Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Groundwater Study
Study Plan Section 7.5

2014-2015 Study Implementation Report

Appendix A

Preliminary Water Table Contour Maps for Focus Areas FA-104 (Whiskers Slough), FA-115 (Slough 6A), FA-128 (Slough 8A), and FA-138 (Gold Creek)

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Pacific Groundwater Group

November 2015

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
AEA	Alaska Energy Authority
FA	Focus Area
FERC	Federal Energy Regulatory Commission
GW/SW	Groundwater
ISR	Initial Study Report
OWFRM	Open-water Flow Routing Model
PRM	Project River Mile
Project	Susitna-Watana Hydroelectric Project, FERC No. 14241
QC	Quality Control
RSP	Revised Study Plan
SIR	Study Implementation Report
SW	Surface Water
USGS	United States Geological Survey

1. INTRODUCTION

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC) its Revised Study Plan (RSP) (AEA 2012) to support the federal licensing process of the Susitna-Watana Hydroelectric Project, FERC No. 14241 (Project). The RSP included 58 individual study plans (AEA 2012). Included within the RSP was the Groundwater Study, Section 7.5. RSP Section 7.5 focuses on providing an overall understanding of groundwater (GW)/surface water (SW) interactions at both the watershed- and local- scales.

Operation of the Project is expected to change the hydrologic characteristics of the riverine portion of the drainage downstream of the proposed dam and the mainstem Susitna River reach inundated by the Project reservoir. Project operations will cause seasonal, daily, and hourly changes in Susitna River flows compared to existing conditions. The potential alteration in flows will influence downstream resources/processes, including fish and aquatic biota and their habitats, channel form and function including sediment transport, water quality, GW/SW interactions, ice dynamics, and riparian and wildlife communities.

With respect to GW, studies have documented the importance of GW upwelling in the selection of spawning areas within the Middle River Segment of the Susitna River by sockeye and chum salmon (Summary Review of Susitna River Aquatic and Instream Flow Studies Conducted in the 1980s with Relevance to Proposed Susitna – Watana Dam Project – 2012: A Compendium of Technical Memoranda, Submitted to FERC March 25, 2013 [R2 2013]; Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables, Submitted to FERC September 17, 2014 [R2 2014]; Habitat Suitability Criteria Development, Submitted to FERC November 2015 [R2 2015a]). In addition, GW upwelling plays an important role in maintaining suitable SW temperatures for egg incubation, fry development, and juvenile salmonid rearing during the winter months (R2 2013; Lorenz and Filer 1998; Douglas 2006; Durst 2000). Groundwater may also play an important role in the sustainability of riparian communities within riverine systems (Nilsson and Berggren 2000; Henszey et al. 2004). The general zones of GW discharge to SW are dependent upon interaction between the river SW stage and GW in the underlying aquifer. Groundwater upwelling in lateral habitats can be generated from small scale features within the hyporheic zone of a stream system or from large scale recharge/discharge features within a GW basin. The GW Study (Study 7.5) was specifically designed to evaluate potential Project operational effects on GW/SW interactions and how those effects may translate to the riparian ecosystem (RIFS Study 8.6) and fish and aquatic habitats (IFS Study 8.5).

2. STUDY OBJECTIVES

During a Groundwater Study Technical Team Meeting on December 5, 2014, a set of preliminary water table maps for Focus Areas (FA) FA-104 (Whiskers Slough), FA-115 (Slough 6A), FA-128 (Slough 8A), and FA-138 (Gold Creek) representing a Late Fall time-step (Sept 29-Oct 1, 2014) were presented and discussed (SIR Study 7.5, Appendix D, December 5, 2014 Technical Team Meeting Notes and Presentation, Submitted to FERC November 2015 [GWS 2015]). The maps proved useful for spatially depicting GW levels at different locations within the Focus Area and for potentially differentiating riverine versus upland dominated categories of GW. As a result, AEA commissioned the development of a time series of water table maps reflective of different seasonal conditions and associated river stages within each of the above Focus Areas. This appendix (Appendix A), describes the development of GW and SW elevation contour maps (water-level contour maps) for discrete target dates and specific Focus Areas and describes the direction of GW flow, slope of elevation gradients, and where possible provides interpretations of general upwelling or GW discharge zones.

3. STUDY AREA

As established by RSP Section 7.5.3, the overall study area related to GW processes includes primarily the Middle River Segment of the Susitna River that extends from Project River Mile (PRM) 102.4 to PRM 187.1 as well as portions of the Lower River Segment associated with domestic wells and riparian transect locations in the Lower River Segment, and the lowest portion of the Upper River Segment near the proposed Watana Dam Site associated with potential GW changes relative to reservoir construction and operations. Figure 3-1 shows these river segments and the general watershed boundary of the Susitna River. Figure 3-2 shows the location of the ten Focus Areas that have been identified for intensive investigation (Initial Study Report [ISR] Study 8.5, Section 4.2.2 [AEA 2014]). This current study element involves the development of water-level contour maps for four Focus Areas: FA-104 (Whiskers Slough), FA-115 (Slough 6A), FA-128 (Slough 8A), and FA-138 (Gold Creek).

4. METHODS

As an initial step in the development of the maps, six different time periods were identified as representative of seasonal patterns of Susitna River GW and SW levels. Those time periods corresponded to conditions during the Fall (September 13, 2013), Late Fall (October 9, 2013), Ice Cover/Ice Jam (February 20, 2014), Pre-breakup (April 20, 2014), Post-breakup (July 11, 2014), and Summer (August 13, 2014) (Table 4-1). Selection of representative dates for the open-water periods were based on a review of flow records for United States Geological Survey (USGS) Gage on the Susitna River at Gold Creek (Gage No. 15292000). The Post-breakup and Fall dates represent higher flows and the Late Fall and Summer dates represent relatively low flows. The date selected for Summer conditions included diurnal glacial melt fluctuations. Selection of dates during the ice covered period was based on a review of discharge measurements during those periods that coincided with GW well data. The Ice Cover/Ice Jam date coincided with development of an ice jam and flooding of lateral habitats within FA-128 (Slough 8A); the Pre-breakup date represented a relatively low flow under ice condition.

A total of six maps corresponding to those six time periods were developed for FA-104 (Whiskers Slough) and FA-128 (Slough 8A), three maps corresponding to three time periods were developed for FA-138 (Gold Creek), and two maps corresponding to two periods were developed for FA-115 (Slough 6A). The number of maps developed for each Focus Area was based in part on the availability of GW data from the respective network of wells within each area, and the relative number of time steps needed to evaluate important biological functions occurring in each. For example, both FA-104 (Whiskers Slough) and FA-128 (Slough 8A) support important fish life history functions on a year-round basis including spawning (Fall and Late Fall), egg incubation and overwintering juvenile rearing (Late Fall, Ice Cover/Ice Jam, and Pre-breakup), and fry emergence, juvenile rearing, and smolt outmigration (Post-breakup and Summer). In comparison, FA-115 (Slough 6A) contains primarily juvenile rearing habitat which can be limiting during the Late Fall (low flow) and Post-breakup (relatively high flow) periods. The specific dates selected for the respective Focus Areas are depicted in Table 4-1.

Development of the water table maps was achieved by first assembling the respective Quality Control (QC) Level 3 water level data for each of the wells and SW measurement stations within the area for the specified dates. These data sets included both telemetered and self-logging data as well as manual measurements where available. The Open-water Flow Routing Model (OWFRM) (Study 8.5) was also used to estimate water levels within the centerlines of each of the Focus Areas for the respective dates during the open-water period. These data sets were then combined and served as the basis for geo-spatially defining elevational isopleths (contours) within each Focus Area. Specific contours were defined first by the empirical data available at each well and then where practical, a combination of visual interpretation and interpolation. The number and density of contours was limited for certain Focus Areas due in part to data limitations for specific dates of interest and the spatial array of wells (e.g., FA-138 [Gold Creek]).

Data processing was facilitated through development of a Microsoft Access database of water-level measurements compiled from the following three information sources for GW and SW and sample points in each of the four Focus Areas:

1. Average value of pressure transducer readings over the 24-hour period on the target dates. These data were culled from individual excel files of QC3 validated data.
2. River elevation at transects on the target dates based on the OWFRM (Updated Fluvial Geomorphology Modeling Approach, Submitted to FERC May 27, 2014 [Tetra Tech 2014] and Open-water Hydrology Data Collection and Open-water Flow Routing Model (Version 2.8), Submitted to FERC November 2015 [R2 2015b]).
3. Manual measurements collected at a single point that were within 0 to 18 days of the target dates. Manual measurements were from individual excel files of QC3 validated data.

For each target date and Focus Area, all water-level elevations derived from the daily averaged pressure transducer readings and OWFRM transects were used. Manual water-level elevations were included and shown on contour maps when no pressure transducer readings were available. It should be noted that manual measurements were not always collected on the target date, and therefore may not be representative of water-level elevation conditions on the target date. Manual measurements were shown on the maps and some measurements were excluded from contouring based on professional judgement. A quantitative inclusion/exclusion criteria based on hydrographs of the Middle River Segment of the Susitna River may be appropriate but was not developed.

The GW wells were completed at depths between 5 and 16 feet with 2 foot screen intervals. Wells are assumed to be completed in an unconfined or water-table aquifer and representative of water-table conditions.

All locations reported in this Appendix use the AK SP Zone 4 NAD 1983 projection. All elevations reported in this Appendix use the NAVD88/Geoid09 datum.

5. WATER-LEVEL CONTOUR MAP DISCUSSION

Water-level contour maps were prepared for the two to six discrete target dates and four specific Focus Areas. A general description of GW flow direction, gradients, and general upwelling or GW discharge zones in each Focus Area is discussed below in Sections 5.1 to 5.4.

Groundwater flow generally is from areas of recharge to areas of discharge, in the direction of decreasing water-level elevation and perpendicular to the water-level elevation contours. For example, when GW elevations are higher than paired SW elevations, water-table flow is toward SW and the relationship suggests GW discharge to SW (upwelling). When GW elevations are lower than paired SW elevations, water-table flow is away from SW and may be indicative of bank storage or recharge (downwelling).

5.1. FA-104 (Whiskers Slough)

Groundwater and SW sample point locations are shown on Figure 5.1-1 and water-level elevations on Figures 5.1-2 to 5.1-7. During Fall, Late Fall, Ice Cover/Ice Jam, Pre-Breakup, and Summer, the GW contours indicate flow generally parallel to or towards the Susitna River and some portions of Whiskers Creek and Whiskers Slough. This results in generally gaining conditions to the Susitna River. The Late Fall, Ice Cover/Ice Jam, and Pre-Breakup flow directions are more directly towards the Susitna River and are less parallel than Fall and Summer contours. The contour map prepared for the Post-Breakup period suggests flows are trending away from the Susitna River, although data sparsity increases the uncertainty of this.

There are paired GW and SW sample points for stations 104-1, 104-5, 104-8, 104-9, and 104-10 available on one or more target dates for calculating the difference in water-level elevations (Table 5.1-1).

5.2. FA-115 (Slough 6A)

Groundwater and SW sample point locations are shown on Figure 5.2-1 and water-level elevations on Figures 5.2-2 and 5.2-3. Only two target dates were selected for this Focus Area consisting of Late Fall (October 9, 2013) and Post-breakup (July 11, 2014). During both of these periods, water-level contours along the right bank in the vicinity of Slough 6A indicate flow is generally towards the Susitna River and possible gaining conditions along that reach (Figures 5.2-2 and 5.2-3).

Of the nine paired GW and SW stations, paired data was available for four stations (115-2, 115-3, 115-5, and 115-7) on one or more of the target dates for calculating the difference in water-level elevations (see Table 5.2-1 below).

5.3. FA-128 (Slough 8A)

Groundwater and SW sample point locations are shown for FA-128 (Slough 8A) on Figure 5.3-1 and water-level elevations on Figures 5.3-2 to 5.3-7. Overall, FA-128 (Slough 8A) has the greatest number of sample locations of the four Focus Areas enabling the development of more detailed water level contour maps. The general pattern of water-level elevation contours during all six periods indicates horizontal GW flow in the downstream (downstream west-southwest) direction across FA-128 (Slough 8A) with some localized areas of divergent and convergent GW flow. The general gradient is either parallel to or slightly away from the axis of the mainstem of the Susitna River toward Slough 8A, with possible gaining conditions along portions of that reach (e.g., stations 128-6 and 128-7) during most periods. This pattern indicates the Susitna River is either relatively neutral (neither gaining nor losing) or losing water along this reach except in areas of localized divergent flow as discussed below. Also, shorter term gain and loss may occur that is not represented by the time-averaged maps.

Divergent flow is apparent on the northern area of the large island located between the Upper Side Channel 8A and Slough 8A. At this location, GW mounding occurs at well station 128-26-W1 during all six periods, with highest elevations during Ice Cover/Ice Jam and Post-breakup. A second GW mound also occurs at nearby station 128-3-W1 during three of the six periods (Fall, Late Fall, and Ice Cover/Ice Jam). Groundwater mounding in these areas suggests localized recharge and/or perched GW conditions (i.e., water table is locally perched on an underlying low permeable geologic unit such as silt or clay). Groundwater mounding in this area results in radial GW flow towards the Susitna River, Slough 8A, and Middle Side Channel 8A. Localized recharge at this location could be from direct precipitation, bank storage, and SW recharge from the main channel of the Susitna River during high stage events. Groundwater elevations are lower than paired SW elevations at stations 128-2 and 128-5 during most periods suggesting losing conditions towards the large island at those locations.

Convergent flow is apparent in a localized area of the smaller island located between the Middle Side Channel 8A and the Upper Half Moon Bay Side Channel. Depressed water-level elevations occur at SW station 128-11-SW during the Fall and Ice/Cover/Ice Jam periods and in nearby GW station 128-11-W1 during the Late Fall and Summer periods. Groundwater depressions suggest areas of localized discharge; although upward gradients, which characterize discharge areas, at station 128-11 were only evident during the Fall and Pre-breakup Periods (Table 5.3-1).

There are paired GW and SW sample points for stations 128-2, 128-5, 128-6, 128-7, 128-9, 128-11, 128-12, 128-13, 128-15, 128-16, and 128-22 available on one or more target dates for calculating the difference in water-level elevations (Table 5.3-1 below).

