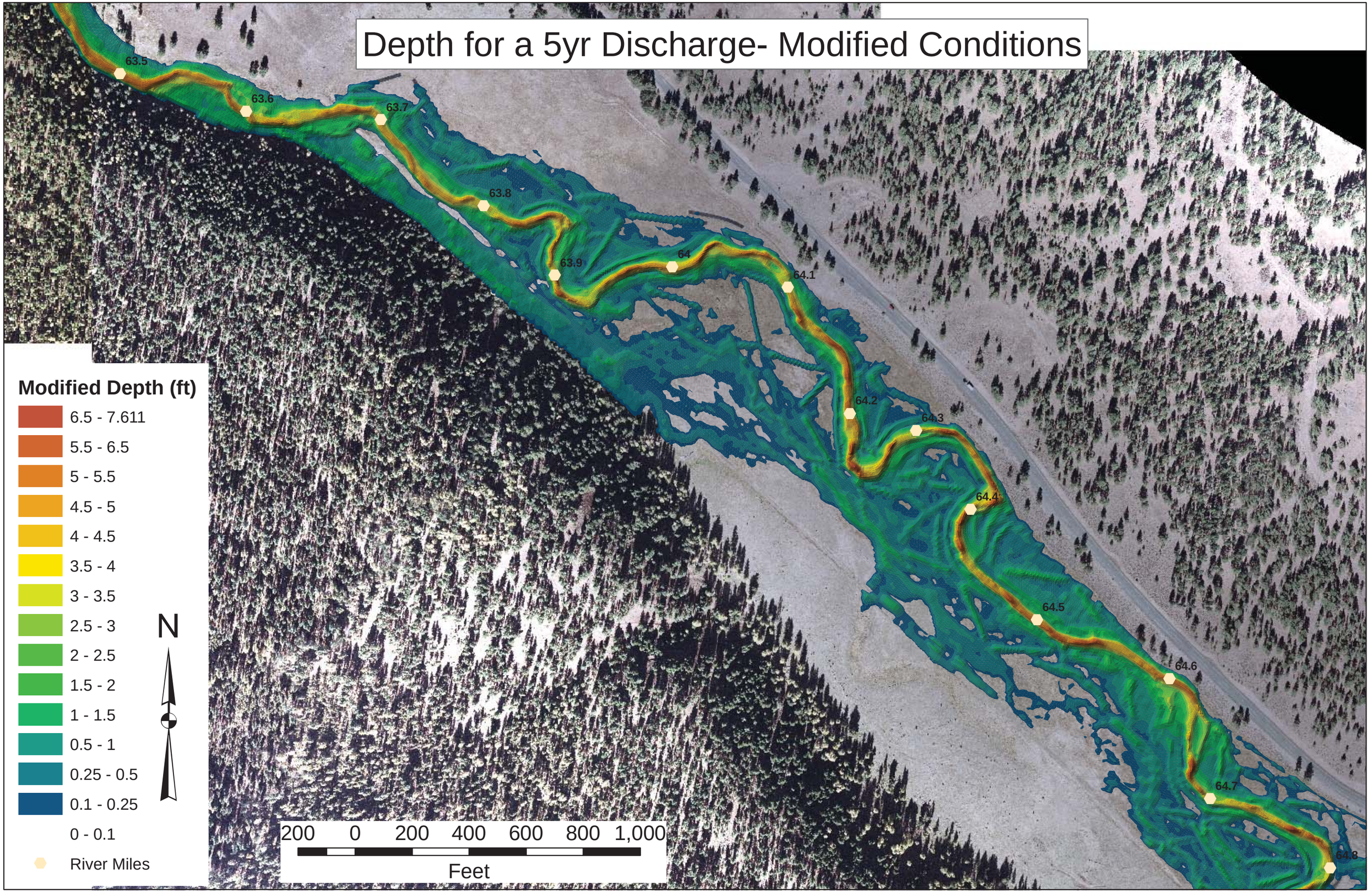
Difference in Depth for a 5yr Discharge

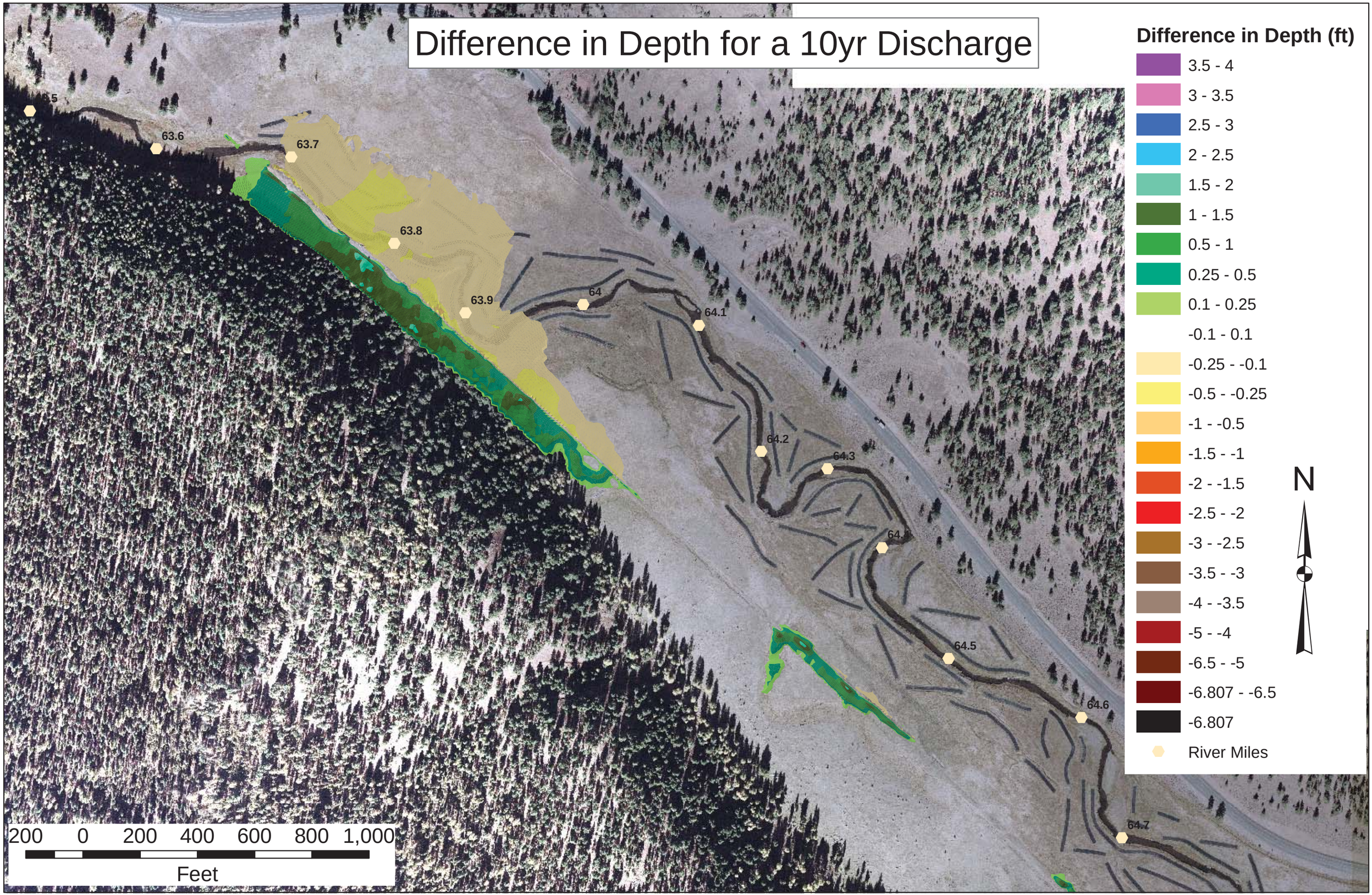


Depth for a 5yr Discharge- Existing Conditions

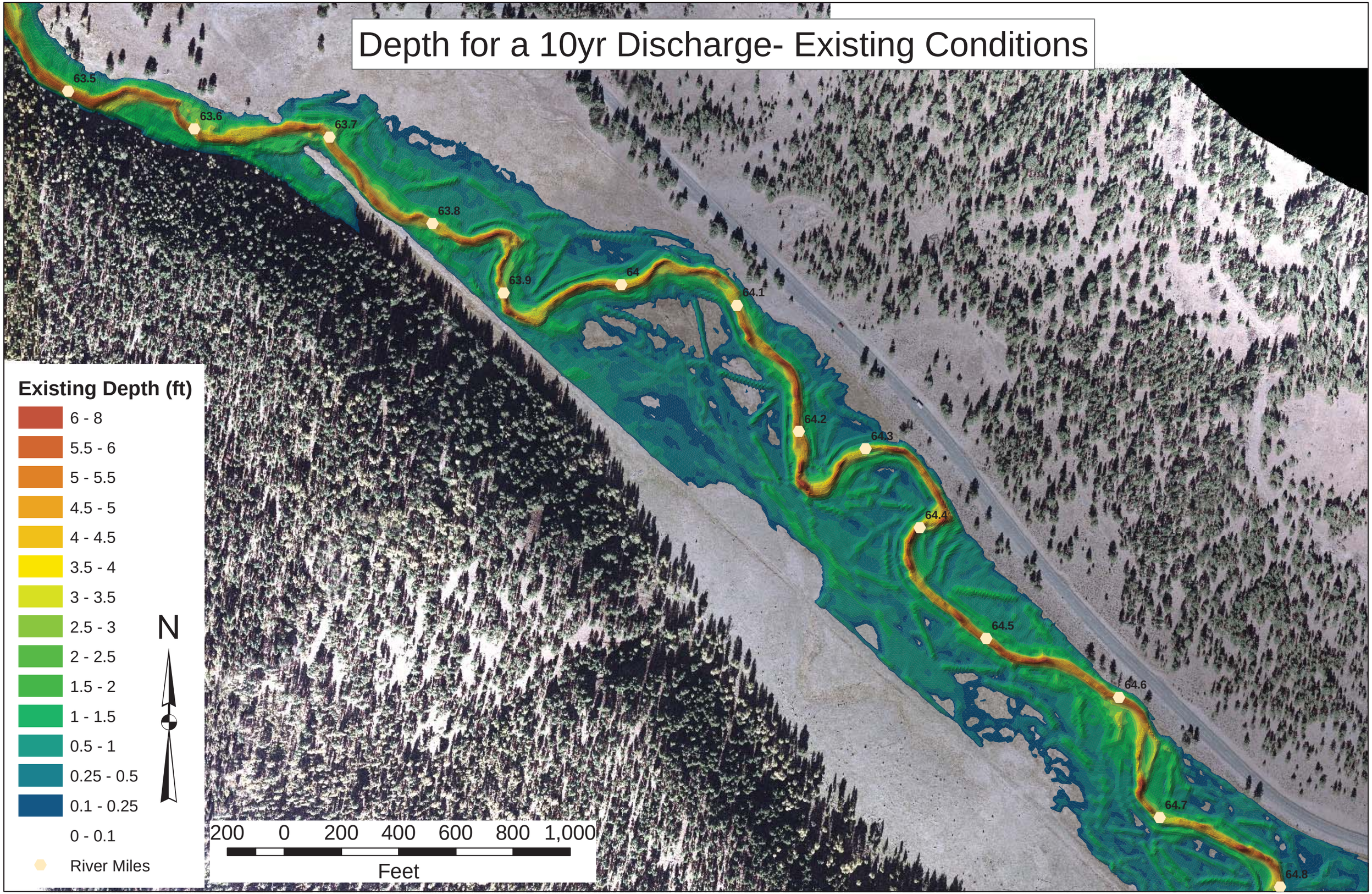


Depth for a 5yr Discharge- Modified Conditions

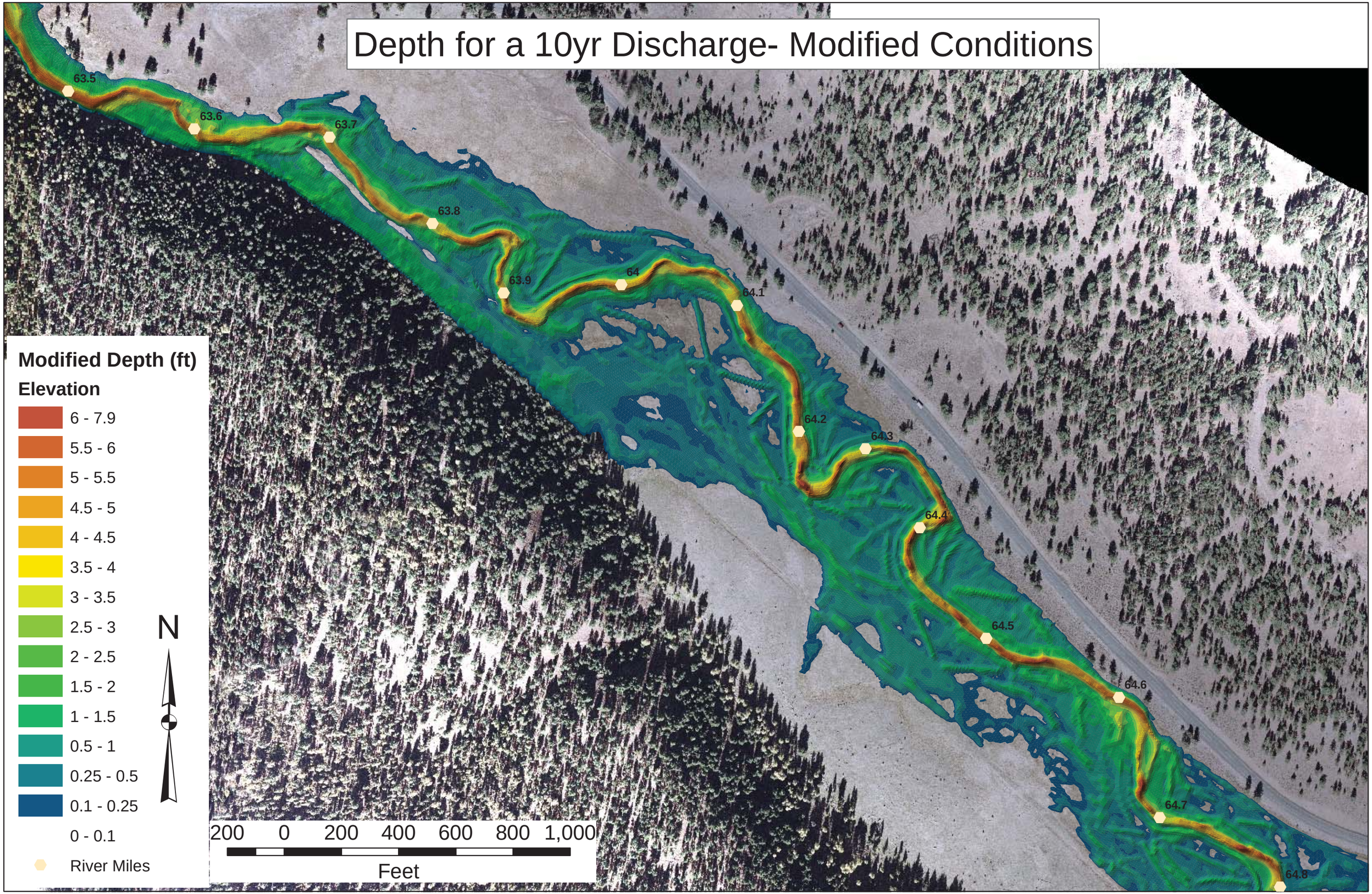



Difference in Depth for a 10yr Discharge
Difference in Depth (ft)
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
-6.807
River Miles
N
5
63.6
63.7
63.8
63.9
64
64.1
64.2
64.3
64.4
64.5
64.6
64.7
200 0 200 400 600 800 1,000
Feet

