Gerle Creek Sensitive Site Investigation and Mitigation Monitoring Plan

Sacramento Municipal Utility District

Hydro License Implementation • May 2015

Upper American River Project

FERC Project No. 2101

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Introduction

This Sensitive Site Investigation and Mitigation Monitoring Plan (SSIMMP or Plan) addresses the Sensitive Site Investigation and Mitigation Monitoring set forth in the FERC Order Issuing New License to Project No. 2101 issued July 23, 2014 (FERC 2014) for the Upper American River Project (UARP; FERC Project 2101), owned and operated by the Sacramento Municipal Utility District (SMUD). Condition 2.B and 8.G of Appendix A and Condition 28 and 31 of Appendix B address this SSIMMP. Appendix A of the License contains the State Water Resources Control Board (SWRCB) Water Quality Certification and Appendix B of the License contains U.S. Forest Service (USFS) 4(e) conditions. The Conditions contained in these License appendices will be referenced as WQC Conditions and USFS Section 4(e) Conditions, respectively, for the remainder of this document.

In addition to the sensitive site investigation, this Plan also addresses elements of WQC Condition No. 2.B and USFS Section 4(e) Condition No. 28, namely test pulse flow releases and analysis of potential effects to downstream infrastructure.

The UARP lies within El Dorado and Sacramento counties, primarily within lands of the Eldorado National Forest. The UARP consists of three major storage reservoirs—Loon Lake, Union Valley and Ice House (with a combined capacity of approximately 379,000 acre-feet), eight smaller regulating or diversion reservoirs, and eight powerhouses. The UARP has an authorized installed capacity of 637.3 megawatts (MW). The UARP also includes recreation facilities containing over 700 campsites, five boat ramps, hiking paths, and bicycle trails at the reservoirs.

Background

This SSIMMP addresses two pairs of related conditions of the UARP FERC license. The first set of conditions, as set forth in Appendix A of the license, are required by the SWRCB WQC. The second set of conditions, as set forth in Appendix B of the license, are required by the USFS's 4(e) conditions.

SWRCB Conditions

Condition 2. Pulse Flows

The Licensee [SMUD] shall, beginning as early as reasonably practicable and within three months after license issuance, but not prior to the implementation of the new minimum streamflows, provide annual pulse flow events in Rubicon River below Rubicon Reservoir Dam, Gerle Creek below Loon Lake Reservoir Dam, and SF Silver Creek below Ice House Reservoir Dam as specified in the following pulse flow schedule.

For compliance purposes, the point of measurement for each required pulse flow is provided in this condition. All specified pulse flows are in cfs. Pulse flows do not need to be implemented in water years where natural spill events provide flows of equivalent magnitude and duration during either: (1) spring snowmelt runoff; or (2) a natural storm event that occurs in the months of January through May. The Licensee shall furnish the streamflow records that show compliance with the pulse flow requirements to the State Water Board [SWRCB] upon request.

Pulse flows may be temporarily modified if equipment malfunction or operating emergencies reasonably beyond the control of the Licensee require it. If a pulse flow is so modified, the Licensee shall provide notice to the Commission [FERC], USFS, USFWS [U.S. Fish and Wildlife Service], CDFW [California Department of Fish and Wildlife], and the State Water Board [SWRCB] as soon as possible but no later than 10 days after each such incident commences. The pulse flows specified may also be temporarily modified for short periods in non-emergency situations upon approval of the [SWRCB] Deputy Director.

Where facility modification is required to provide the specified pulse flows, the Licensee shall make such modifications as soon as reasonably practicable and no later than three years after license issuance. Prior to such required facility modifications, the Licensee shall provide evidence (such as flow records) to the Deputy Director by July 1 of each year that shows whether the specified pulse flows have been delivered within the capabilities of the existing facilities.

Condition 2.B Gerle Creek below Loon Lake Reservoir Dam

The Licensee shall provide pulse flows timed to coincide with spring snowmelt runoff as specified in the five-day schedule outlined in Table 15 or as modified by the USFS with concurrence from the Deputy Director.

Table 15. Gerle Creek below Loon Lake Reservoir Dam Pulse Flows (cfs)

	BN[1]	AN[1]	WET[1]
Day 1	125	200	600
Day 2	125	200	600
Day 3	180	250	740[2]
Day 4	125	200	600
Day 5	125	200	600

Notes:
[1] Water year types as defined in FERC License Appendix A Condition 1
[2] Or the maximum capacity of the outlet works, whichever is less

Within two years of license issuance and prior to implementing the pulse flows in Gerle Creek below Loon Lake Reservoir Dam, the Licensee shall complete the following items to develop the information necessary to determine the appropriate magnitude of pulse flows:

1. A sensitive site investigation to address the potential for stream bank erosion resulting from pulse flows, which includes additional permanent cross-sections to characterize the upper and middle geomorphology study sites LL-G1 and LL-G2 (study site designations and locations are described in the *Channel Morphology Technical Report* (January 2005) prepared during the relicensing proceeding). Areas of unstable banks and downed logs obstructing streamflow shall be mapped. A professional riparian ecologist shall participate in the investigation.