5.4. FA-138 (Gold Creek)

Groundwater and SW sample point locations for FA-138 (Gold Creek) are shown on Figure 5.4-1 and water-level elevations on Figures 5.4-2 to 5.4-4. During the Late Fall, Pre-breakup, and Post-breakup, GW contours along the right bank in the vicinity of Slough 14 indicate flow generally towards the Susitna River and gaining conditions (Figures 5.4-2 to 5.4-4).

There are paired GW and SW sample points for stations 138-1, 138-2, 138-6, and 138-7 available on one or more target dates for calculating the difference in water-level elevations (Table 5.4-1 below).

6. DISCUSSION AND RECOMMENDATIONS

The water level contour maps presented in this Appendix provide an indication of how GW levels respond to changes in river stage under existing conditions, and will therefore be informative for assessing GW Project operational responses. The maps and information used in their development will be used and integrated with other data, analyses and models for evaluating how Project operations may influence GW/SW interactions over space and time, and the resulting effects on riparian (RIFS Study 8.6) and aquatic habitats (IFS Study 8.5).

As previously noted, the level of detail presented in the maps was largely constrained by the number and density of GW wells within a given Focus Area, and the availability of paired GW and SW data sets for specific target dates. Thus, the water contour maps for FA-128 (Slough 8A) are the most detailed, followed by FA-104 (Whiskers Slough), and then FA-115 (Slough 6A) and FA-138 (Gold Creek). Further refinements to these maps may be possible by evaluating the relationship of GW levels to topography and where applicable, using those relationships to infer GW levels between wells in some Focus Areas. Furthermore, selection of target dates based on data availability would maximize the data used in development of the maps and may provide for a more detailed picture of GW flow directions. In doing so, it would still be important to evaluate the hydrographs during any selected target time period to evaluate water-level stability, as periods that are more stable could incorporate water-level measurements from a wider time frame.

As a further consideration, changes in gradient direction and resulting bank storage can be rapid and of short duration. The effects may also vary based on the type of hydrologic event: precipitation, ice dam, or river rise. Evaluation of short duration temporal variations in gradient directions should be evaluated on a station by station basis in response to the various hydrologic events. If there are spatial and temporal patterns discerned, then these could be generalized to areas outside the Focus Areas.

7. LITERATURE CITED

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8. TABLES

Table 4-1. Focus Areas and respective target dates for development of Water-Level Contour Maps for the Susitna River.

Focus Area	9/13/2013 Fall	10/9/2013 Late Fall	2/20/2014 Ice Cover / Ice Jam	4/20/2014 Pre-breakup	7/11/2014 Post-breakup	8/13/2014 Summer
FA-104 (Whiskers Slough)	X	X	X	X	X	X
FA-115 (Slough 6A)		X			X	
FA-128 (Slough 8A)	X	X	X	X	X	X
FA-138 (Gold Creek)		X		X	X	

Table 5.1-1. FA-104 (Whiskers Slough), Water-Elevation Differences between Paired Groundwater and Surface-Water Sample Points for the Susitna River. See Figure 5.1-1 for point locations.

Station Pairs	9/13/2013 Fall	10/9/2013 Late Fall	2/20/2014 Ice Cover / Ice Jam	4/20/2014 Pre-breakup	7/11/2014 Post-breakup	8/13/2014 Summer
104-1 (104-1-W1 & 104-1-SW)	0.00	-0.07		**+0.16**	-0.01	0.00
104-5 (104-5-W1 & 104-5-1-SW)	**+0.47**	**+0.42**	**+0.36**	**+0.32**		
104-5 (104-5-W1 & 104-5-2-SW)	-0.78	-1.35	-0.21	-0.36		
104-8 (104-8-W2 & 104-8-SW)	**+3.22**	**+1.66**		**+2.20**		
104-9 (104-9-W1 & 104-9-SW)						
104-10 (104-10-W1 & 104-10-SW)	**+1.33**	**+1.84**	**+1.32**	**+1.30**		

Notes:

1. + plus sign indicates the groundwater elevation is **higher** than the paired surface water elevation.
2. – minus sign indicates the groundwater elevation is **lower** than the paired surface water elevation.
3. Blanks indicate there is **insufficient data** to evaluate the relationship.
4. Water-level elevation difference in feet. Positive values shown in bold.
5. Manual measurements before or after the target date may not be representative of conditions on the target date, but was not evaluated for this table and no manual measurements were excluded.

Table 5.2-1. FA-115 (Slough 6A), Water-Elevation Difference between Paired Groundwater and Surface-Water Sample Points for the Susitna River. See Figure 5.2-1 for point locations.

Station Pairs	10/9/2013 Late Fall	7/11/2014 Post-breakup
115-2 (115-2-W1 & 115-2-SW)	**+0.74**	**+0.93**
115-3 (115-3-W1 & 115-3-SW)	**+1.12**	**+0.95**
115-5 (115-5-W1 & 115-5-SW)	-1.58	-0.85
115-7(115-7-W1 & 115-7-SW)		**+1.15**

Notes:

1. + plus sign indicates the groundwater elevation is **higher** than the paired surface water elevation.
2. – minus sign indicates the groundwater elevation is **lower** than the paired surface water elevation.
3. Blanks indicate there is **insufficient data** to evaluate the relationship.
4. Water-level elevation difference in feet. Positive values shown in bold.
5. Manual measurements before or after the target date may not be representative of conditions on the target date, but was not evaluated for this table and no manual measurements were excluded.

Table 5.3-1. FA-128 (Slough 8A), Water-Elevation Difference between Paired Groundwater and Surface-Water Sample Points for the Susitna River. See Figure 5.3-1 for point locations.

Station Pairs	9/13/2013 Fall	10/9/2013 Late Fall	2/20/2014 Ice Cover / Ice Jam	4/20/2014 Pre-breakup	7/11/2014 Post-breakup	8/13/2014 Summer
128-2 (128-2-W1 & 128-2-SW)	-1.01	-0.38	-1.60	-1.90		-2.63
128-5 (128-5-W1 & 128-5-1-SW)	-1.88	-0.20	-0.17	-0.16	-0.17	**+0.13**
128-6 (128-6-W1 & 128-6-SW)	0.00	0.00	**+0.56**	**+0.62**	**+0.91**	**+0.12**
128-7 (128-7-W1 & 128-7-SW)	**+0.15**	**+0.17**	-0.13	**+0.22**		
128-7 (128-7-W2 & 128-7-SW)	-0.32	0.00	-0.32	**+0.50**		-0.40
128-9 (128-9-W1 & 128-9-SW)	0.00	0.00	0.00			
128-11 (128-11-W1 & 128-11-SW)	**+2.51**	-0.69		**+0.34**	-0.46	-0.66
128-12 (128-12-W1 & 128-12-SW)	-1.03		-1.40	-2.45		-8.61
128-13 (128-13-W1 & 128-13-SW)	0.00	**+0.13**	-0.13	-0.29	-0.16	0.00
128-13 (128-13-W2 & 128-13-SW)		**+0.22**	-0.26	-0.43	-0.13	0.00
128-15 (128-15-W1 & 128-15-SW)		0.00		**+0.27**		
128-16 (128-16-W1 & 128-16-SW)		0.00		0.00		
128-22 (128-22-W1 & 128-22-SW)		0.00				

Notes:

1 + plus sign indicates the groundwater elevation is **higher** than the paired surface water elevation.
2 – minus sign indicates the groundwater elevation is **lower** than the paired surface water elevation.
3 Blanks indicate there is **insufficient data** to evaluate the relationship.
4 Water-level elevation difference in feet. Positive values shown in bold.
5 Manual measurements before or after the target date may not be representative of conditions on the target date, but was not evaluated for this table and no manual measurements were excluded.

Table 5.4-1. FA-138 (Gold Creek), Water-Elevation Difference between Paired Groundwater and Surface-Water Sample Points for the Susitna River. See Figure 5.4-1 for point locations.

Station Pairs	10/9/2013 Late Fall	4/20/2014 Pre-breakup	7/11/2014 Post-breakup
138-1 (138-1-W1 & 138-1-SW)	**+0.58**	**+0.01**	**+0.96**
138-1 (138-1-W2 & 138-1-SW)	**+1.02**	**+0.31**	**+1.68**
138-2 (138-2-W1 & 138-2-SW)	**+0.46**	**+0.36**	-0.02
138-2 (138-2-W2 & 138-2-SW)	**+0.72**	**+0.42**	**+0.26**
138-6 (138-6-W1 & 138-6-SW)	**+0.07**	**+0.05**	0.00
138-7 (138-7-W1 & 138-7-Susitna)	**+7.3**		
138-7 (138-7-W1 & 138-7-Slough)	-0.17		

Notes:

1. + plus sign indicates the groundwater elevation is **higher** than the paired surface water elevation.
2. – minus sign indicates the groundwater elevation is **lower** than the paired surface water elevation.
3. Blanks indicate there is **insufficient data** to evaluate the relationship.
4. Water-level elevation difference in feet. Positive values shown in bold.
5. Manual measurements before or after the target date may not be representative of conditions on the target date, but was not evaluated for this table and no manual measurements were excluded.

9. FIGURES

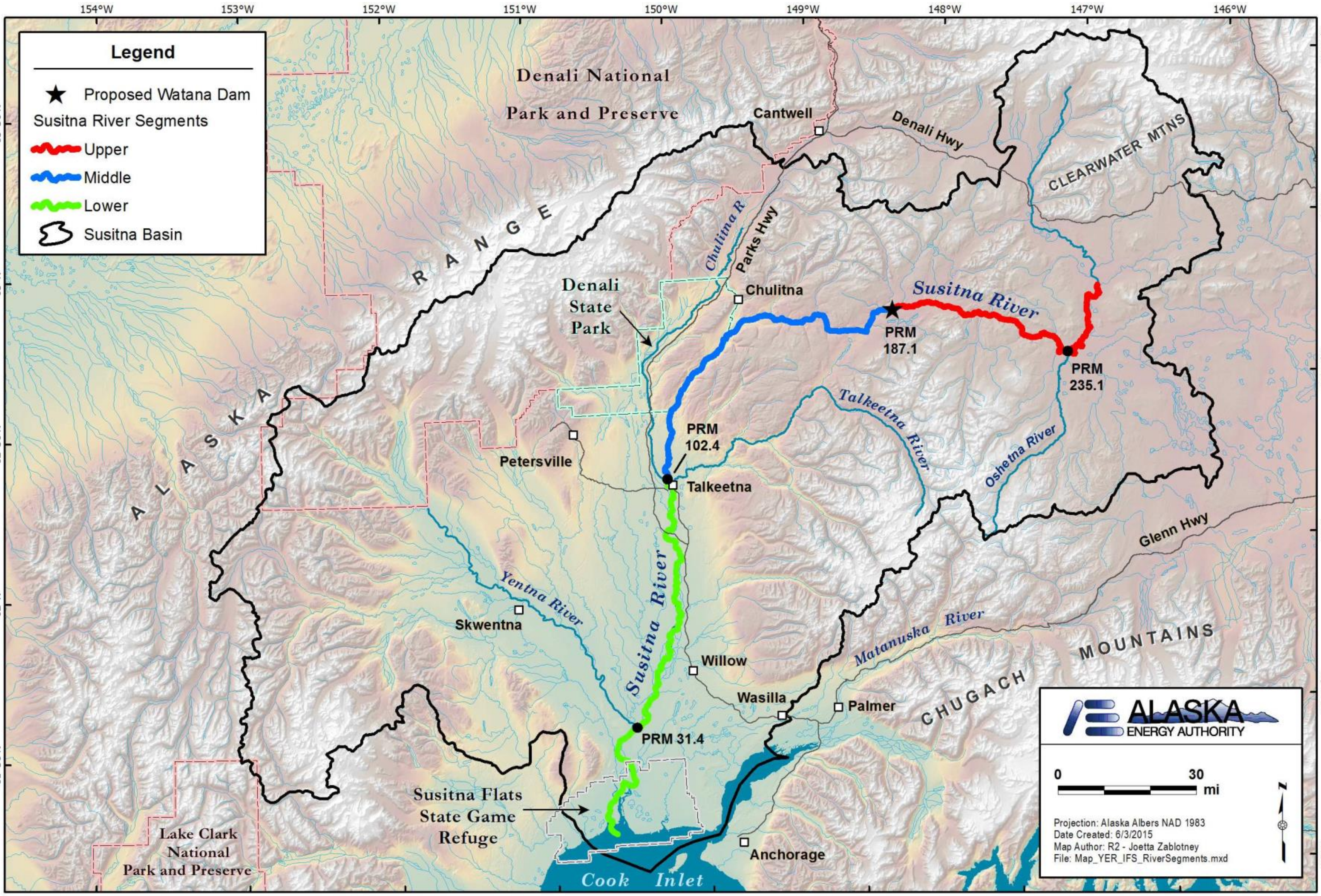

Figure 3-1. Susitna River Watershed Basin Boundaries, showing the Project designation of Upper, Middle, and Lower River segments.