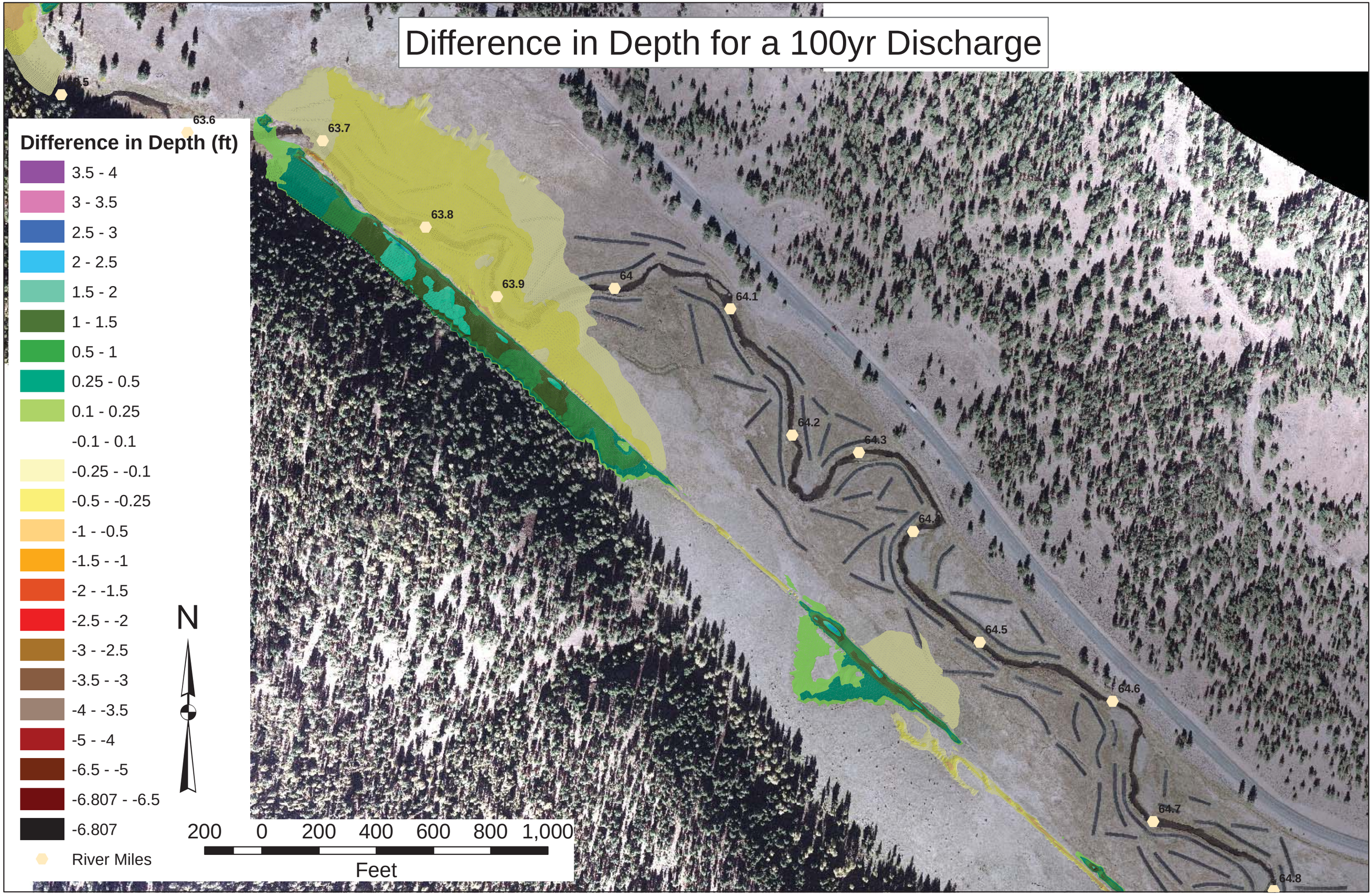
Depth for a 10yr Discharge- Existing Conditions



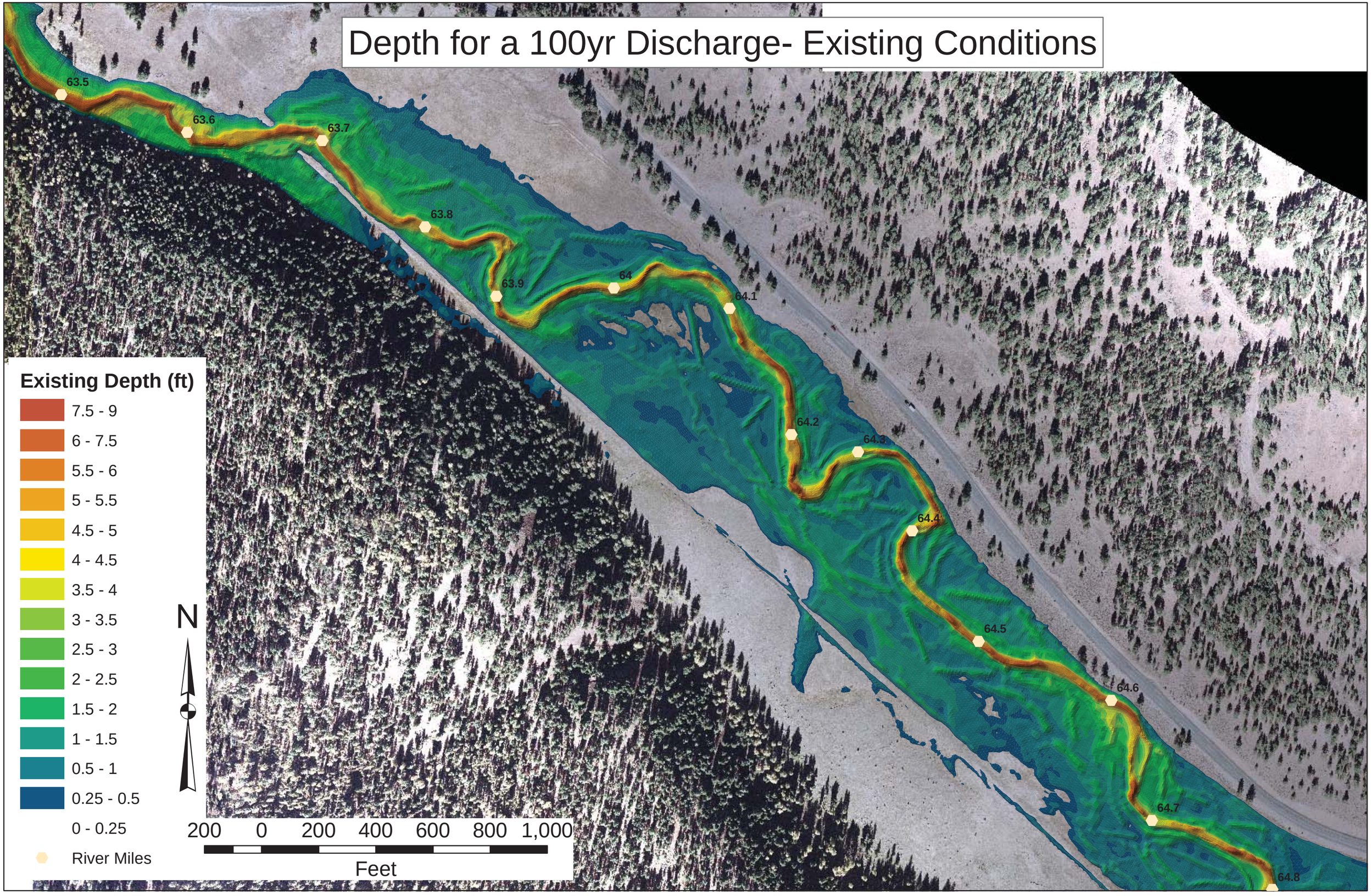
Depth for a 10yr Discharge- Modified Conditions



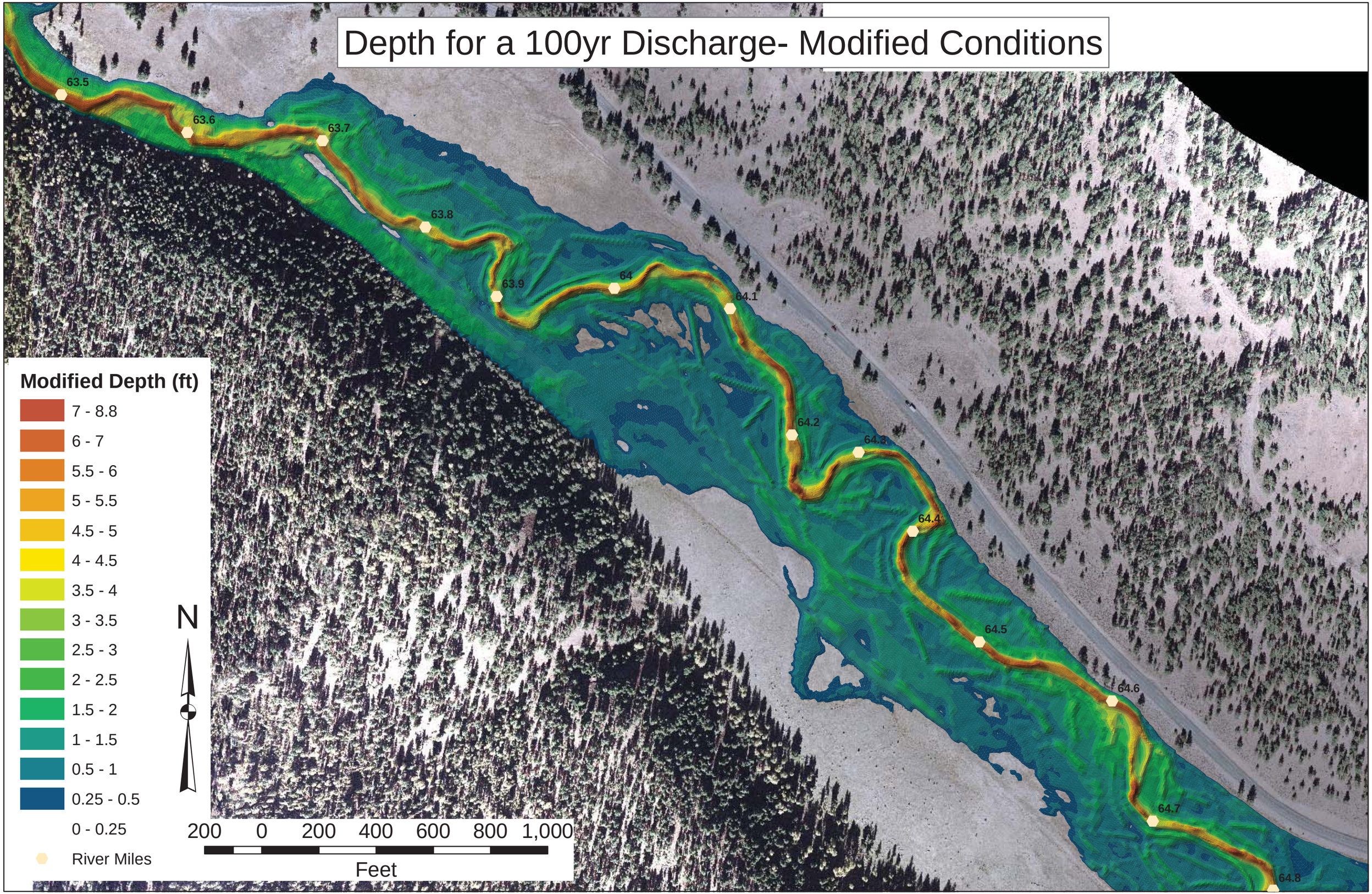
Difference in Depth for a 100yr Discharge



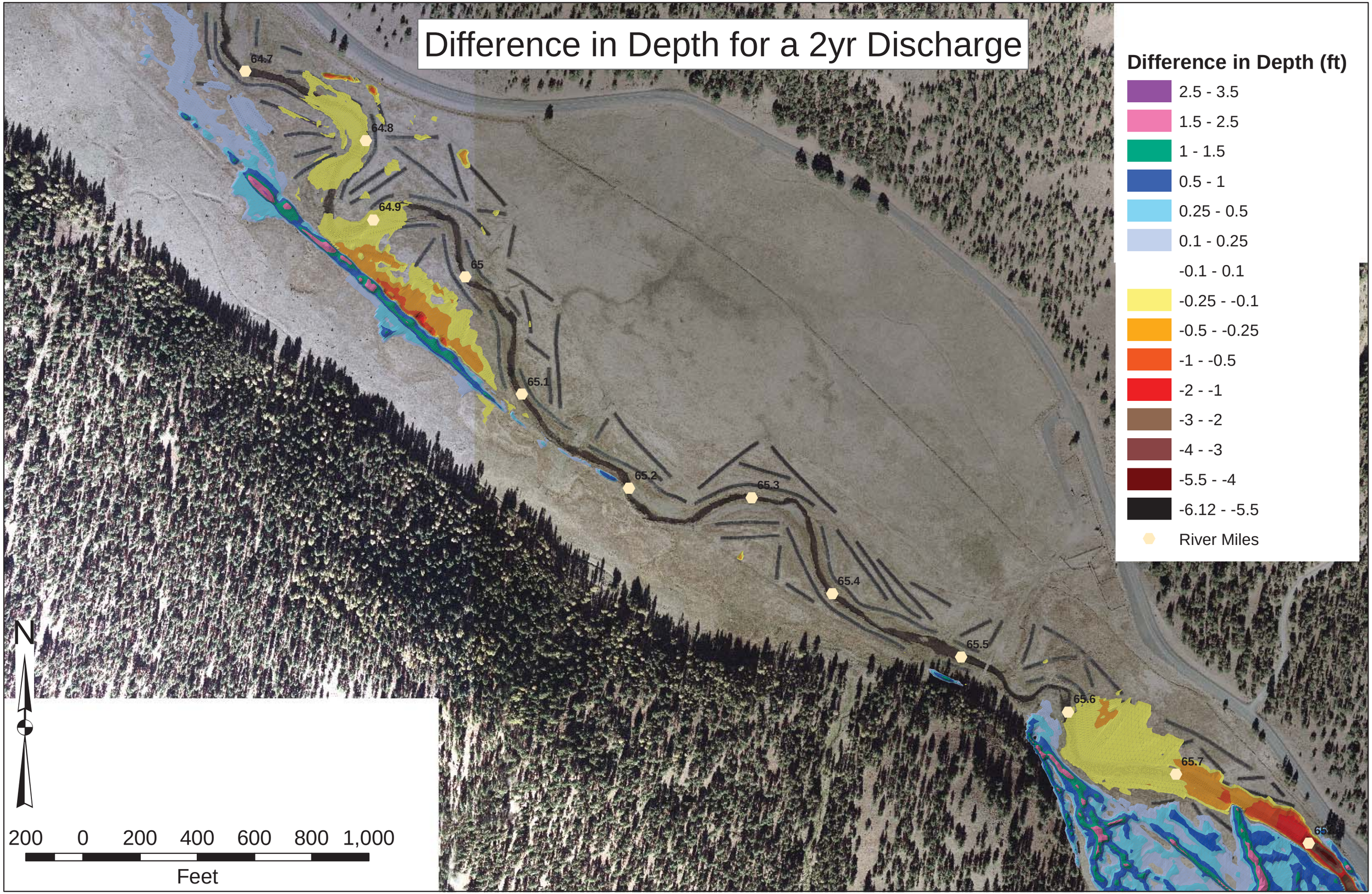
Depth for a 100yr Discharge- Existing Conditions