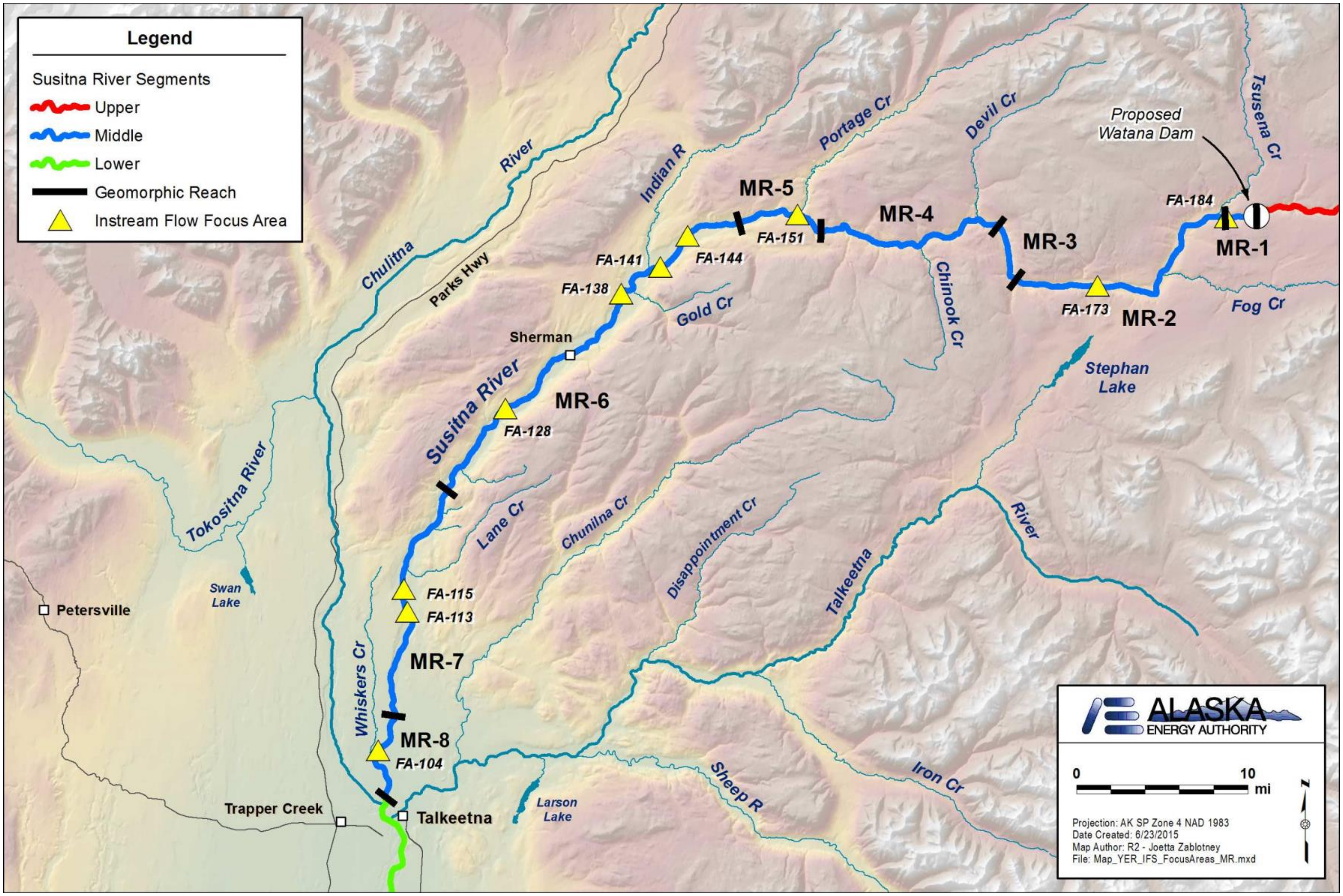

Figure 3-2. Susitna River Watershed Middle River Segment, with geomorphic reaches and Focus Areas indicated. Water level contour maps were developed for FA-104 (Whiskers Slough), FA-115 (Slough 6A), FA-128 (Slough 8A), and FA-138 (Gold Creek).

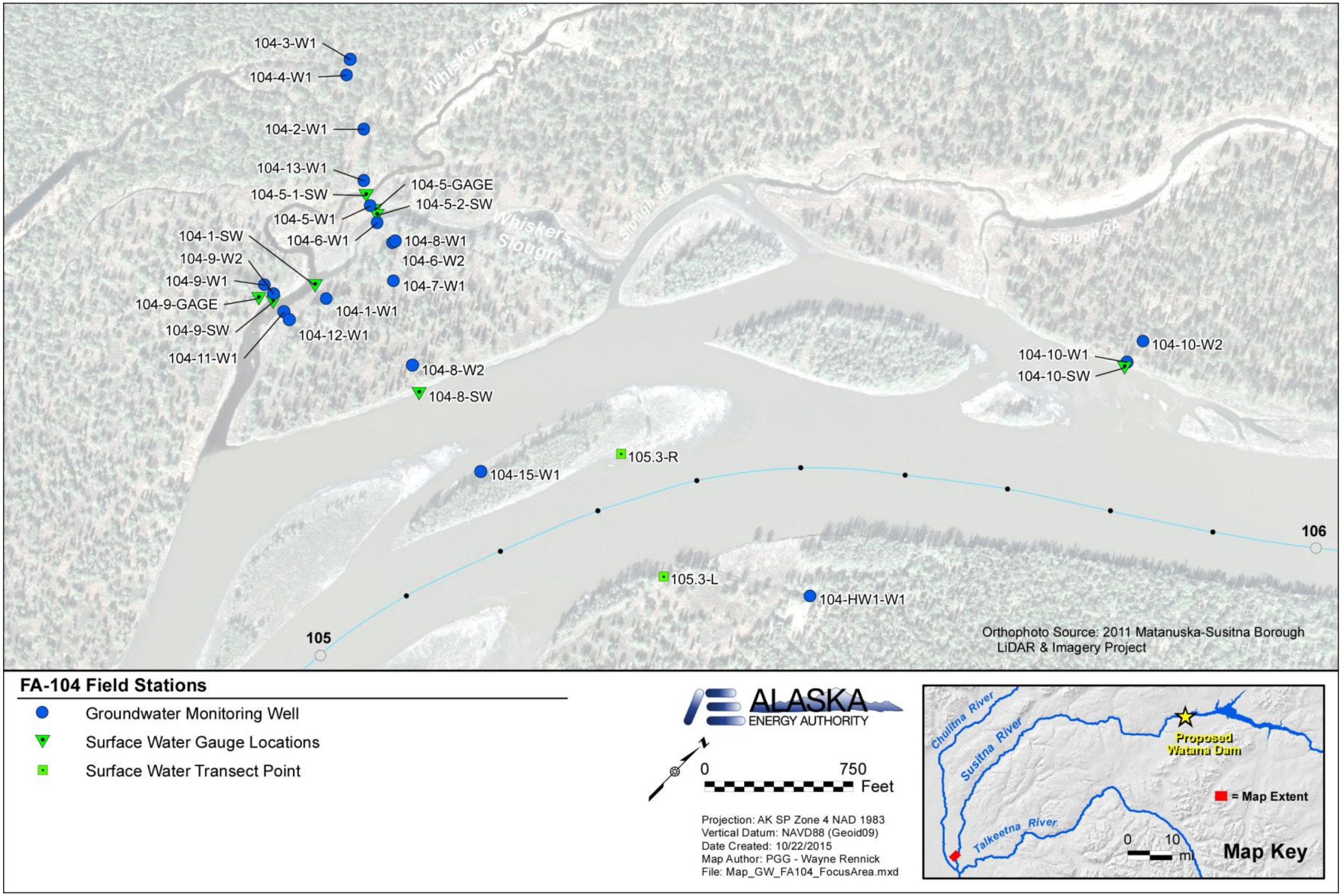

Figure 5.1-1. FA-104 (Whiskers Slough), showing groundwater and surface water monitoring locations, Susitna River.

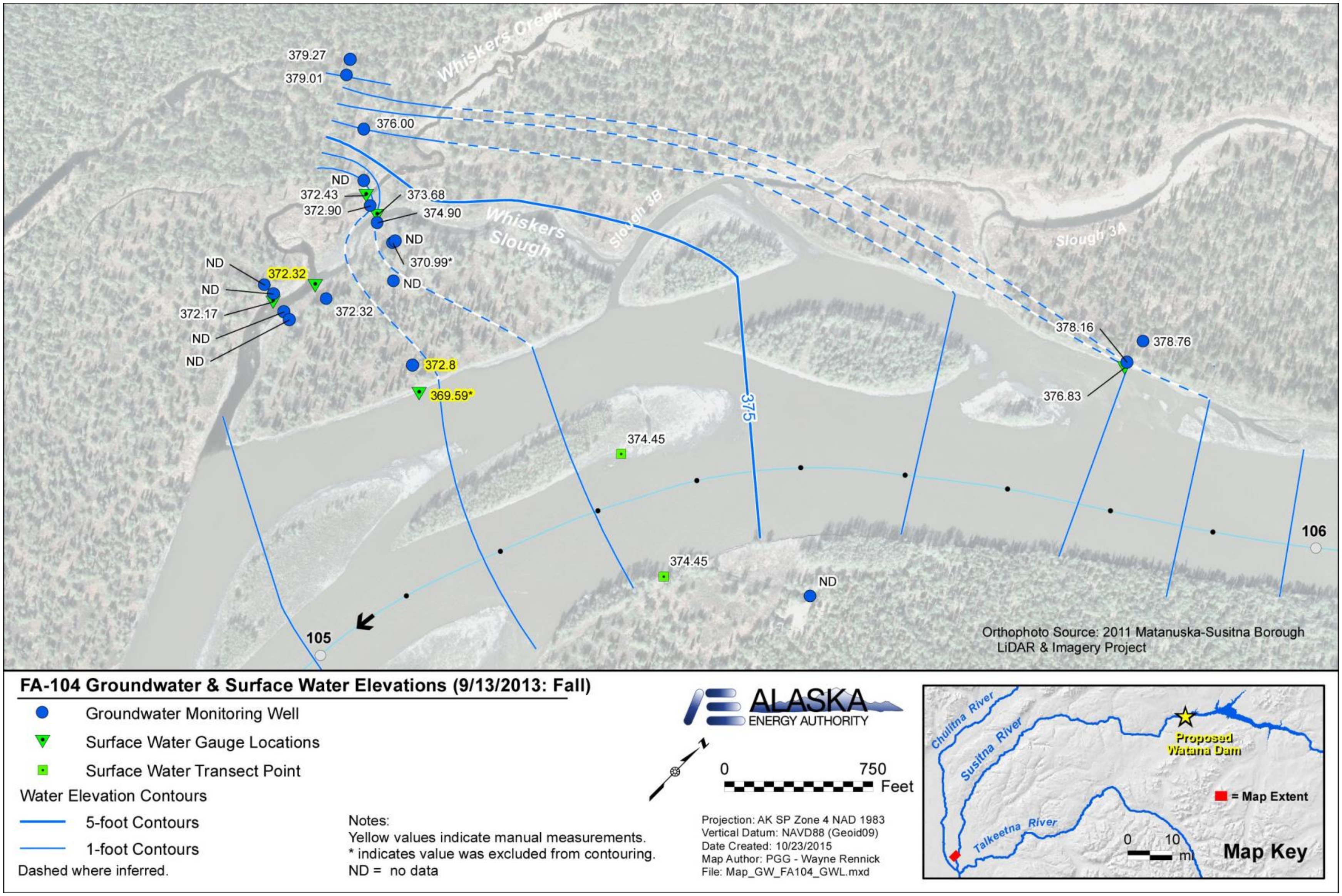

Figure 5.1-2. FA-104 (Whiskers Slough), showing water-level elevation contours for Fall – September 13, 2013, Susitna River.

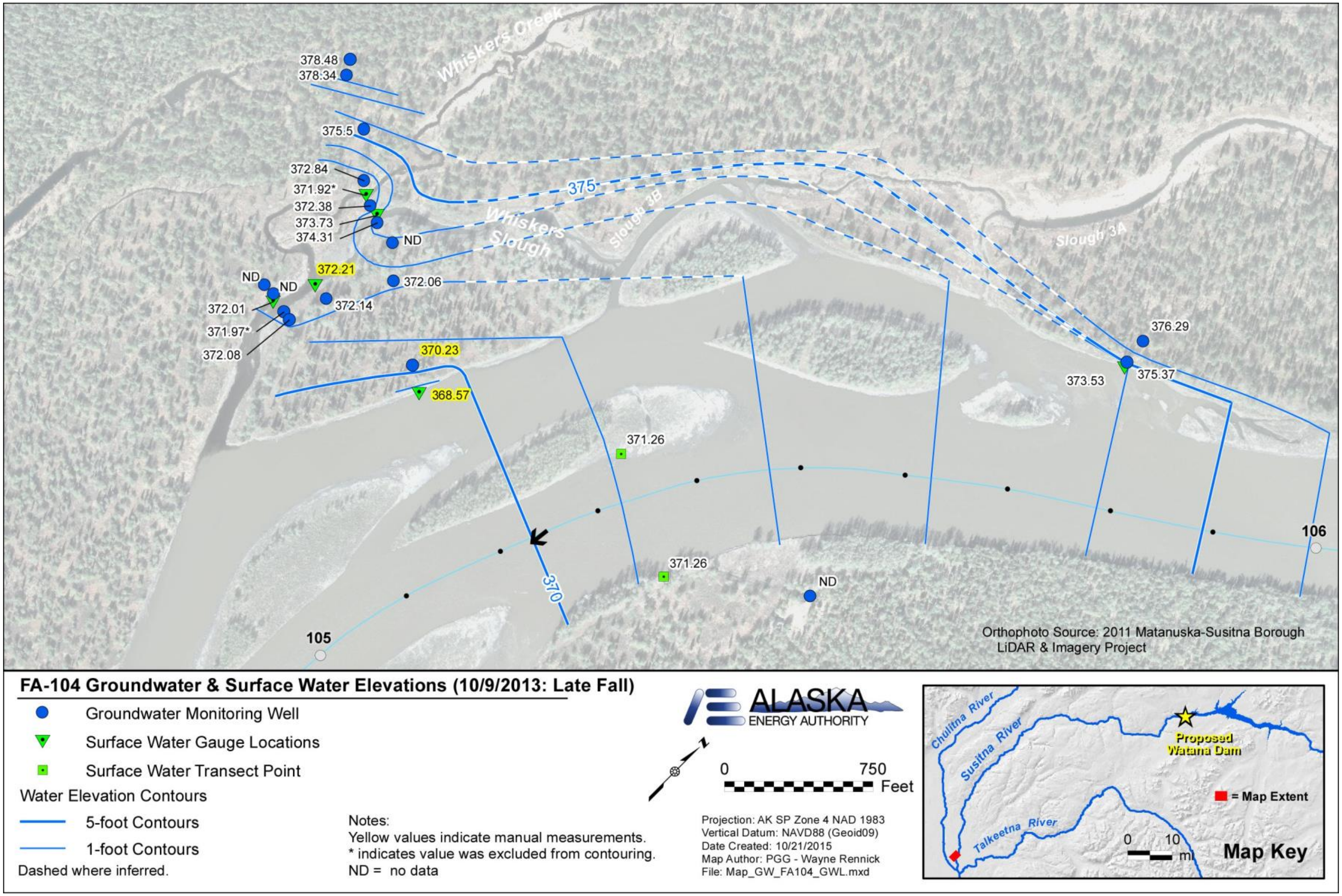

Figure 5.1-3. FA-104 (Whiskers Slough), showing water-level elevation contours for Late Fall – October 9, 2013, Susitna River.

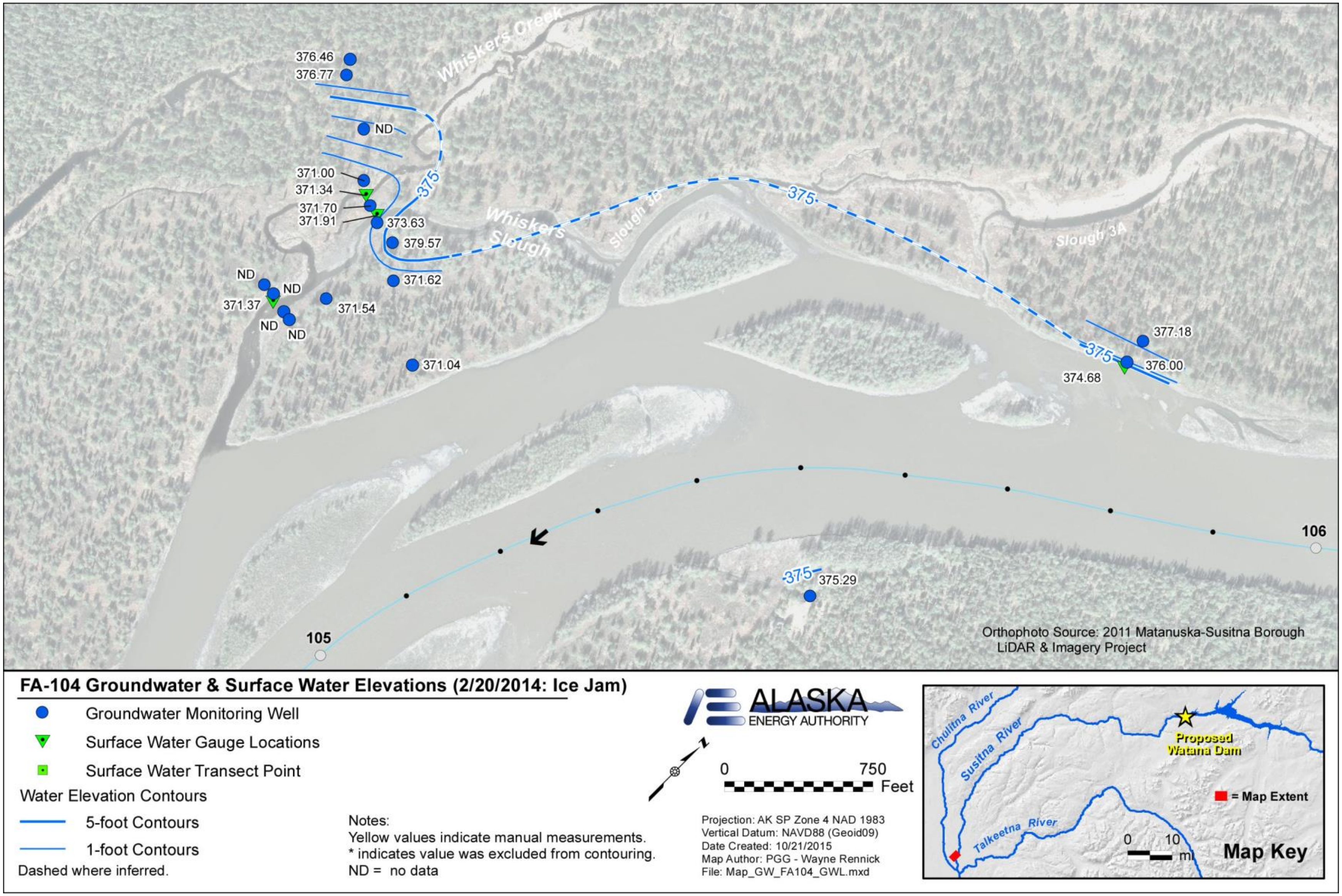

Figure 5.1-4. FA-104 (Whiskers Slough), showing water-level elevation contours for Ice Cover/Ice Jam – February 20, 2014, Susitna River.

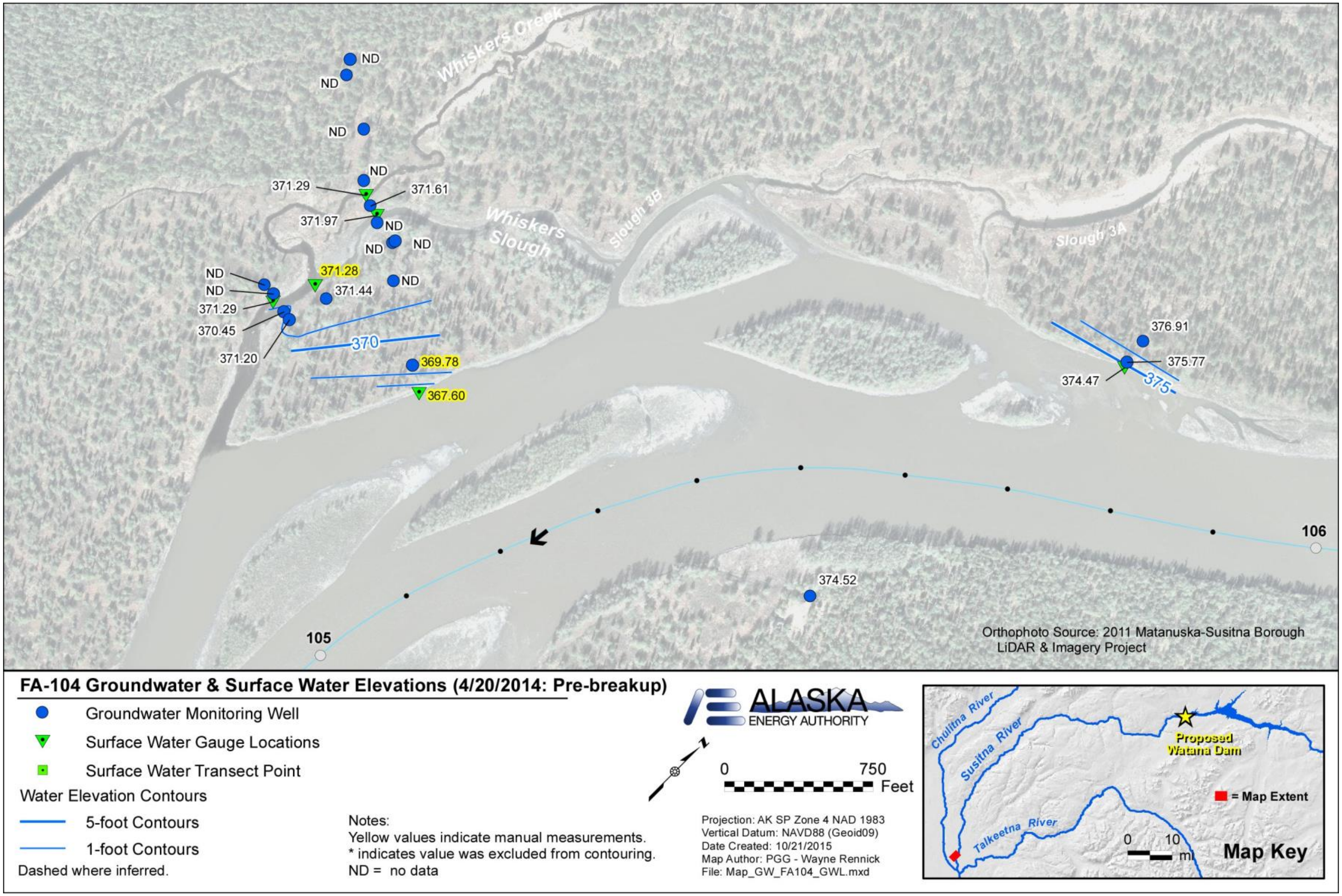

Figure 5.1-5. FA-104 (Whiskers Slough), showing water-level elevation contours for Pre-Breakup – April 20, 2014, Susitna River.

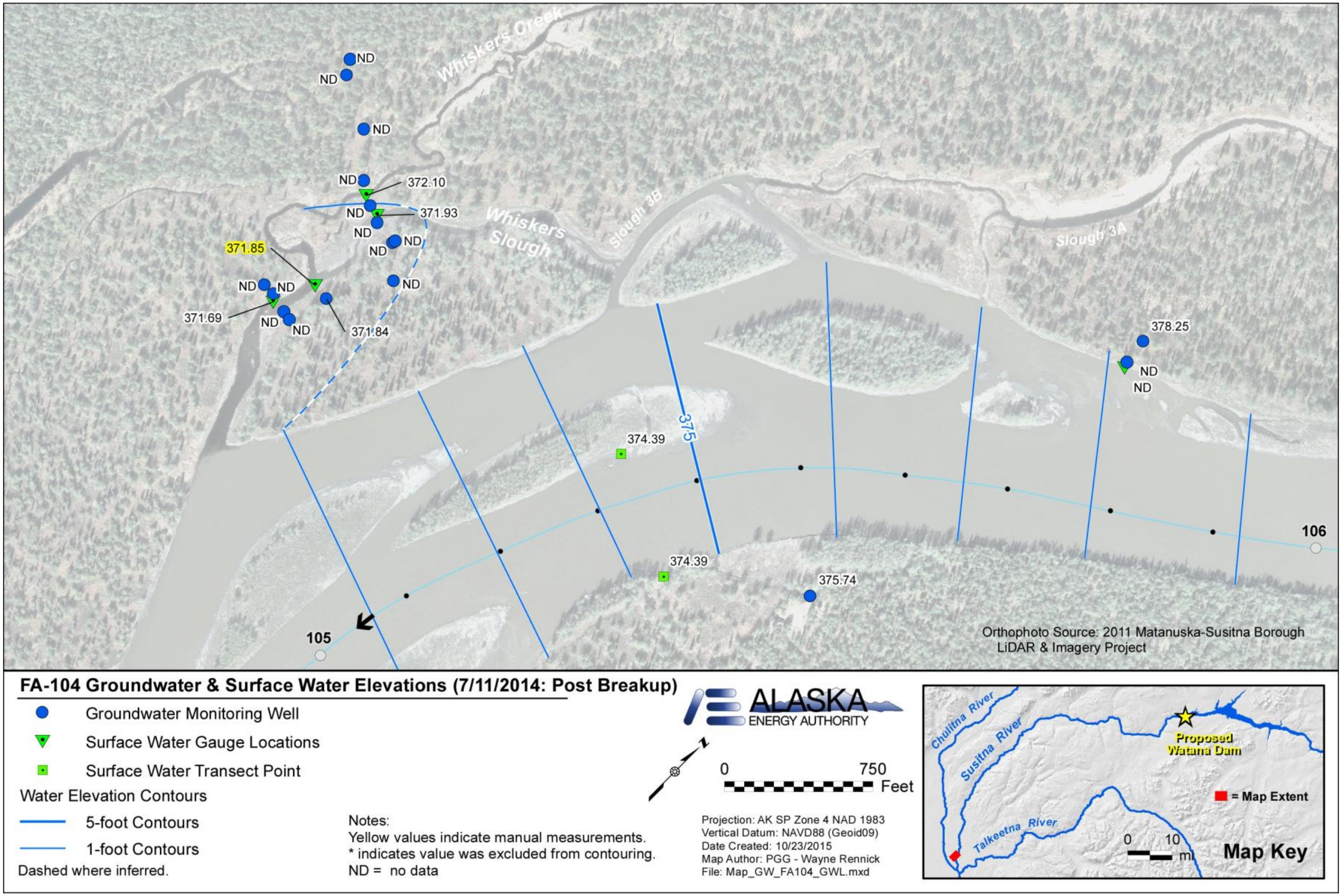

Figure 5.1-6. FA-104 (Whiskers Slough), showing water-level elevation contours for Post-breakup – July 11, 2014, Susitna River.