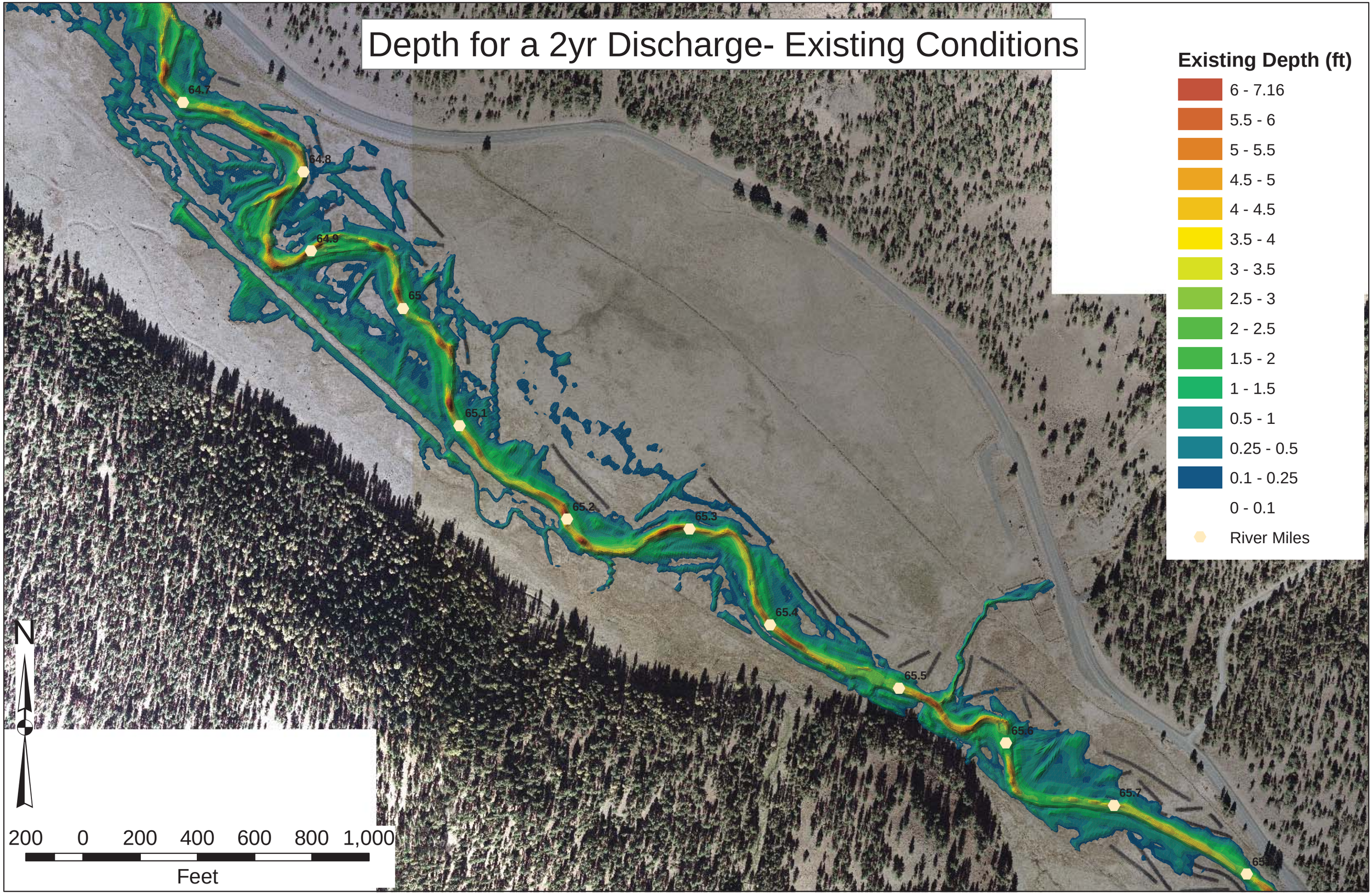


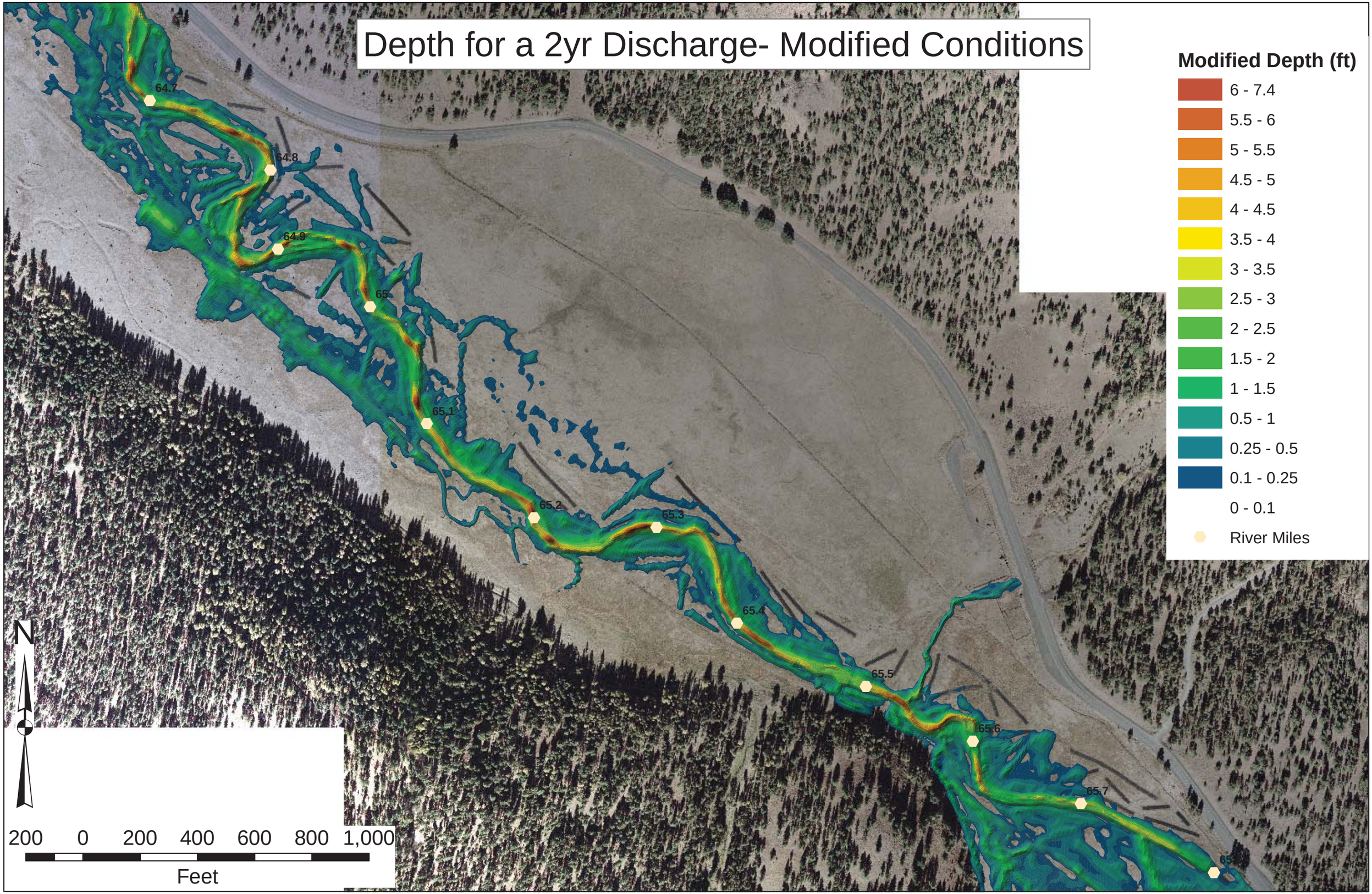
Depth for a 100yr Discharge- Modified Conditions

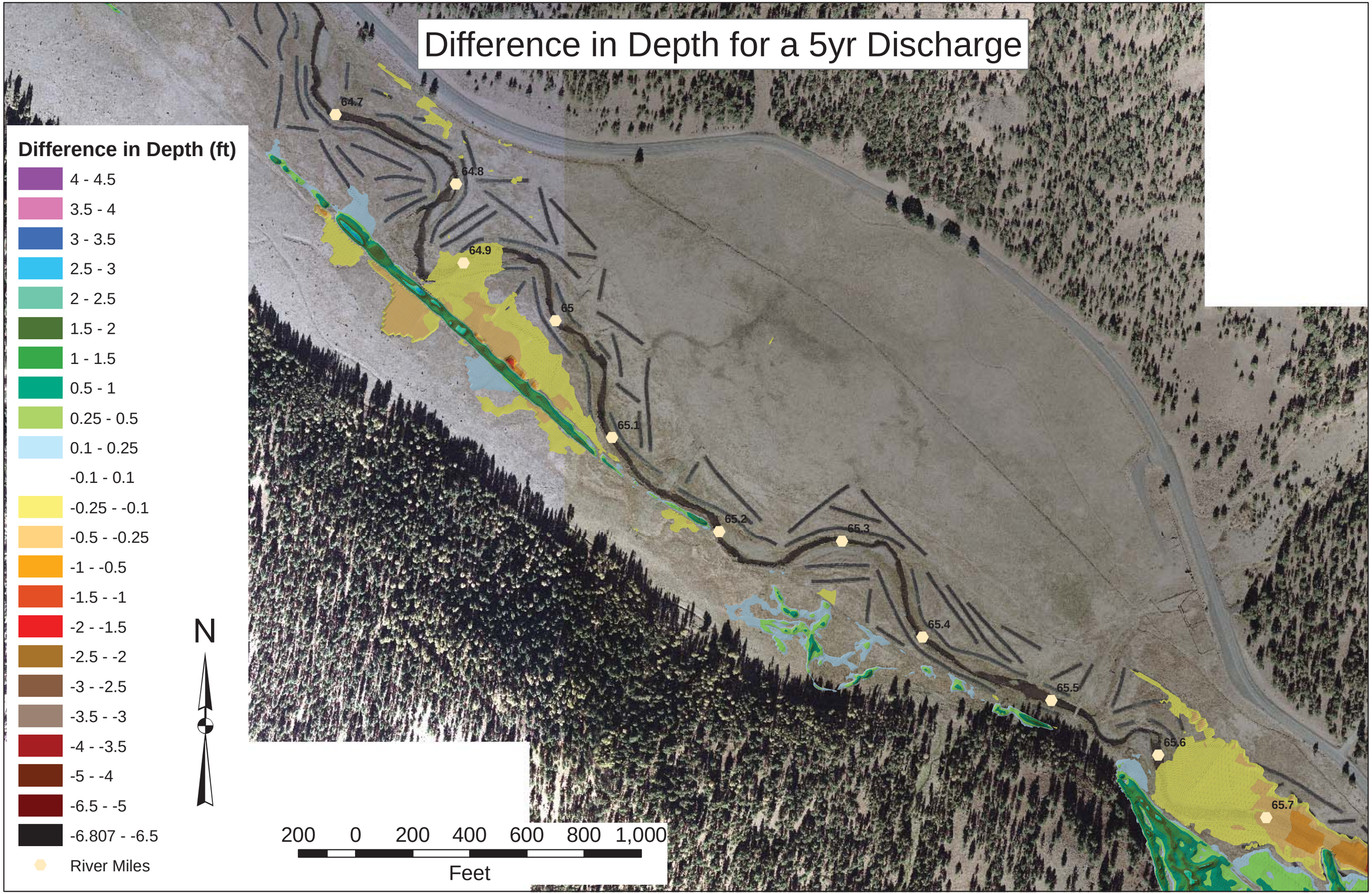


Vincent Creek to River Mile 65

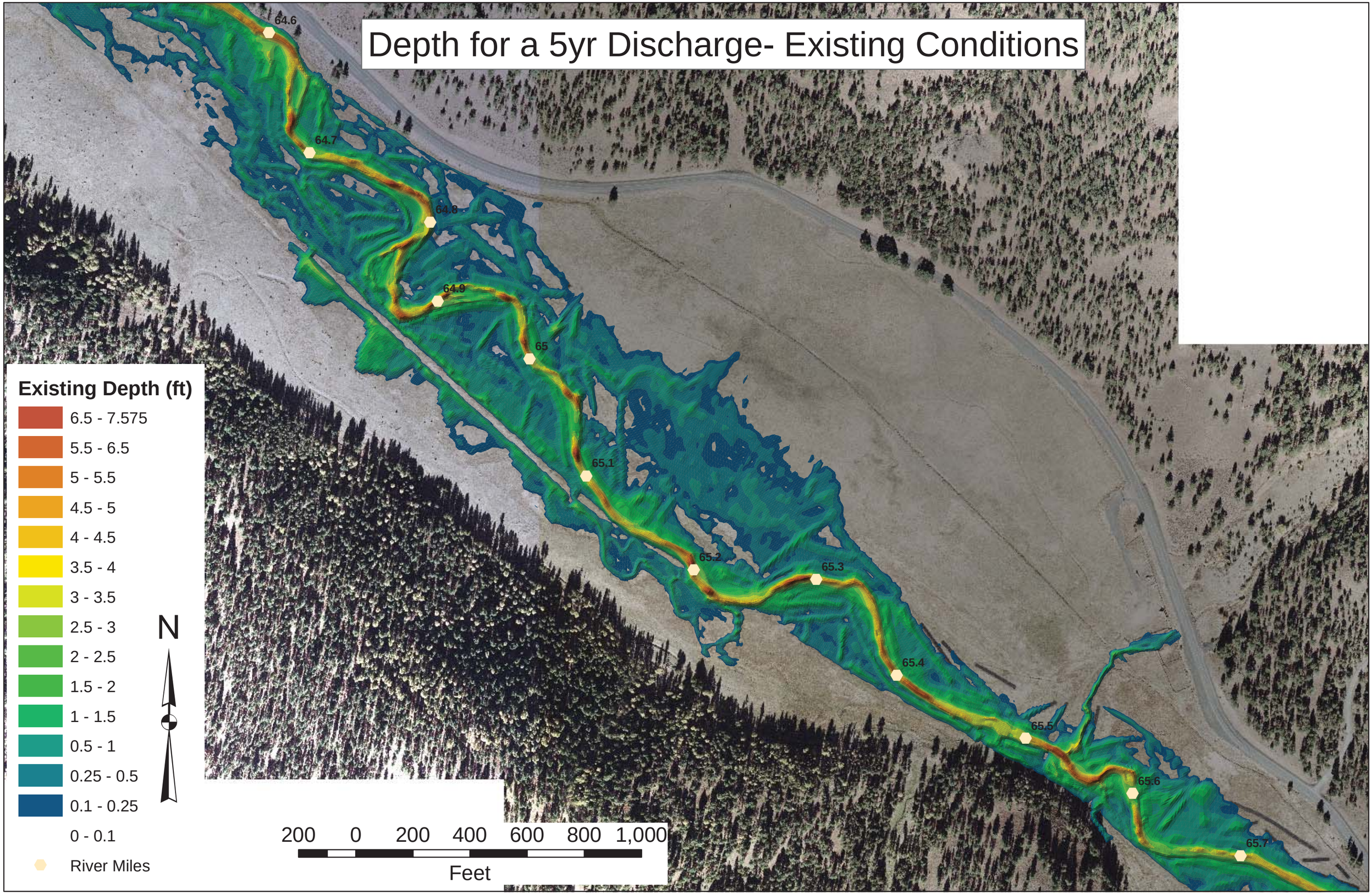

Difference in Depth for a 2yr Discharge
Difference in Depth (ft)
2.5 - 3.5
1.5 - 2.5
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-2 - -1
-3 - -2
-4 - -3
-5.5 - -4
-6.12 - -5.5
River Miles
64.7
64.8
64.9
65
65.1
65.2
65.3
65.4
65.5
65.6
65.7
N
200 0 200 400 600 800 1,000
Feet