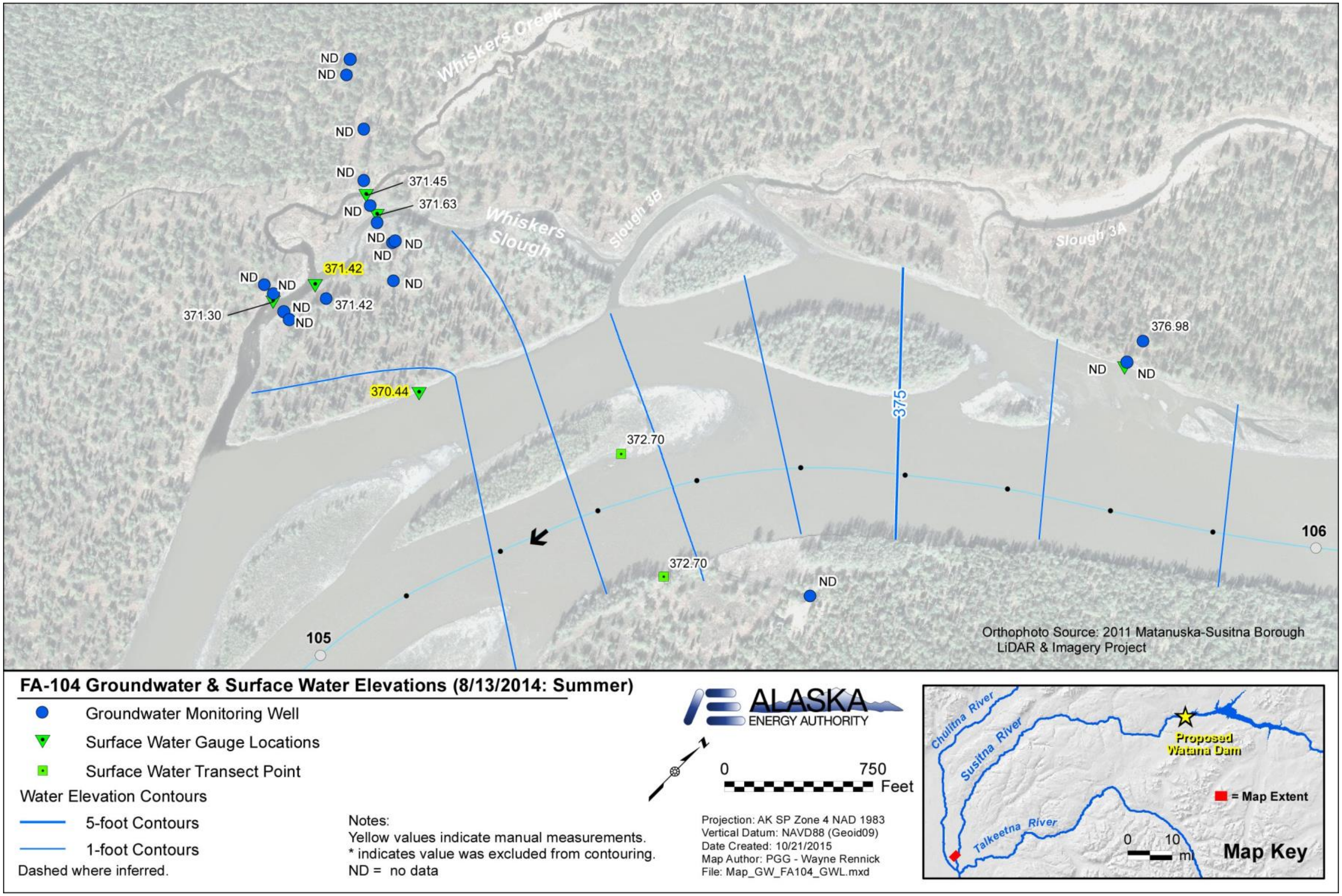

Figure 5.1-7. FA-104 (Whiskers Slough), showing water-level elevation contours for Summer – August 13, 2014, Susitna River.

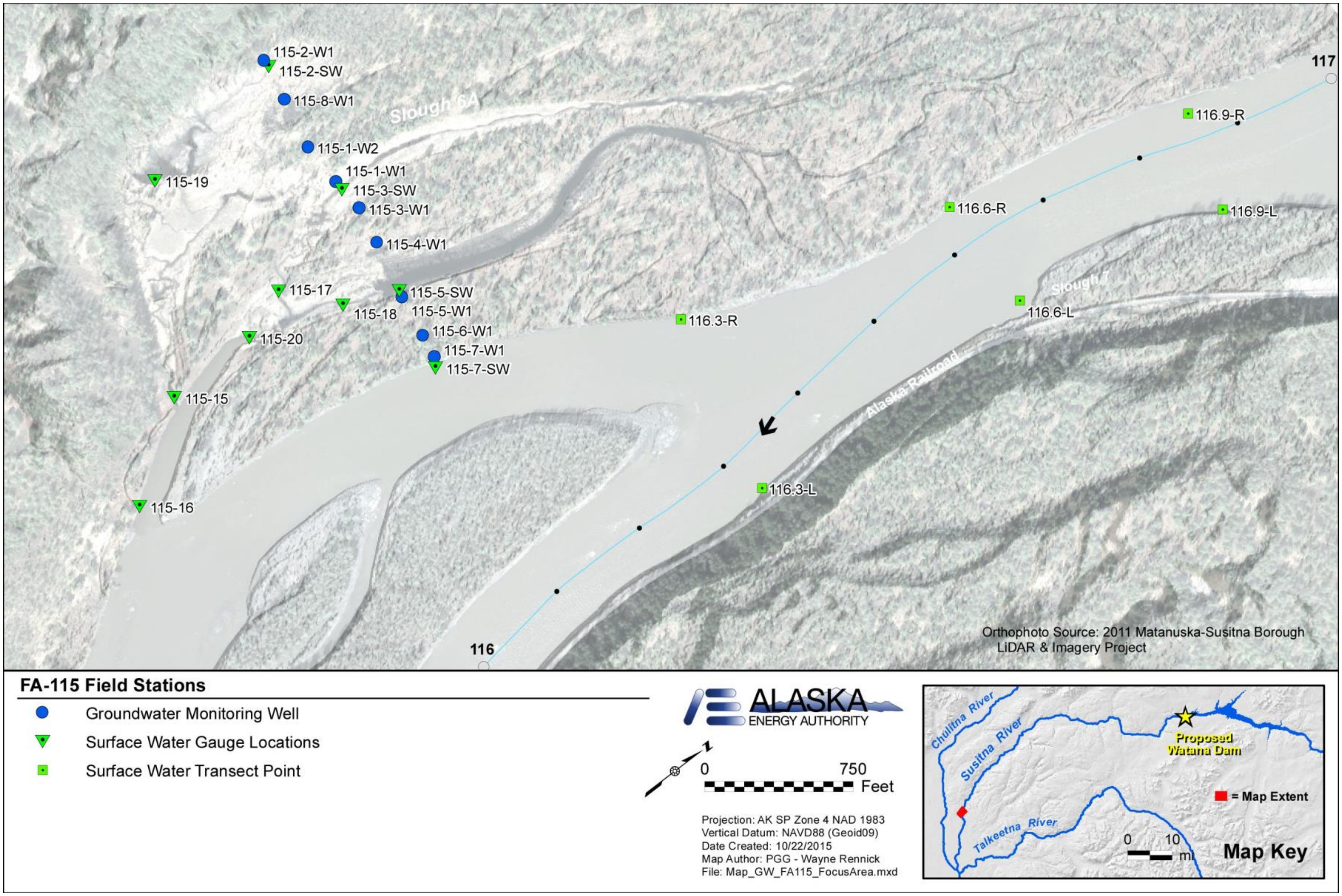

Figure 5.2-1. FA-115 (Slough 6A), showing groundwater and surface water monitoring locations, Susitna River.

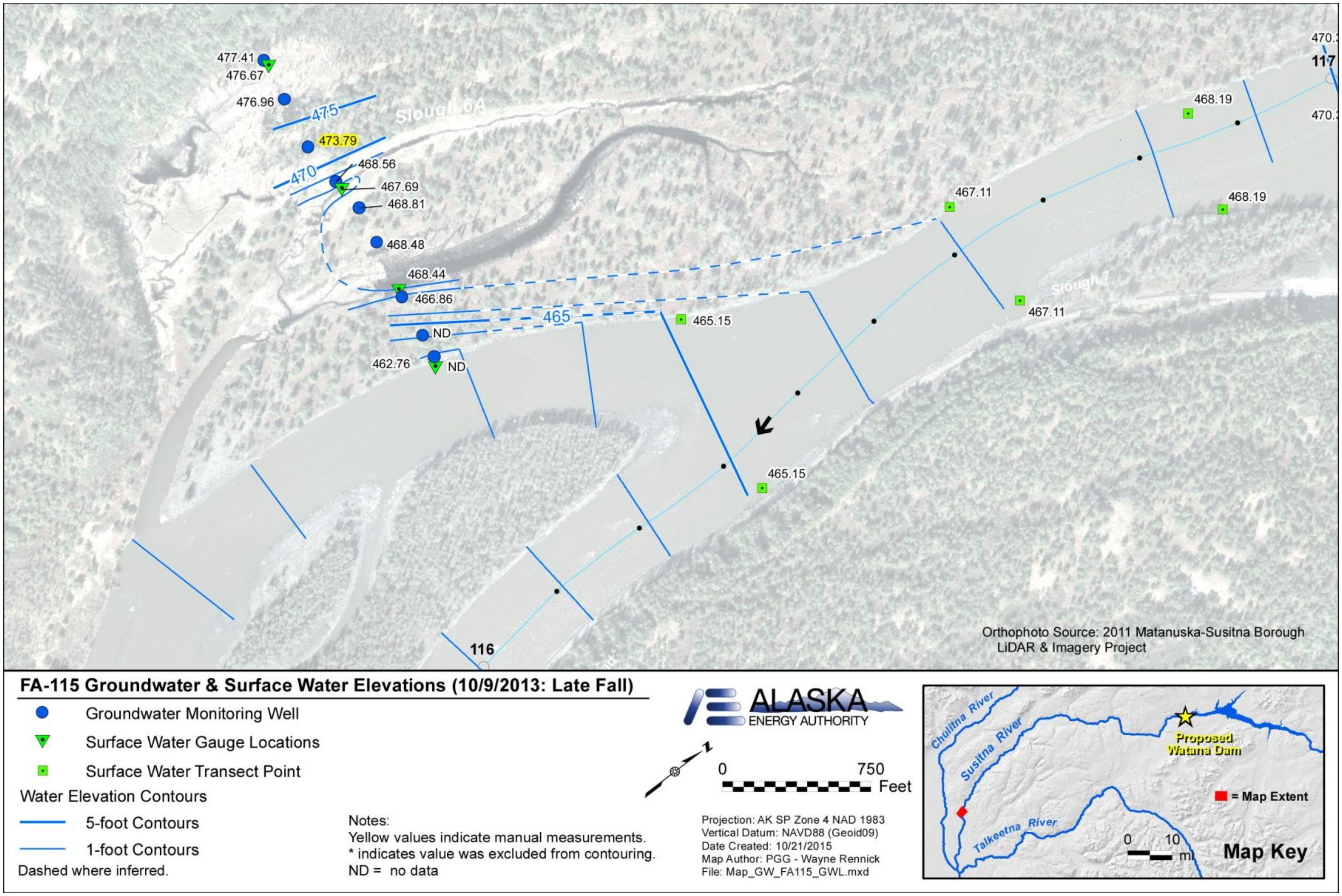

Figure 5.2-2. FA-115 (Slough 6A), showing water-level elevation contours for Late Fall – October 9, 2013, Susitna River.

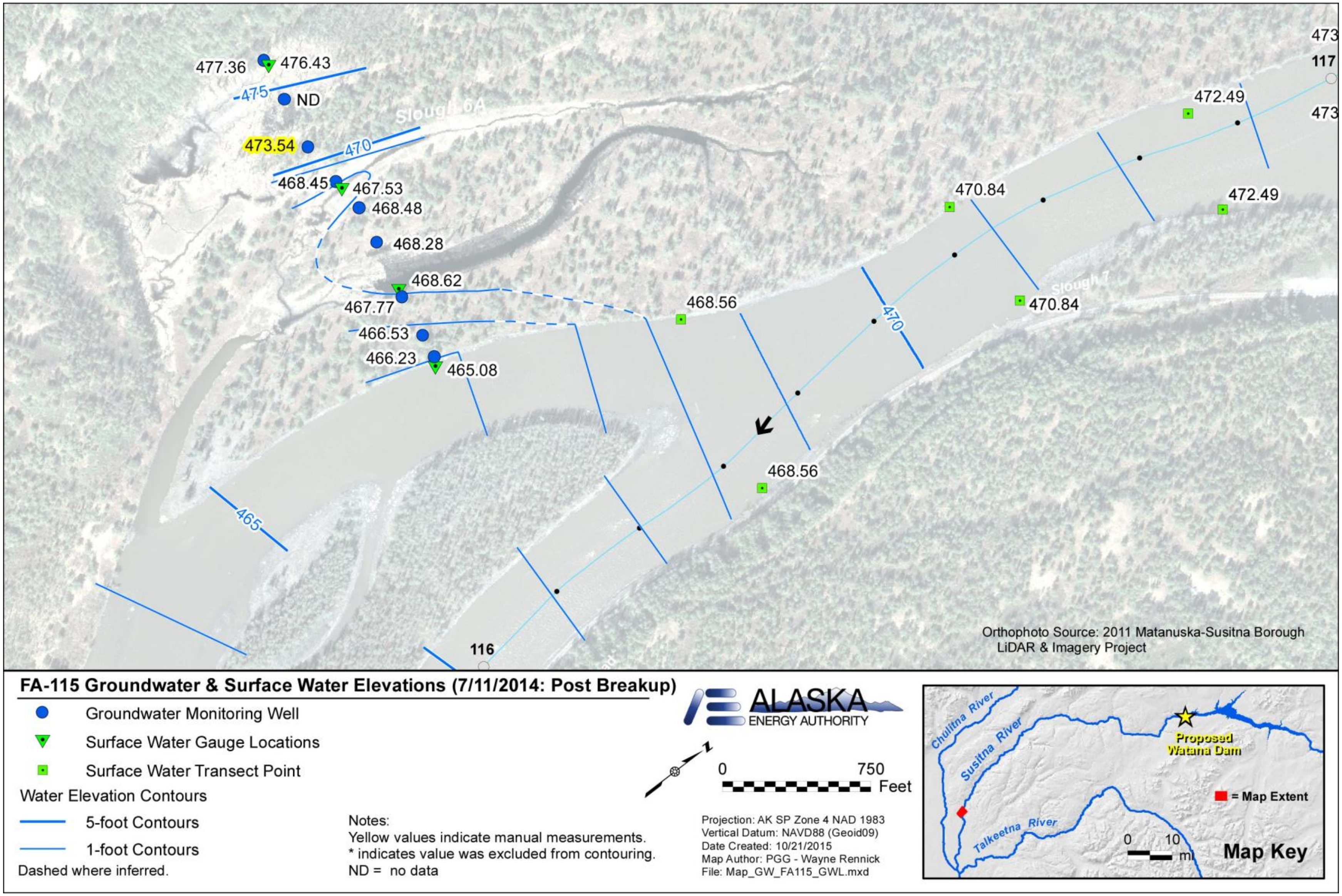

Figure 5.2-3. FA-115 (Slough 6A), showing water-level elevation contours for Post-breakup – July 11, 2014, Susitna River.

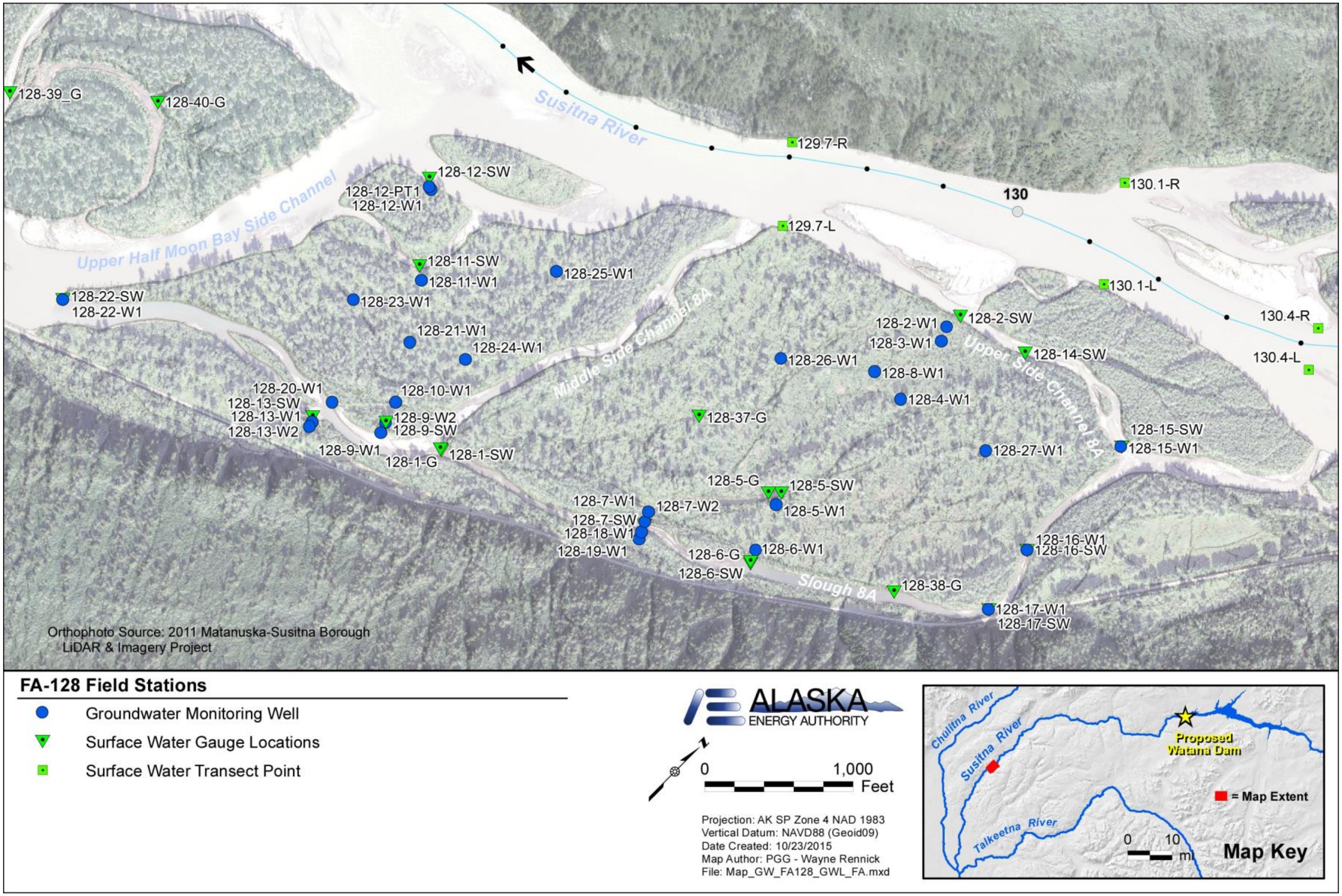

Figure 5.3-1. FA-128 (Slough 8A), showing groundwater and surface water monitoring locations, Susitna River.

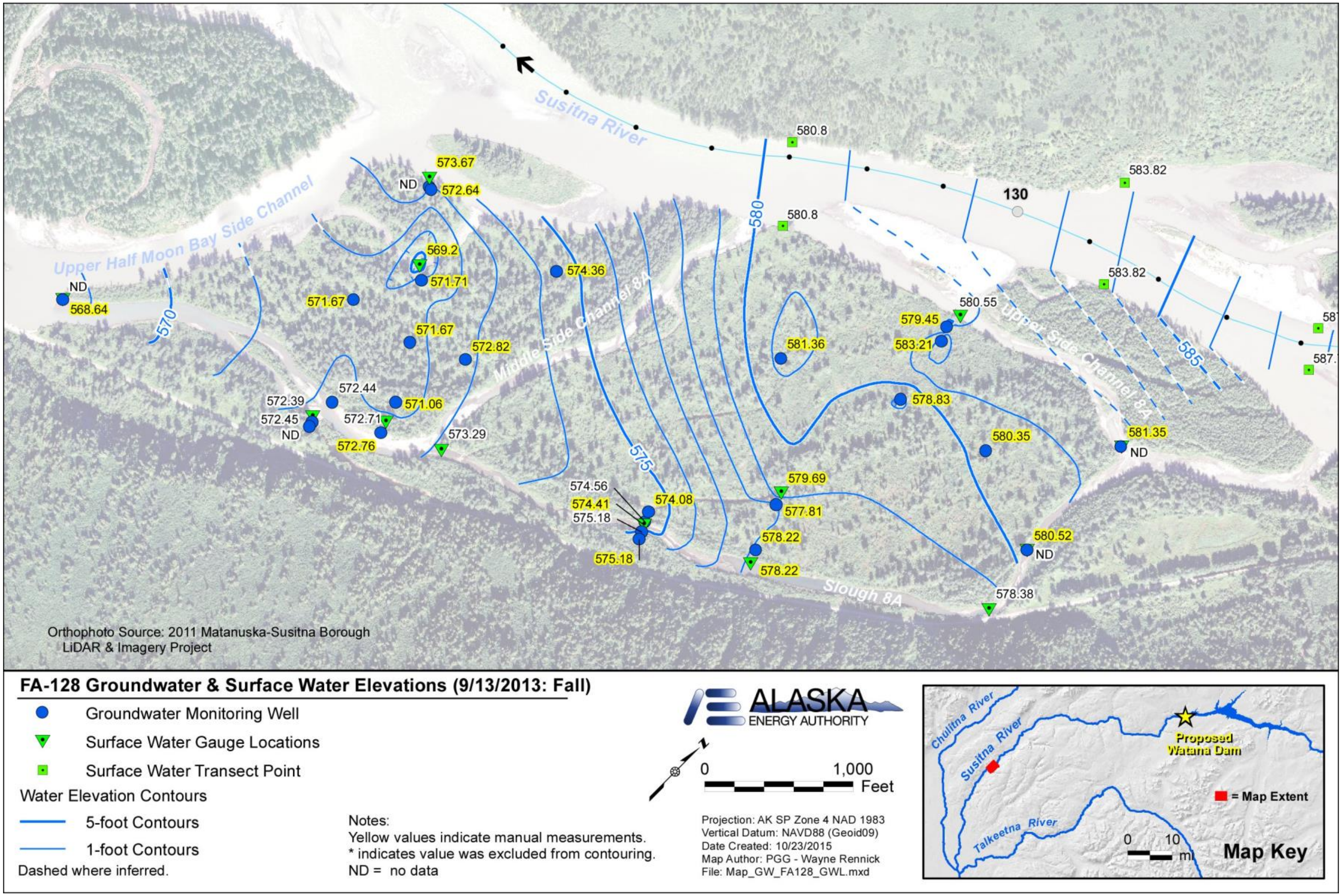

Figure 5.3-2. FA-128 (Slough 8A), showing water-level elevation contours for Fall – September 13, 2013, Susitna River.

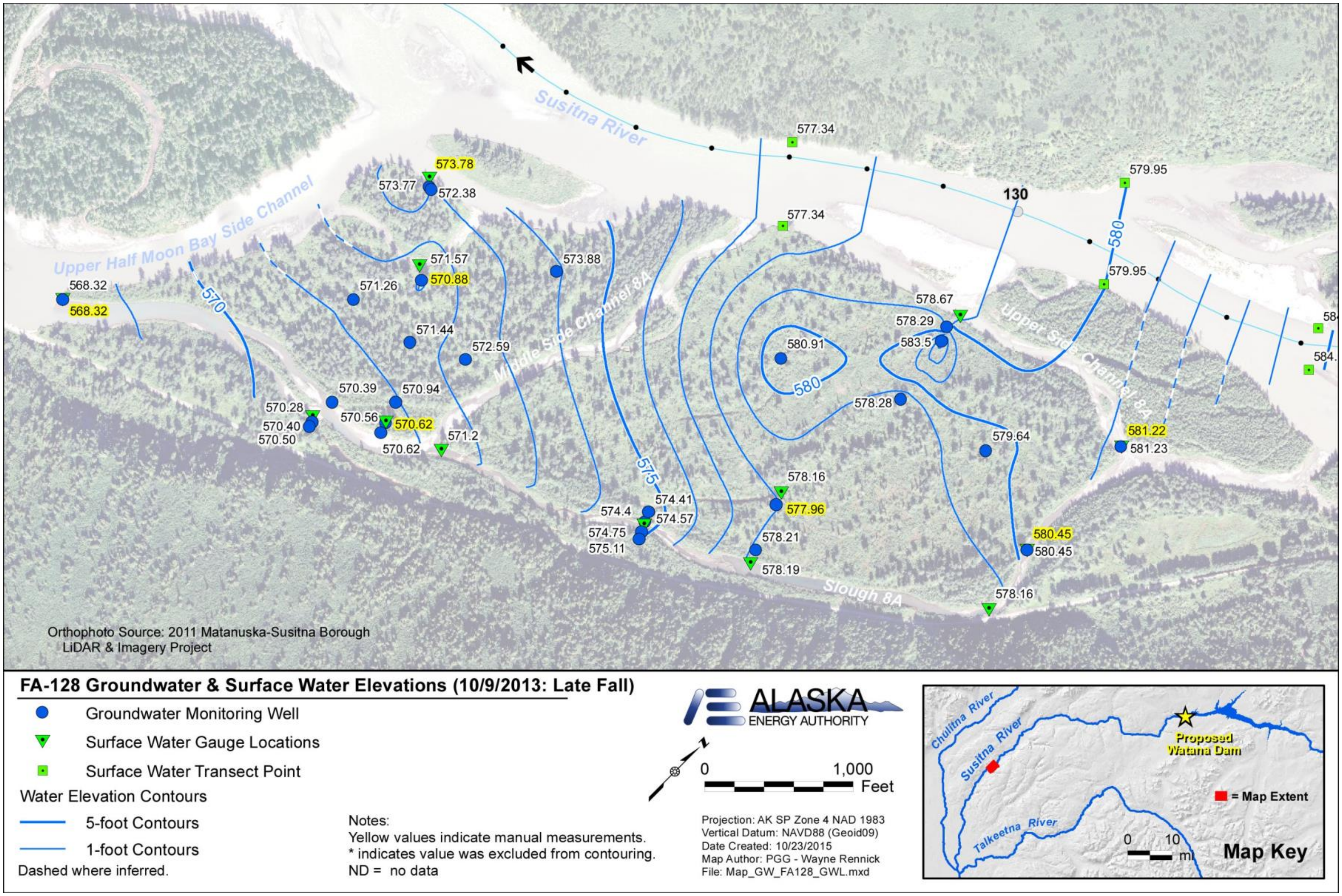

Figure 5.3-3. FA-128 (Slough 8A), showing water-level elevation contours for Late Fall – October 9, 2013, Susitna River.

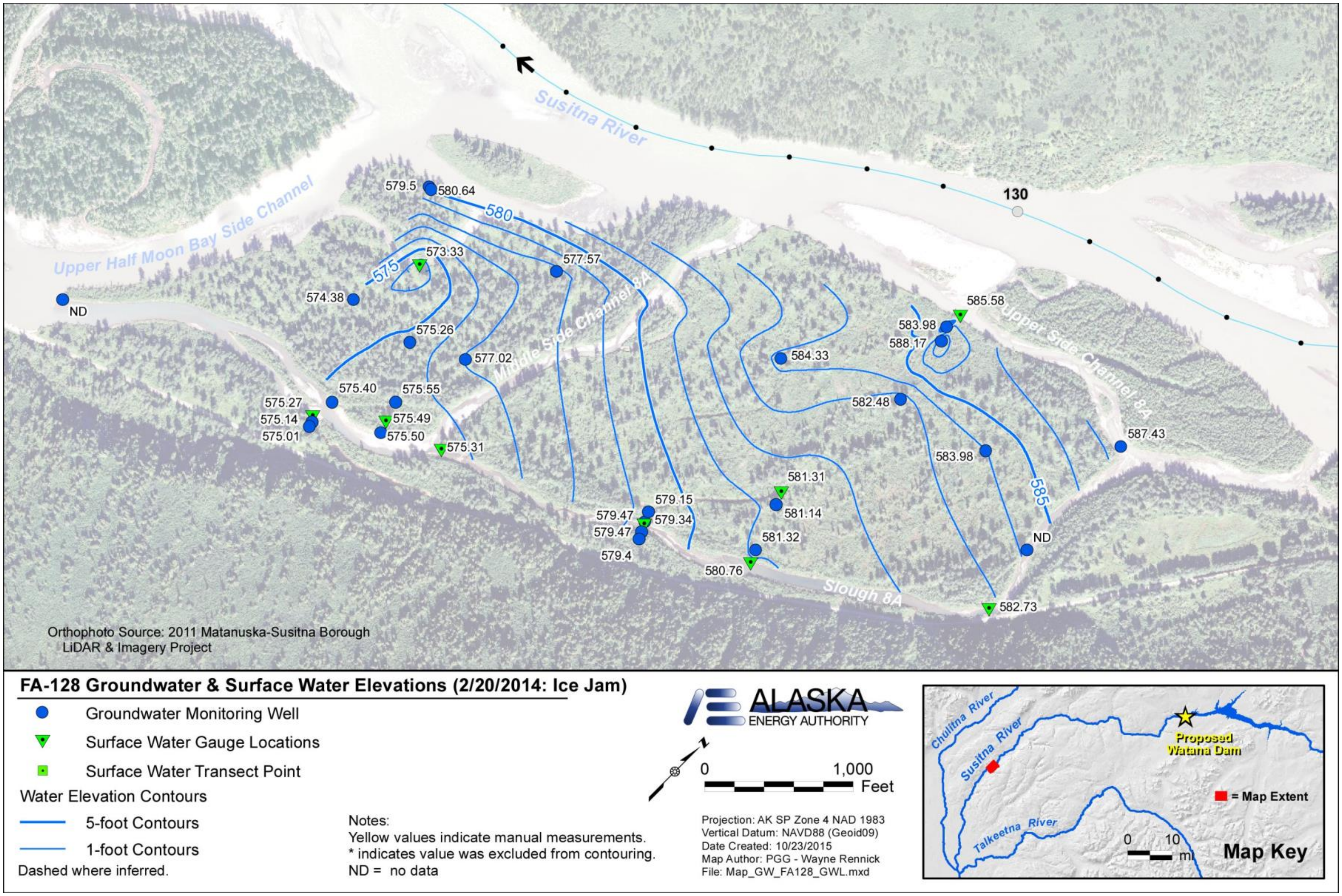

Figure 5.3-4. FA-128 (Slough 8A), showing water-level elevation contours for Ice Cover/Ice Jam – February 20, 2014, Susitna River.