Depth for a 2yr Discharge- Existing Conditions
Existing Depth (ft)
6 - 7.16
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
0 - 0.1
River Miles
64.7
64.8
64.9
65
65.1
65.2
65.3
65.4
65.5
65.6
65.7
N
200 0 200 400 600 800 1,000
Feet

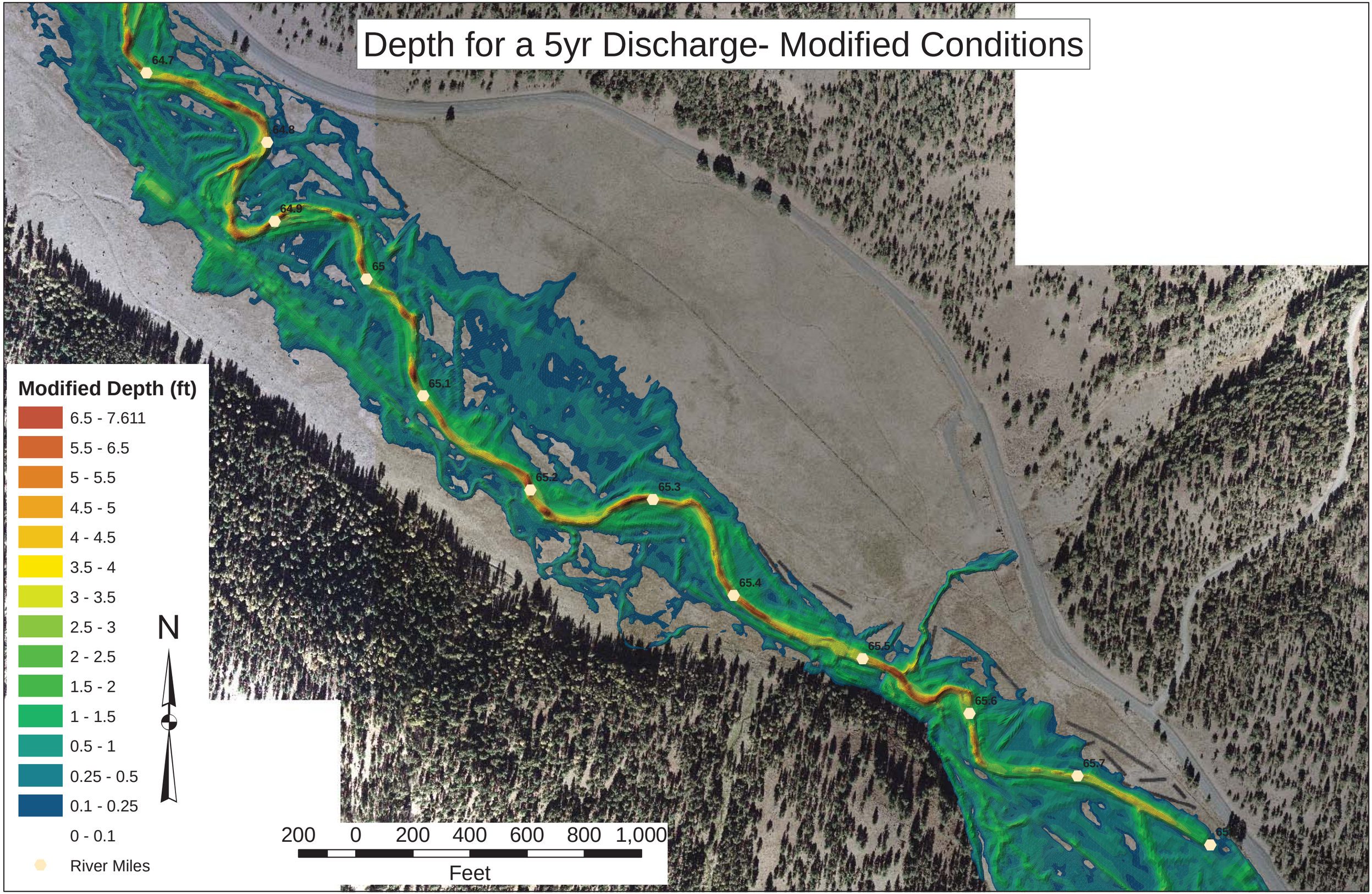

Depth for a 2yr Discharge- Modified Conditions
Modified Depth (ft)
6 - 7.4
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
0 - 0.1
River Miles
64.7
64.8
64.9
65
65.1
65.2
65.3
65.4
65.5
65.6
65.7
N
200 0 200 400 600 800 1,000
Feet

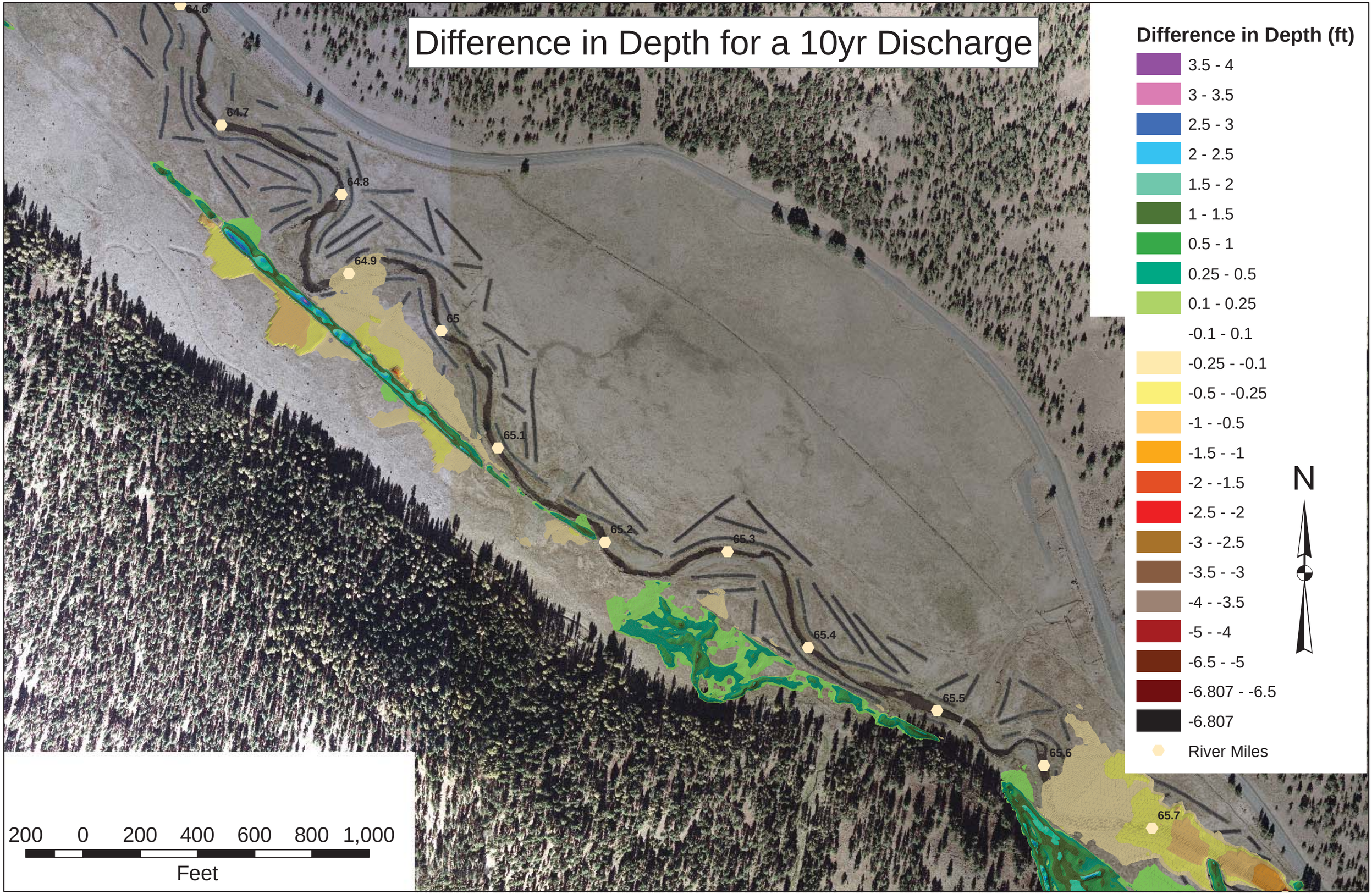

Difference in Depth for a 5yr Discharge
Difference in Depth (ft)
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
River Miles
N
200 0 200 400 600 800 1,000
Feet
64.7
64.8
64.9
65
65.1
65.2
65.3
65.4
65.5
65.6
65.7