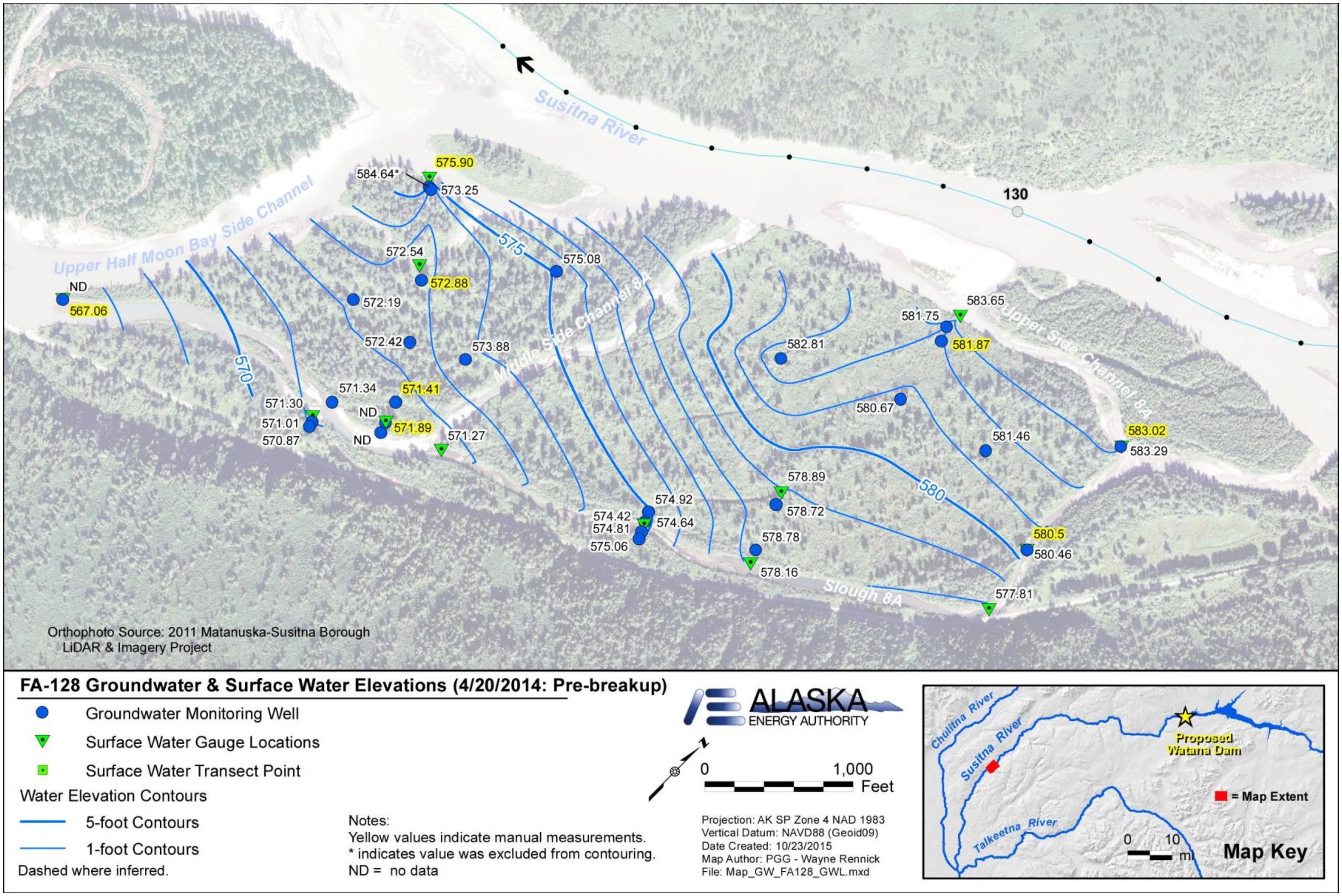

Figure 5.3-5. FA-128 (Slough 8A), showing water-level elevation contours for Pre-breakup – April 20, 2014, Susitna River.

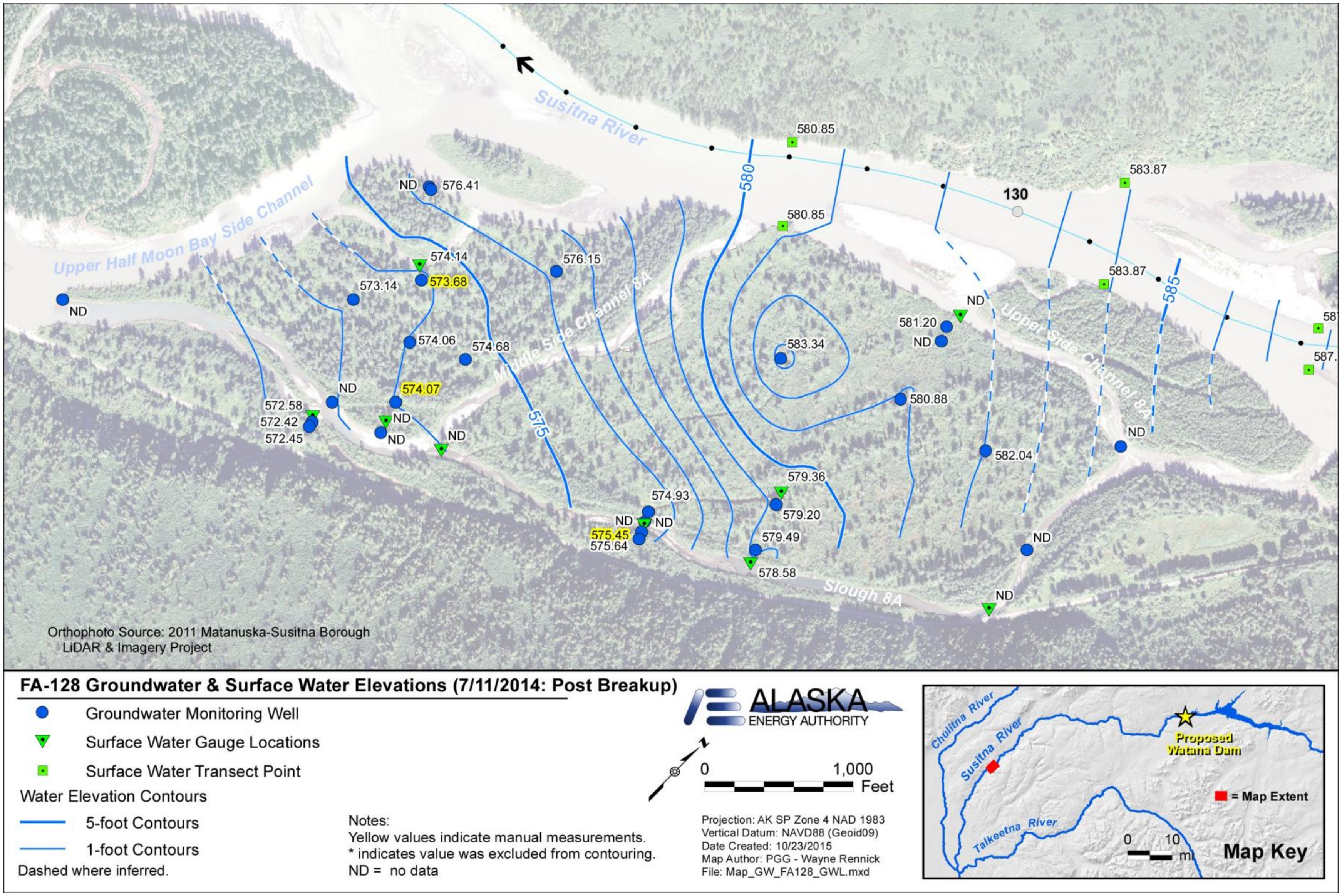

Figure 5.3-6. FA-128 (Slough 8A), showing water-level elevation contours for Post-break-up – July 11, 2014, Susitna River.

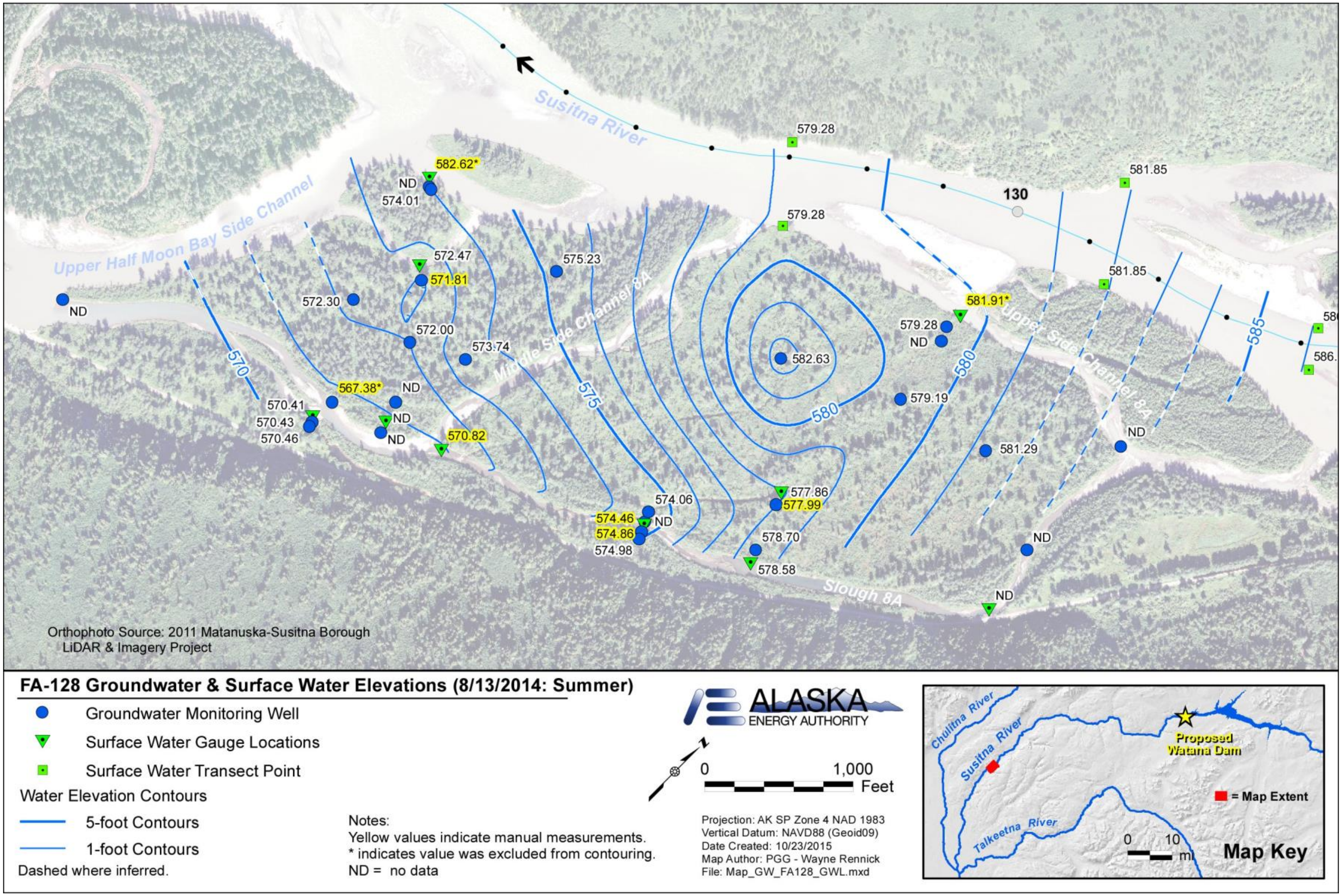

Figure 5.3-7. FA-128 (Slough 8A), showing water-level elevation contours for Summer – August 13, 2014, Susitna River.