Depth for a 5yr Discharge- Existing Conditions

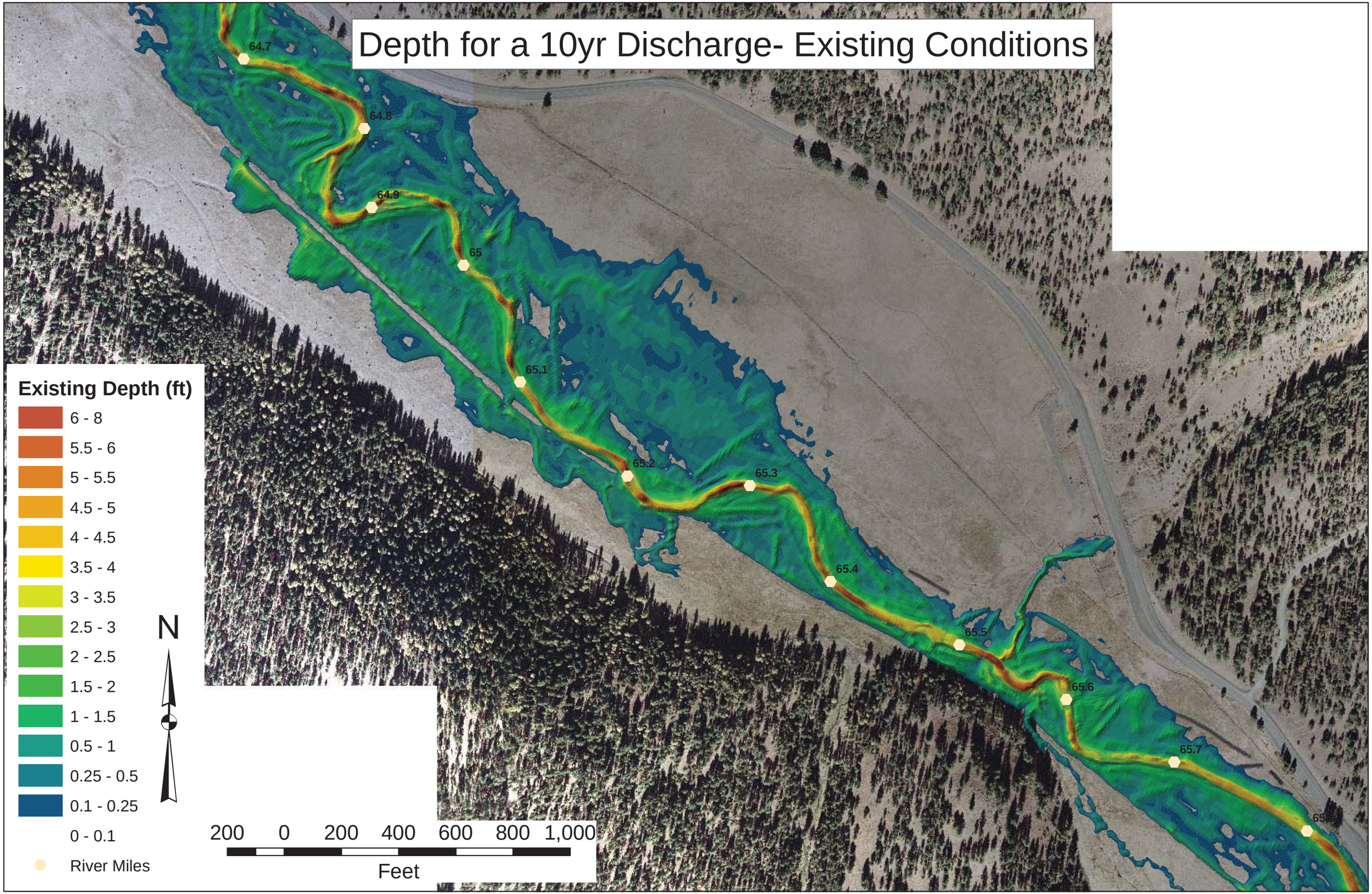


Depth for a 5yr Discharge- Modified Conditions

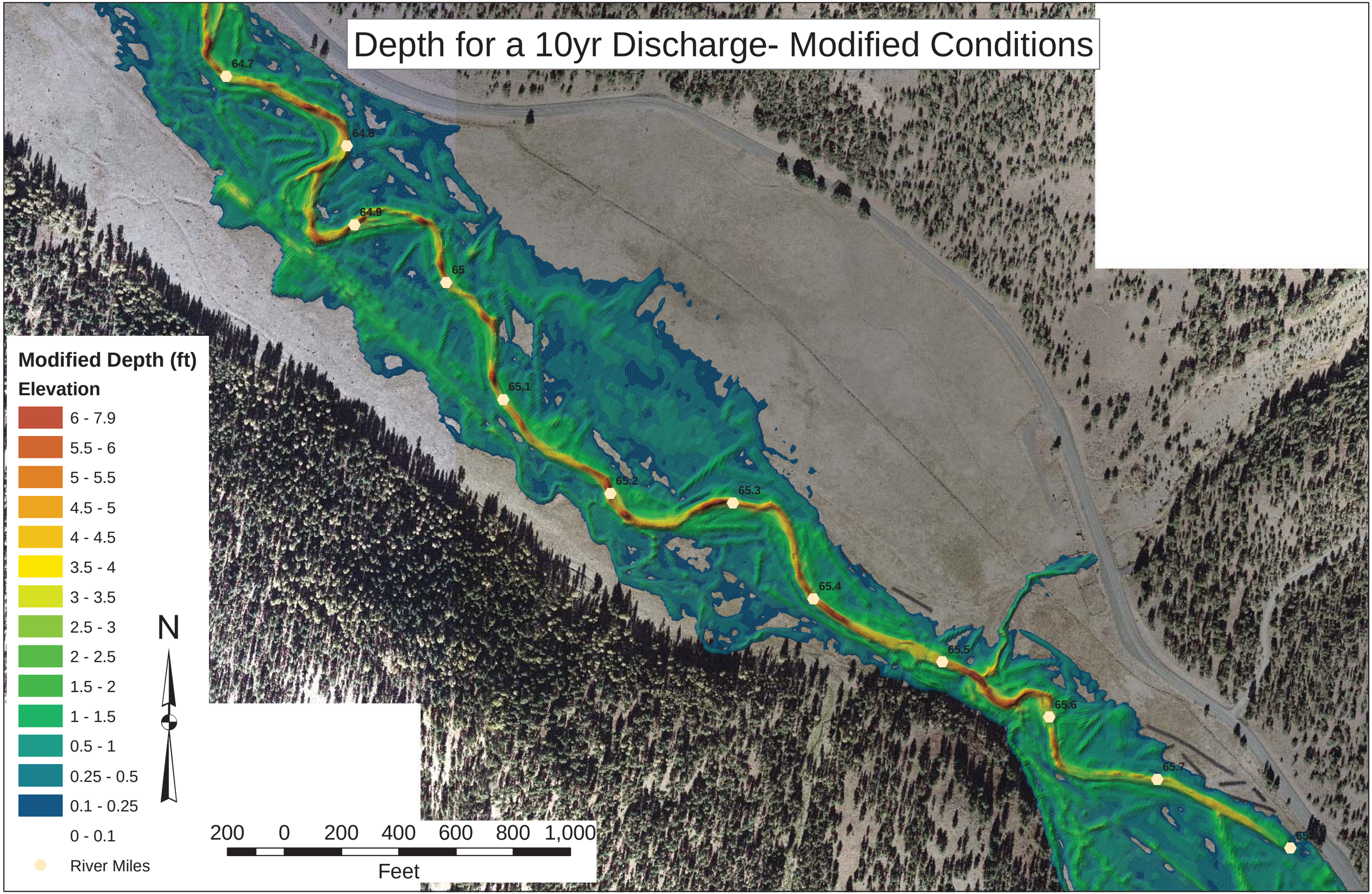


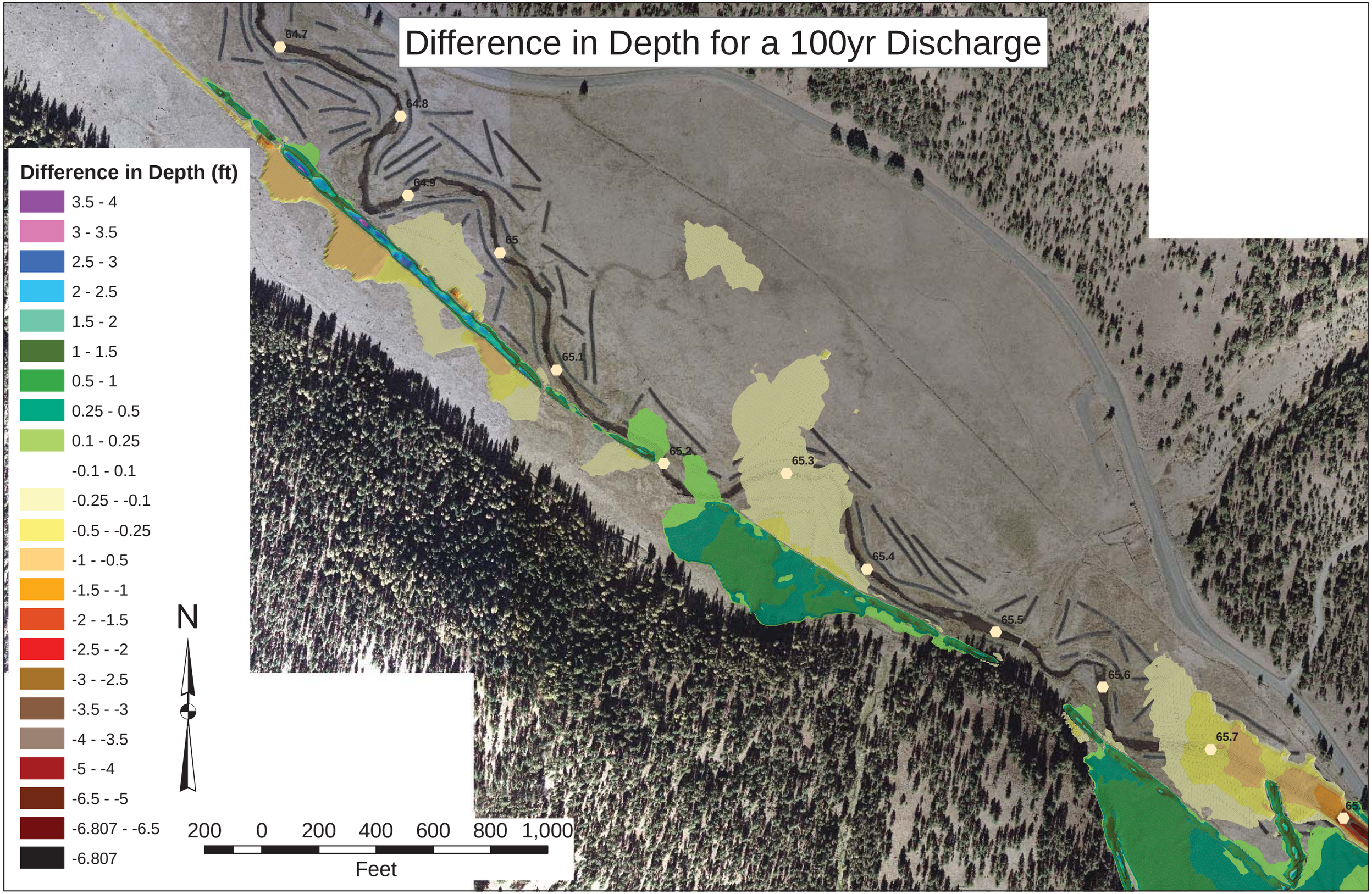

Difference in Depth for a 10yr Discharge
Difference in Depth (ft)
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
-6.807
River Miles
N
64.6
64.7
64.8
64.9
65
65.1
65.2
65.3
65.4
65.5
65.6
65.7
200 0 200 400 600 800 1,000
Feet

Depth for a 10yr Discharge- Existing Conditions

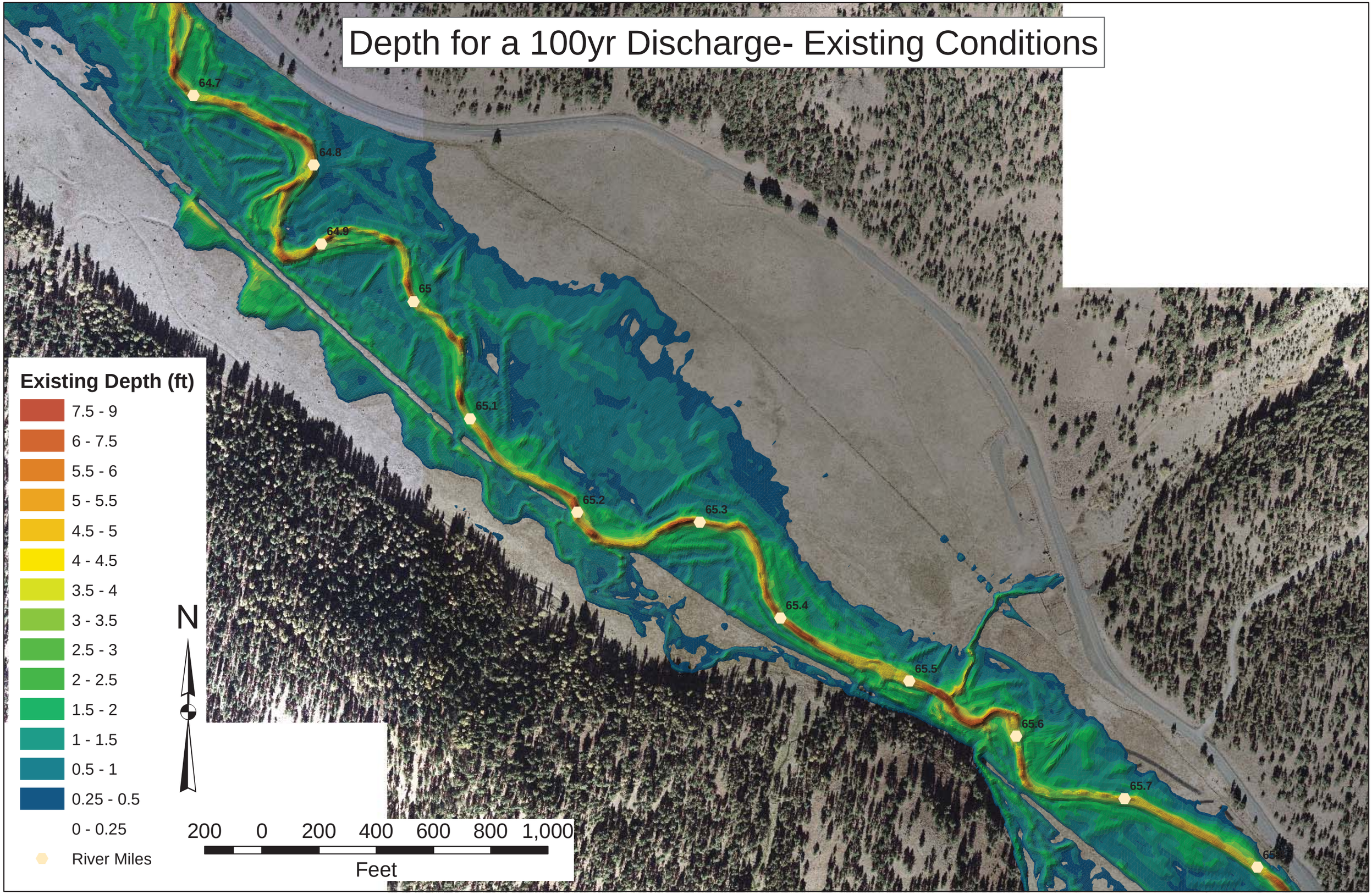


Depth for a 10yr Discharge- Modified Conditions

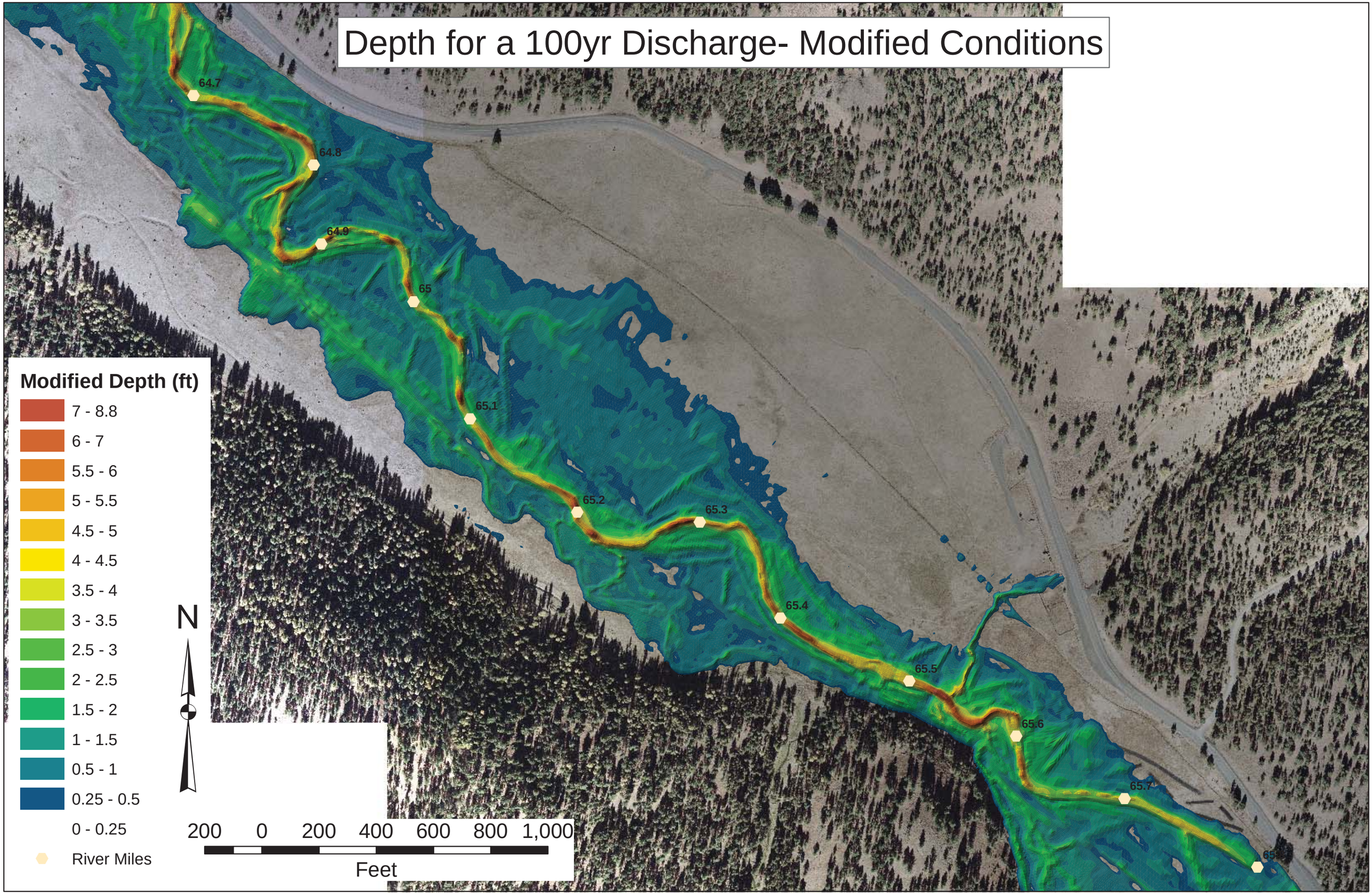



Difference in Depth for a 100yr Discharge
Difference in Depth (ft)
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
-6.807
N
200 0 200 400 600 800 1,000
Feet
64.7
64.8
64.9
65
65.1
65.2
65.3
65.4
65.5
65.6
65.7

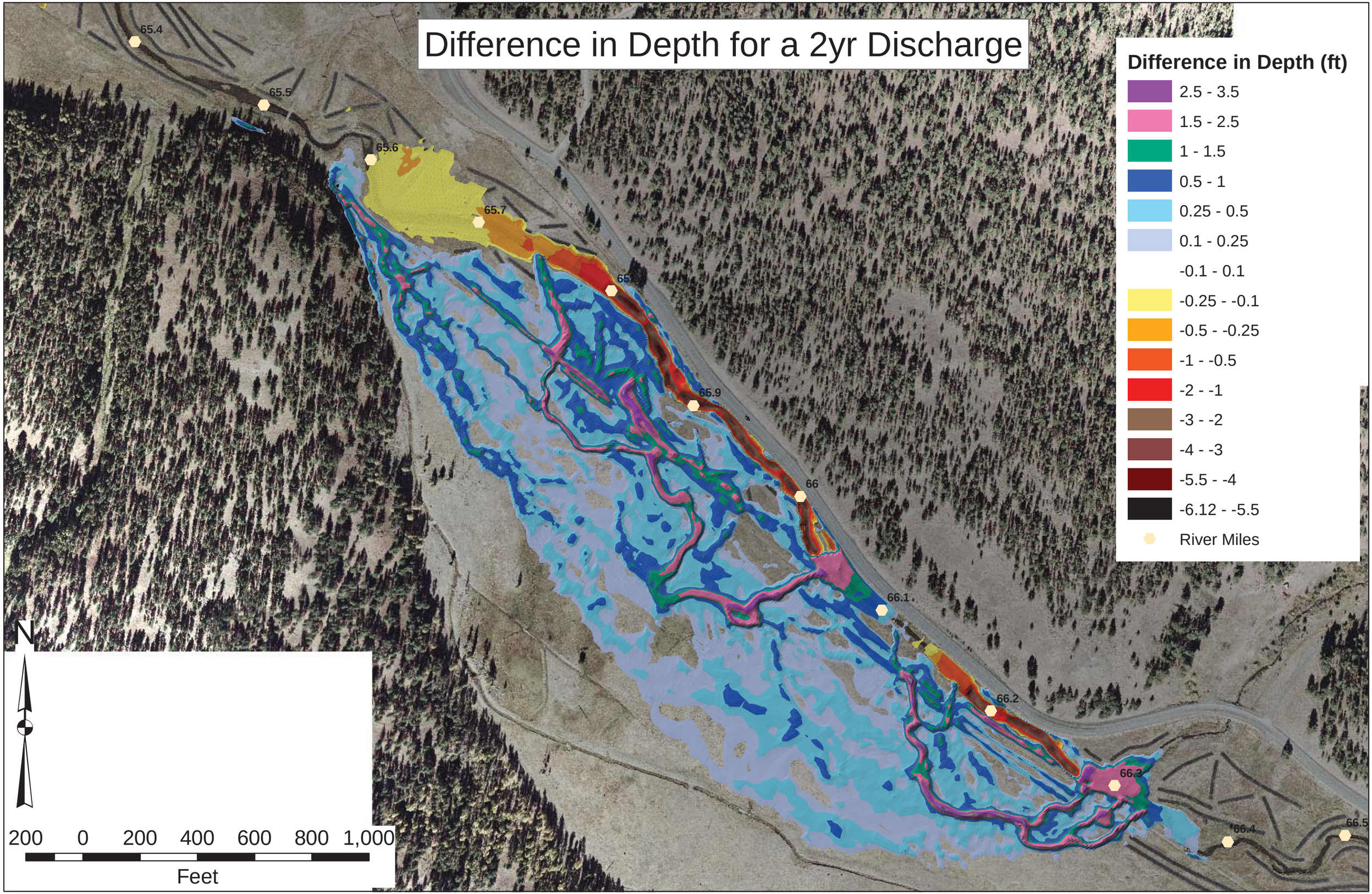
Depth for a 100yr Discharge- Existing Conditions