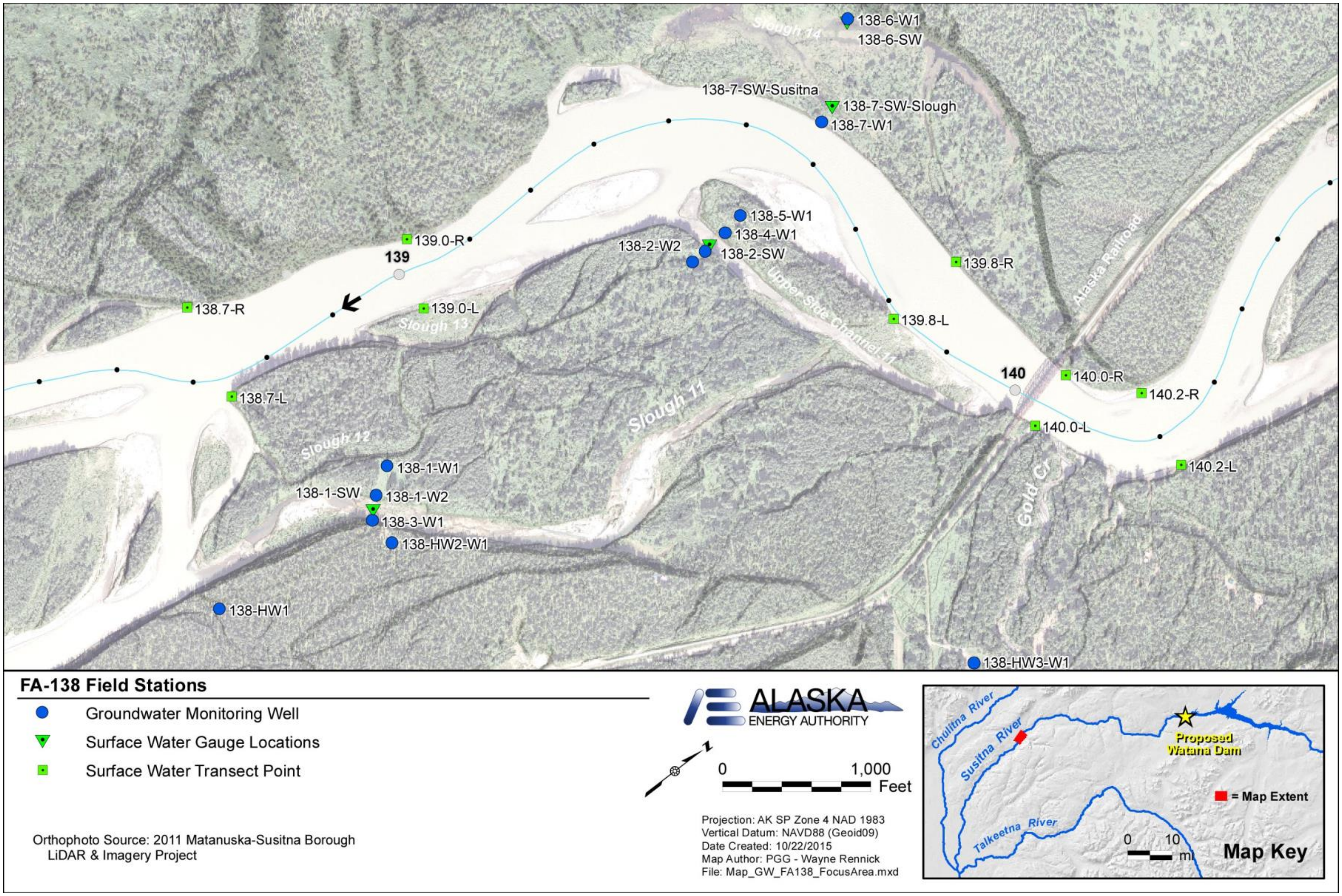

Figure 5.4-1. FA-138 (Gold Creek), showing groundwater and surface water monitoring locations, Susitna River.

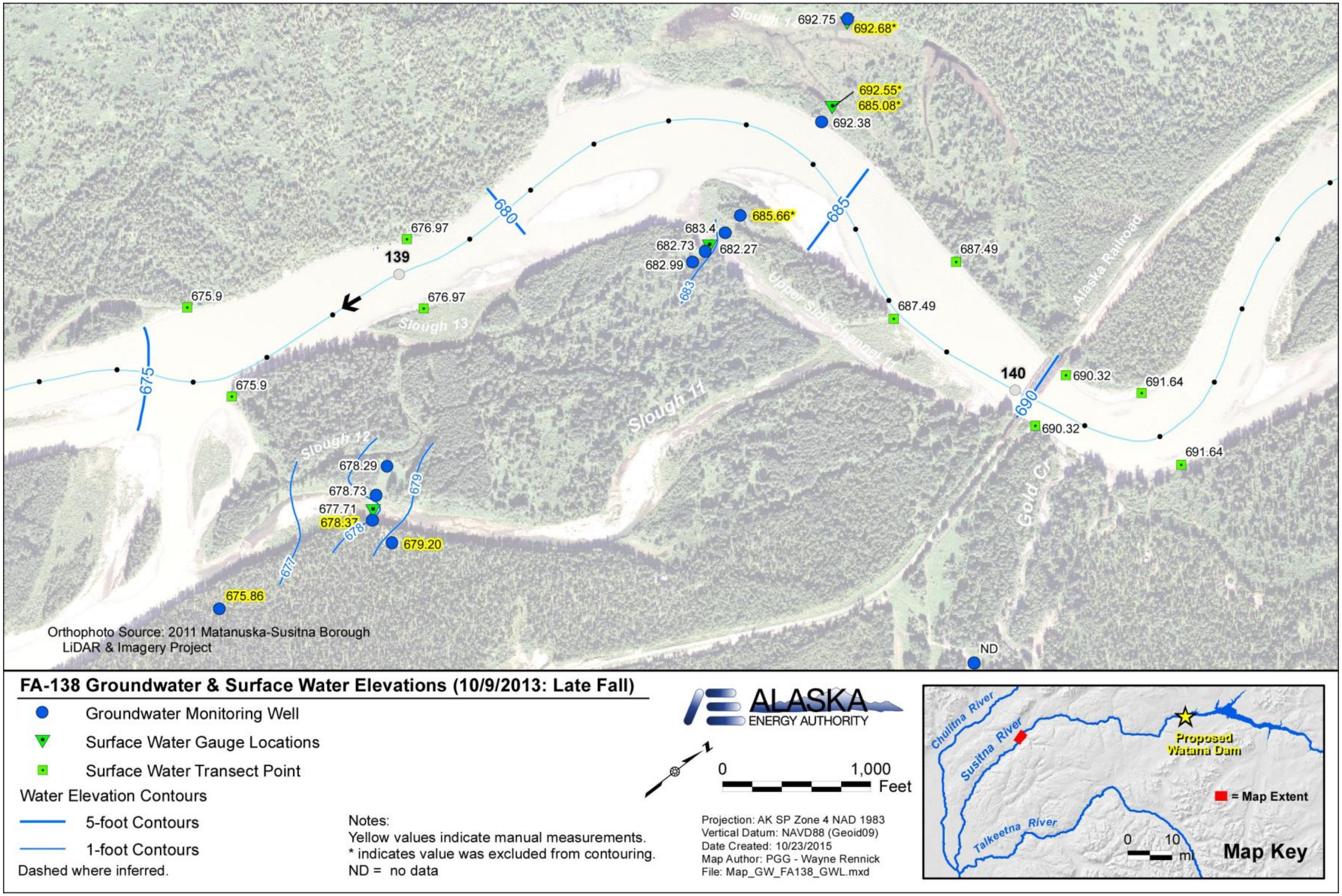

Figure 5.4.2. FA-138 (Gold Creek), showing water-level elevation contours for Late Fall – October 9, 2014, Susitna River.

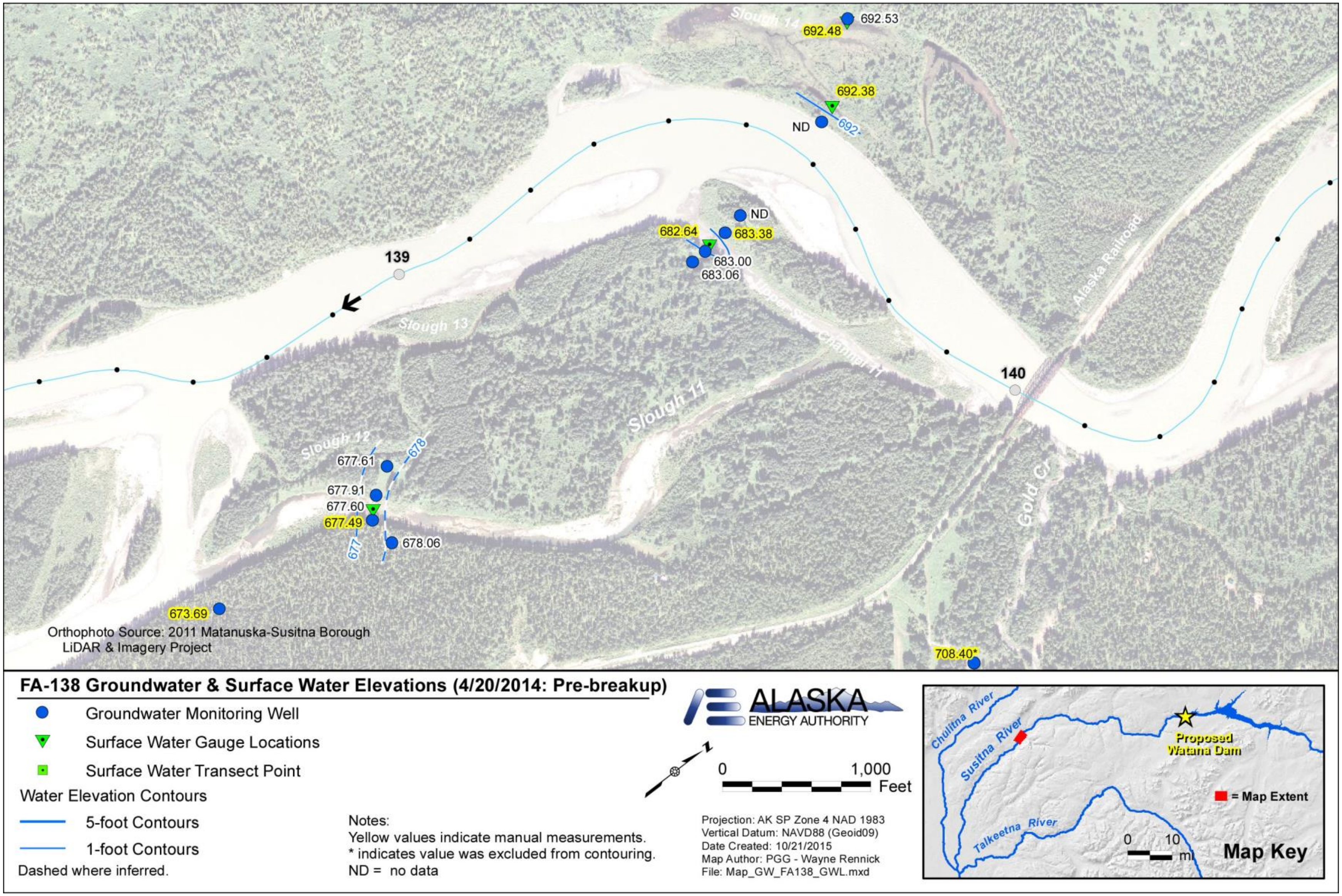

Figure 5.4-3. FA-138 (Gold Creek), showing water-level elevation contours for Pre-breakup – April 20, 2014, Susitna River.

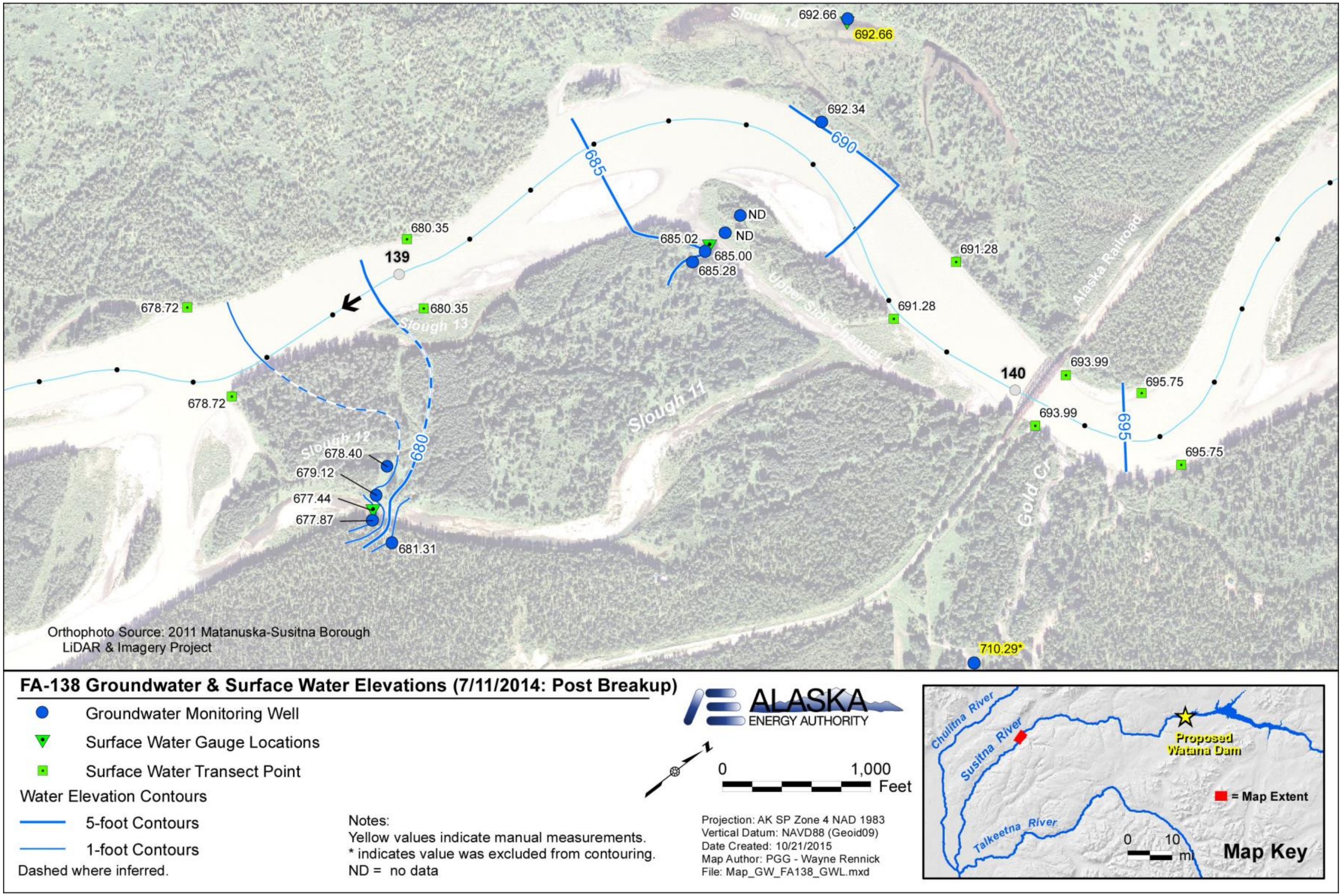

Figure 5.4-4. FA-138 (Gold Creek), showing water-level elevation contours for Post-breakup – July 11, 2014, Susitna River.