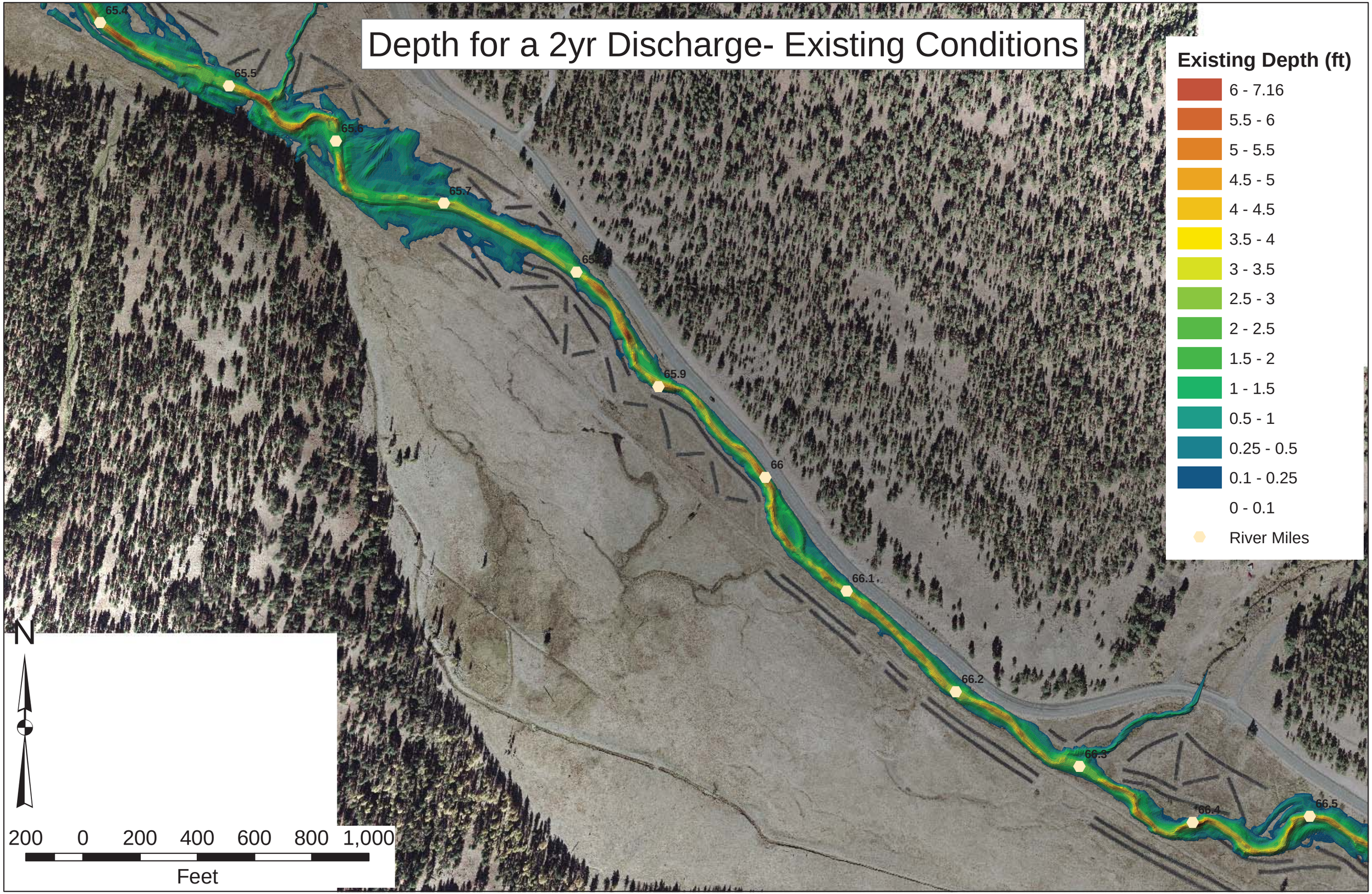


Depth for a 100yr Discharge- Modified Conditions

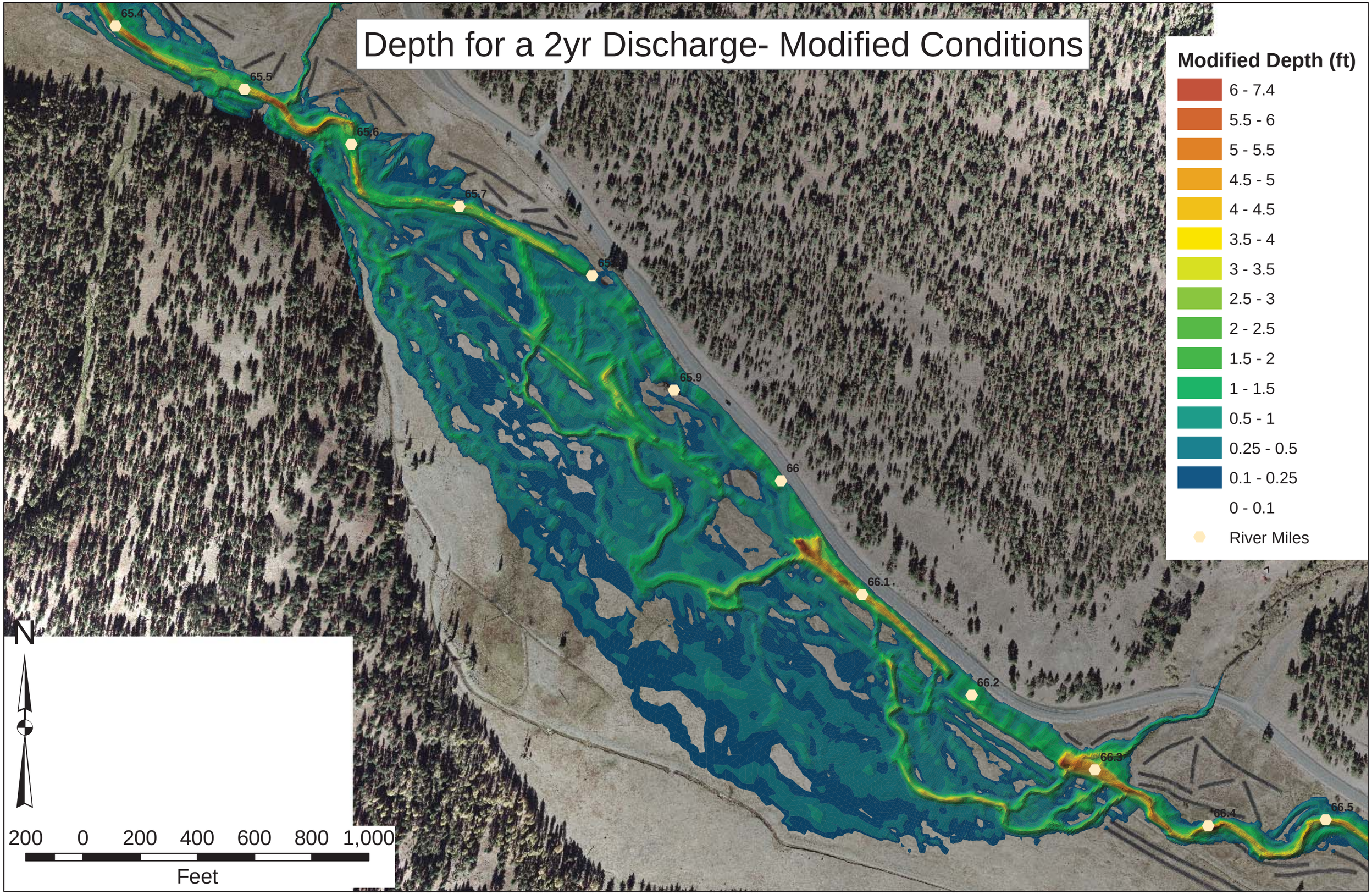


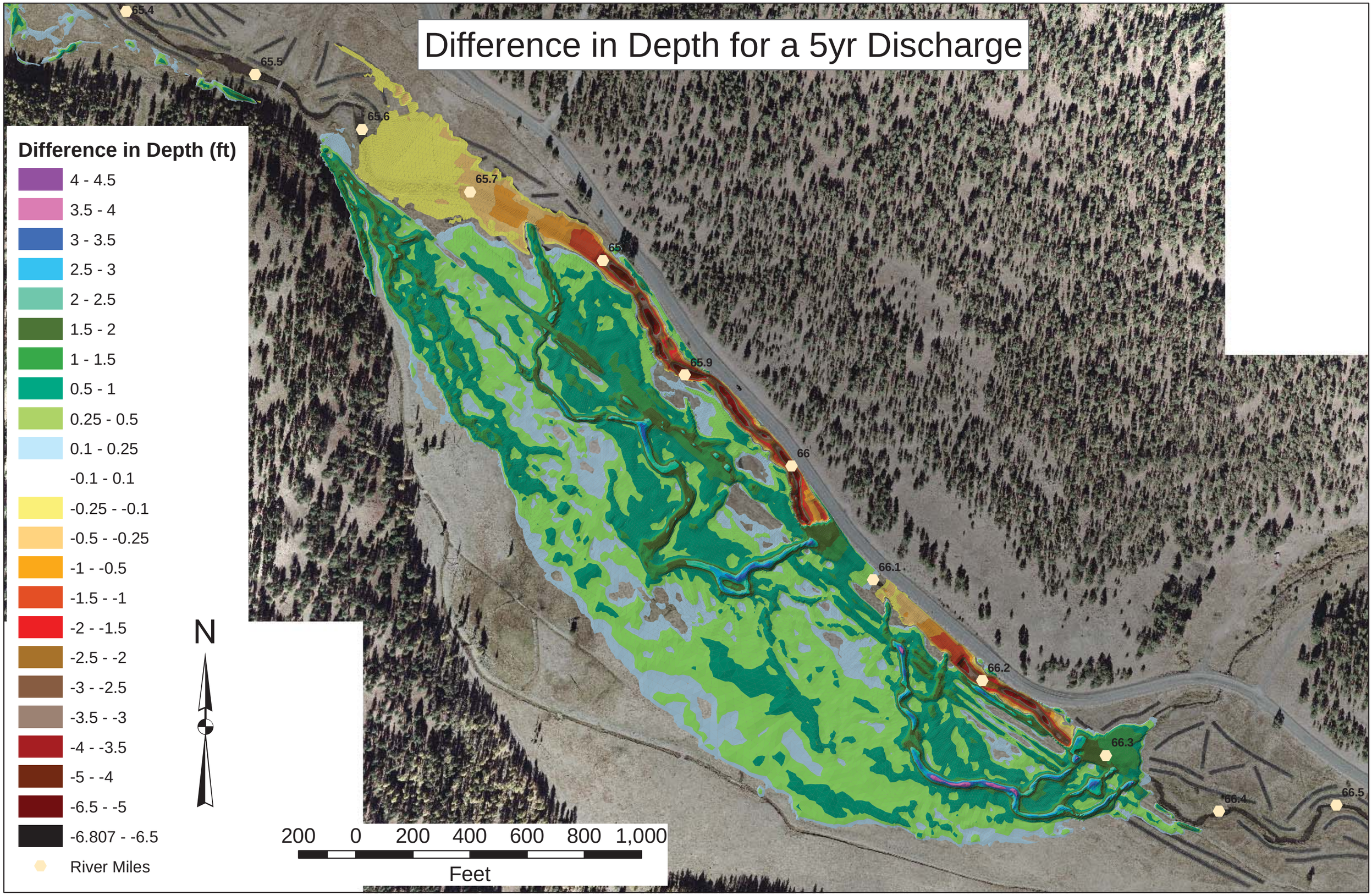
Vinegar Creek to Vincent Creek

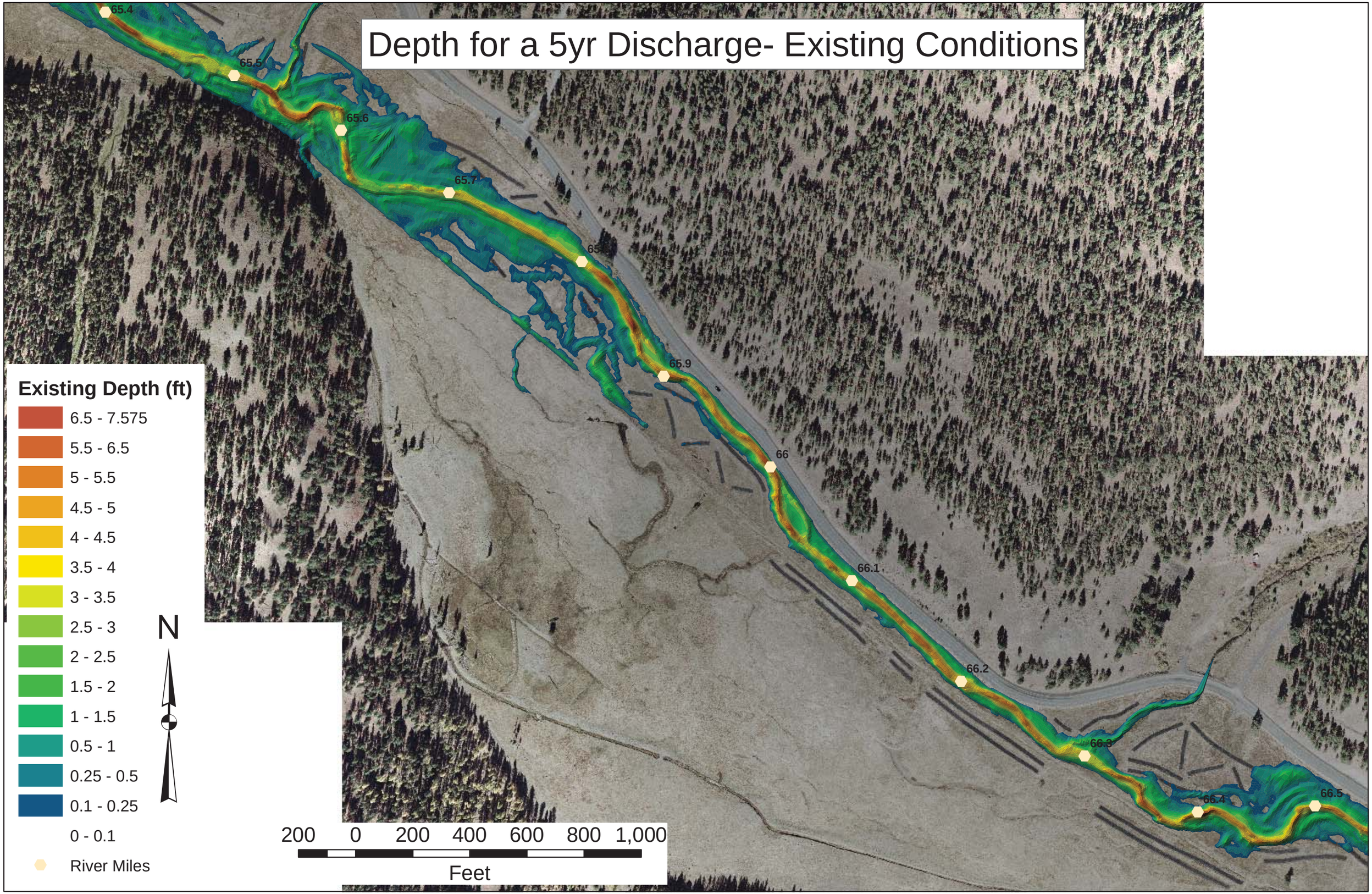

Difference in Depth for a 2yr Discharge
Difference in Depth (ft)
2.5 - 3.5
1.5 - 2.5
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-2 - -1
-3 - -2
-4 - -3
-5.5 - -4
-6.12 - -5.5
River Miles
65.4
65.5
65.6
65.7
65
65.9
66
66.1
66.2
66.3
66.4
66.5
N
200 0 200 400 600 800 1,000
Feet


Depth for a 2yr Discharge- Existing Conditions
Existing Depth (ft)
6 - 7.16
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
0 - 0.1
River Miles
65.4
65.5
65.6
65.7
65.9
66
66.1
66.2
66.3
66.4
66.5
N
200 0 200 400 600 800 1,000
Feet

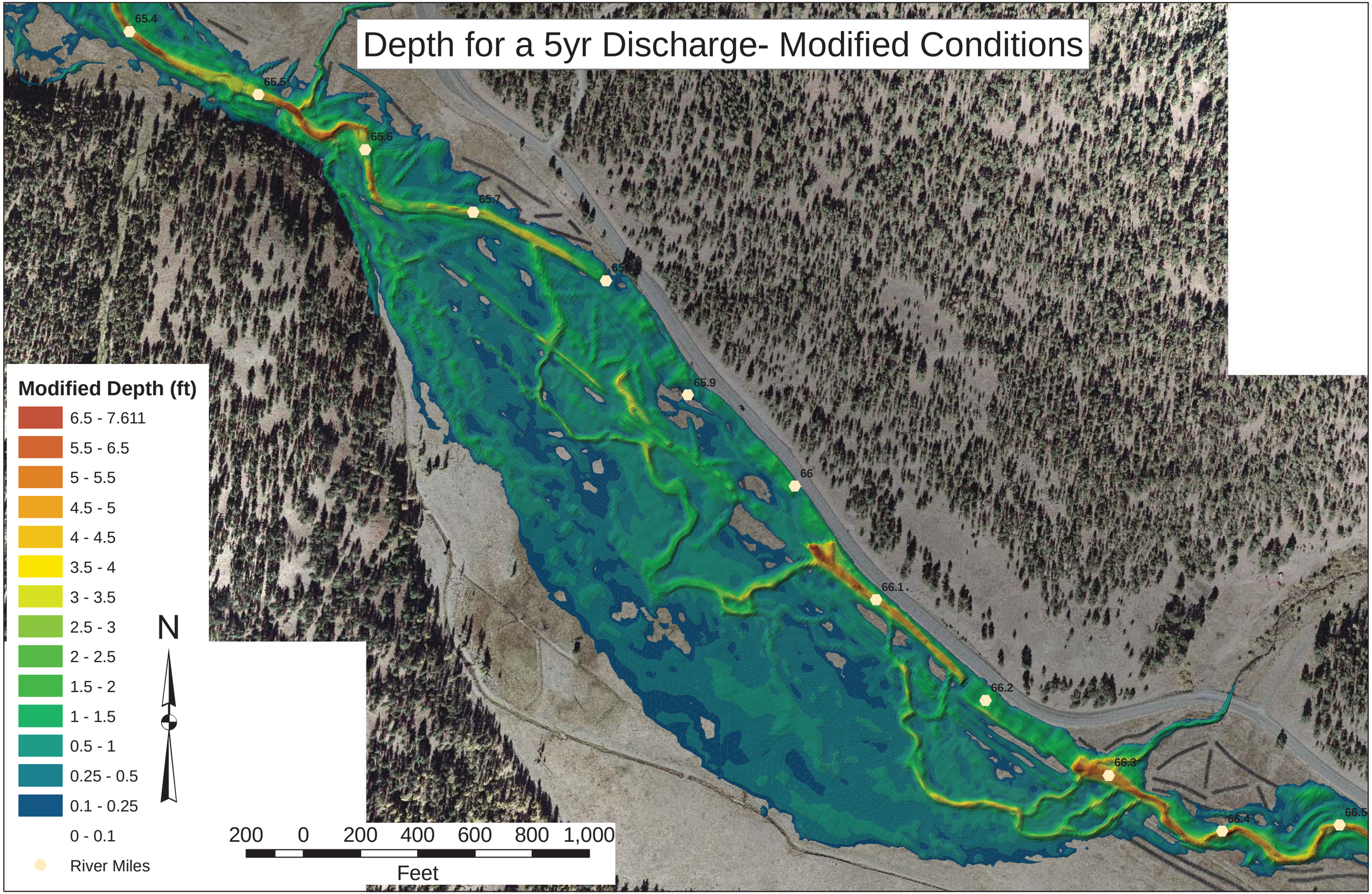
Depth for a 2yr Discharge- Modified Conditions



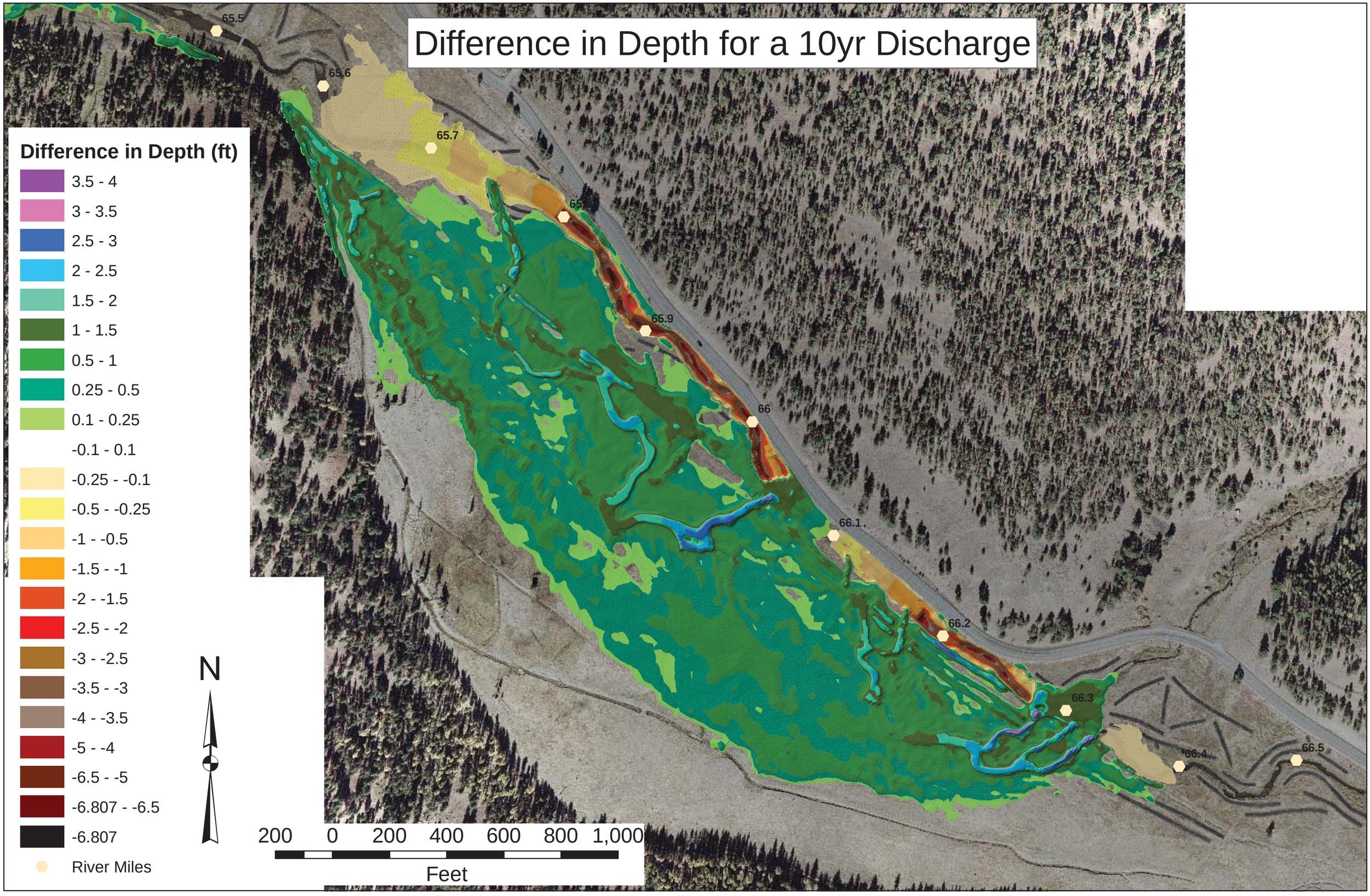

Difference in Depth for a 5yr Discharge
Difference in Depth (ft)
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
River Miles
N
200 0 200 400 600 800 1,000
Feet
65.4
65.5
65.6
65.7
65.9
66
66.1
66.2
66.3
66.4
66.5


Depth for a 5yr Discharge- Existing Conditions
65.4
65.5
65.6
65.7
65.9
66
66.1
66.2
66.3
66.4
66.5
Existing Depth (ft)
6.5 - 7.575
5.5 - 6.5
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
0 - 0.1
River Miles
N
200 0 200 400 600 800 1,000
Feet

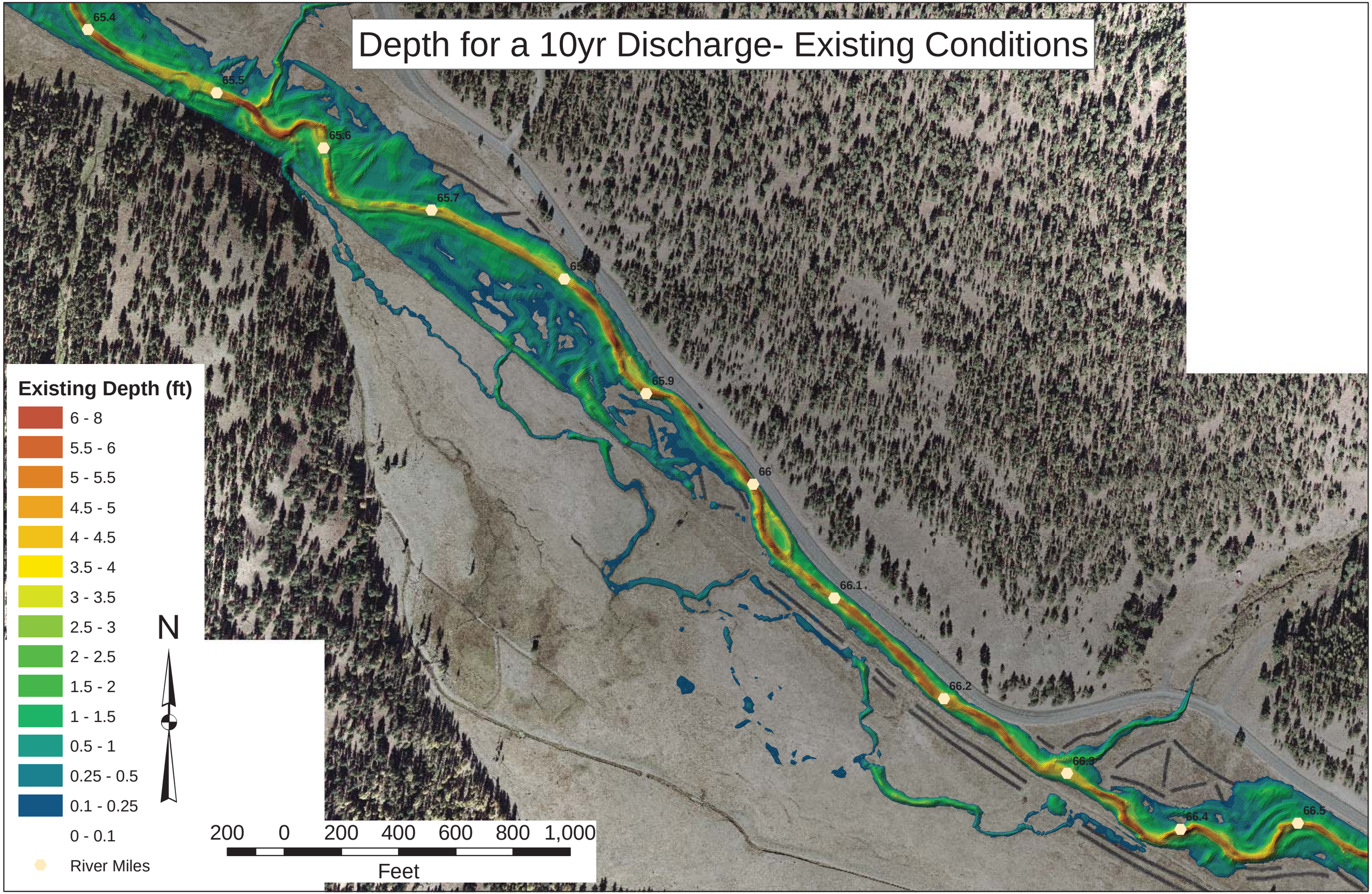
Depth for a 5yr Discharge- Modified Conditions

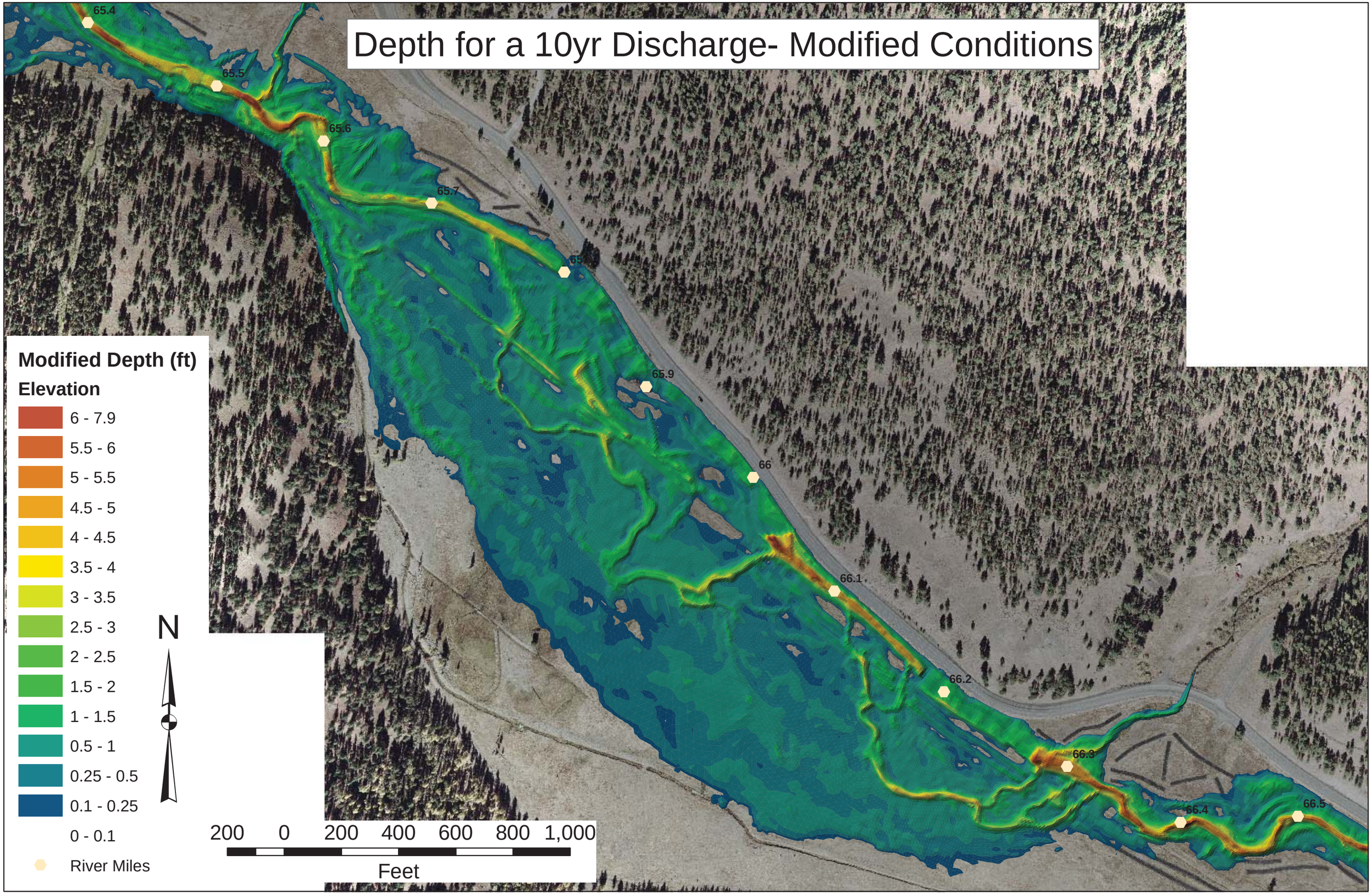


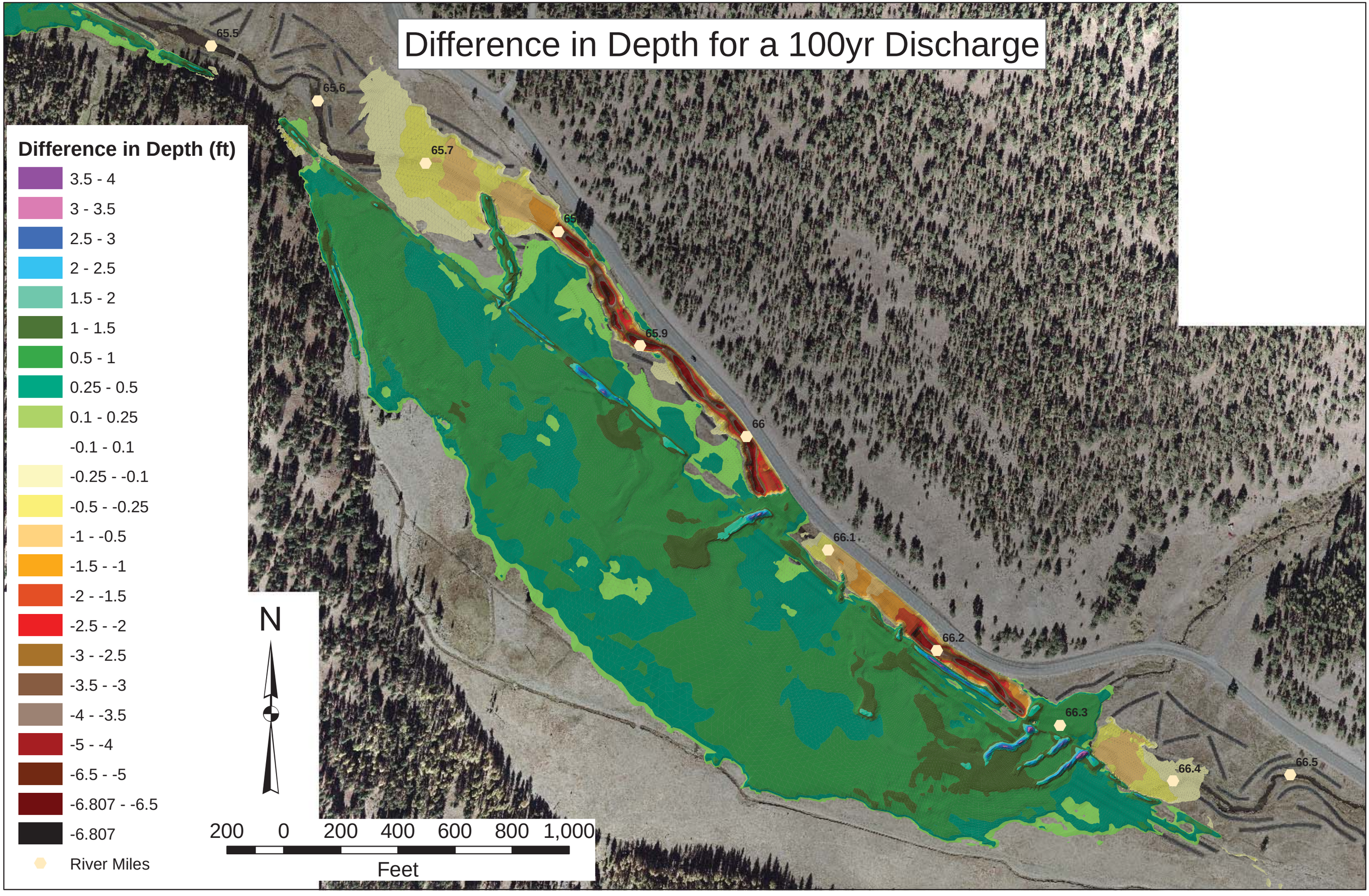
Difference in Depth for a 10yr Discharge



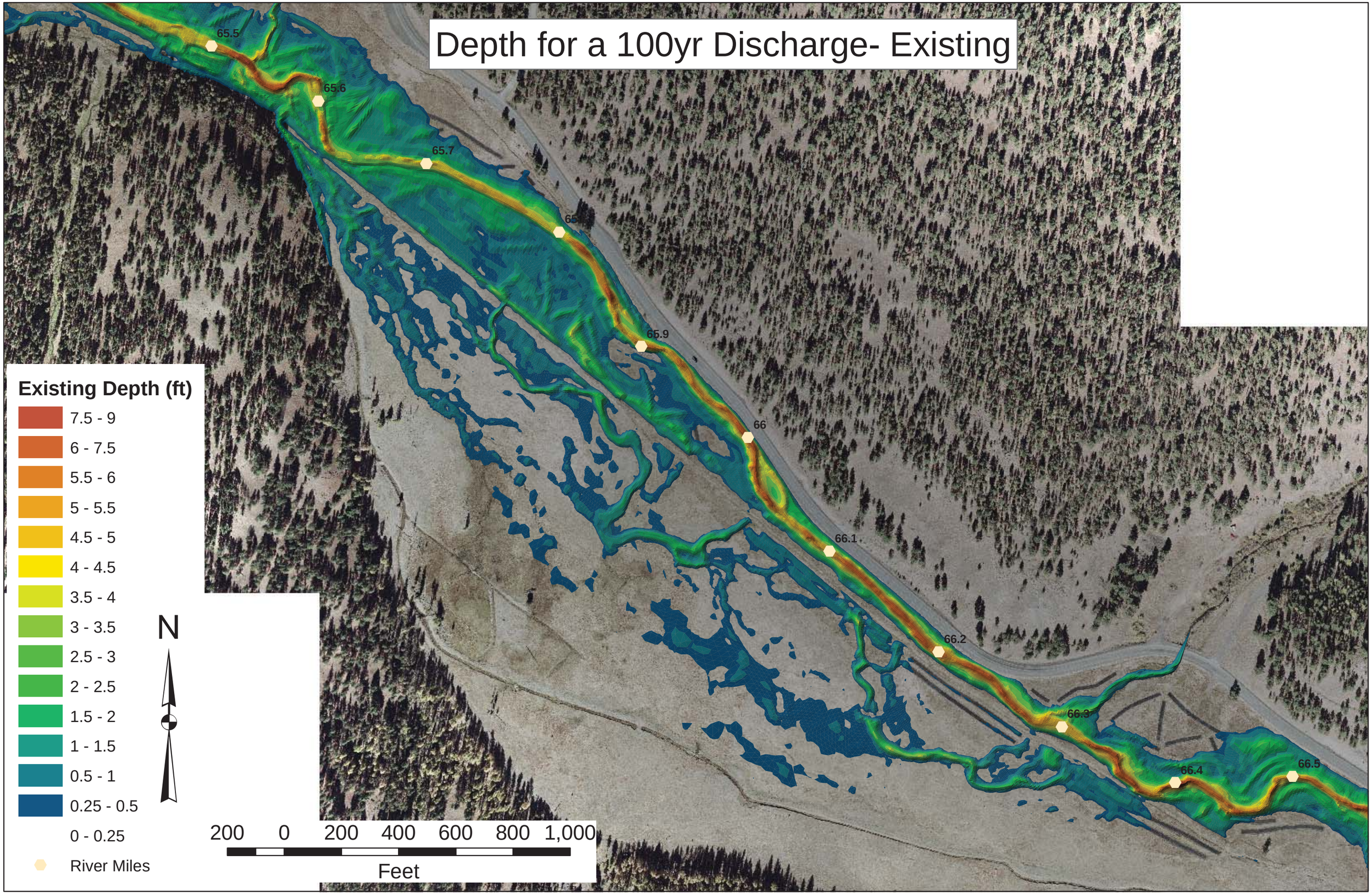
Depth for a 10yr Discharge- Existing Conditions

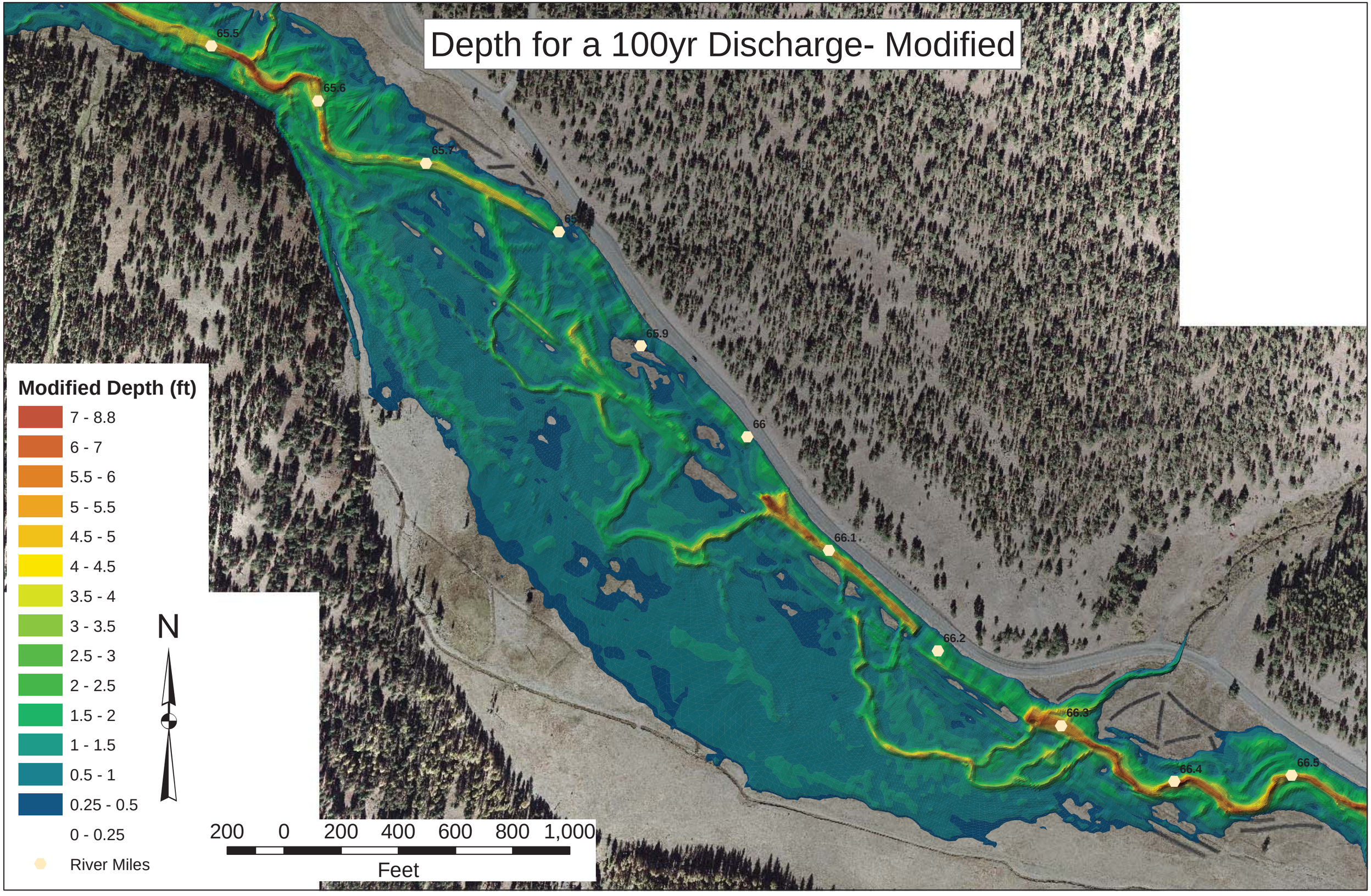



Depth for a 10yr Discharge- Modified Conditions
65.4
65.5
65.6
65.7
65.9
66
66.1
66.2
66.3
66.4
66.5
Modified Depth (ft)
Elevation
6 - 7.9
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
0 - 0.1
River Miles
N
200 0 200 400 600 800 1,000
Feet


Difference in Depth for a 100yr Discharge
Difference in Depth (ft)
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0.1 - 0.25
-0.1 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-1 - -0.5
-1.5 - -1
-2 - -1.5
-2.5 - -2
-3 - -2.5
-3.5 - -3
-4 - -3.5
-5 - -4
-6.5 - -5
-6.807 - -6.5
-6.807
River Miles
N
200 0 200 400 600 800 1,000
Feet
65.5
65.6
65.7
65
65.9
66
66.1
66.2
66.3
66.4
66.5

Depth for a 100yr Discharge- Existing




Depth for a 100yr Discharge- Modified
65.5
65.6
65.7
65
65.9
66
66.1
66.2
66.3
66.4
66.5
Modified Depth (ft)
7 - 8.8
6 - 7
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.25 - 0.5
0 - 0.25
River Miles
N
200 0 200 400 600 800 1,000
Feet