2. Test pulse releases shall be made from the outlet works at different levels up to the prescribed 740 cfs of the maximum capacity of the outlet works, whichever is less, to determine the appropriate pulse flows for the desired channel conditions. The desired outcomes from the pulse flows are to redefine the stream channel, sort the spawning gravel and transport bedload and fine material downstream.

3. Analysis of the effects and potential impacts of the pulse flows on downstream features including bridges, campgrounds, and day-use areas.

Once items 1 through 3 are complete, USFS, with the concurrence of the Deputy Director, may adjust the prescribed pulse flows if the results indicate adjustment is necessary to reach the objectives of restoring the stream channel to a proper functioning condition. The final pulse flows shall not exceed those described in the pulse flow schedule (Table 15). The pulse flows shall be measured at USGS gage 11429500, located approximately 0.3 miles downstream from Loon Lake Reservoir Dam.

Condition 8. Monitoring Program

The Licensee shall implement the following Monitoring Program after license issuance and through the term of the new license and any extensions, in coordination with USFS, CDFW, USFWS, and the State Water Board. The Licensee shall ensure that the final monitoring plan for each element of the Monitoring Program is reviewed by USFS, CDFW, USFWS, and the Deputy Director. The Licensee shall also receive approval by the Deputy Directory prior to implementation of each monitoring element described below. The Licensee shall consult and coordinate with the Chili Bar Project Licensee (PG&E) as appropriate.

For purposes of the ecological resources adaptive management program, each year is defined on a calendar year basis (i.e., January through December). This Monitoring Program covers monitoring to be conducted during all years until a new license is issued. Where years are specified, Year 1 is the first year during which all initial minimum streamflows required by the license are implemented by May 1.

USFS, CDFW, USFWS, and the State Water Board may alter the Monitoring Program methodologies and frequencies of data collection if it is determined that: (a) there is a more appropriate or preferable methodology or site to use than that described in the individual elements of the Monitoring Program; or (b) monitoring may be reduced or terminated because the relevant ecological resource objectives have been met or no change in resource response is expected. Within the scope of the specified Monitoring Program, USFS, CDFW, USFWS, and the State Water Board may select an equal number of alternative years to ensure that surveys occur during a range of water year types. Modifications made to the monitoring plans must be approved by the Deputy Director prior to implementing the modified monitoring plan.

The Licensee shall submit a revised monitoring plan to the Deputy Director for approval based on the Deputy Director's or another agency's recommendations. The Licensee may also submit a revised monitoring plan to the Deputy Director for approval based on its own recommendation. The Licensee shall file the Deputy Director's approval, together with any required modifications to the revised monitoring plan, with the Commission.

The Licensee shall prepare an annual report that fully describes the monitoring efforts of the previous calendar year, including the data collected and analysis of that data. The report shall be filed with the Commission by June 30 of each year for the preceding year. USFS, CDFW, USFWS, and the State Water Board shall have at least 30 days to review and comment on the draft report prior to filing with the Commission. The Licensee shall provide copies of the final annual report to USFS, CDFW, USFWS, and the Deputy Director.

The following guidelines shall be used in implementing the Monitoring Program: (a) monitoring and studies shall be relevant to the UARP; (b) monitoring and studies shall be conducted such that they provide useful information for management decisions or establishing compliance with license conditions; and (c) monitoring and studies shall be as cost-effective as possible.

Condition 8.G Geomorphology: Sensitive Site Investigation and Mitigation Plan

Within six months of license issuance, the Licensee shall develop a geomorphology sensitive site investigation and mitigation monitoring plan in consultation with USFS, CDFW, USFWS, and the State Water Board. The Licensee shall provide the Deputy Director with any comments provided by the agencies during the consultation process. The Licensee shall provide the Deputy Director with at least 90 days to review and approve the plan prior to submittal to the Commission, if applicable. The Deputy Director may require modifications as part of the approval. The Licensee shall file the Deputy Director's approval, together with any required plan modifications, with the Commission.

Method: A detailed investigation of fluvial geomorphic properties will be carried out. The focus of the investigation shall be to determine the most effective method of stabilization for the Gerle Creek channel downstream of Loon Lake.

Location: Gerle Creek below Loon Lake Reservoir Dam, at LL-DG1 [*sic*, LL-G1] and LL-G2. (Refer to Condition 2.B. – Gerle Creek below Loon Lake Reservoir Dam).

Timing: Years 1 and 2. Within two years of license issuance, the Licensee shall develop and submit to the Deputy Director for approval a stabilization plan for the Gerle Creek channel below Loon Lake Reservoir Dam. The Licensee will consult with appropriate staff from USFS, USFWS, CDFW, and the State Water Board in the development of the stabilization plan. The Licensee shall provide the Deputy Director with any comments provided by agencies during the consultation process. The Deputy Director may require modifications as part of approval. The Licensee shall implement the plan upon receiving Deputy Director and all other necessary regulatory approvals.

<u>USFS 4(e) Conditions</u>

Condition No. 28 - Pulse Flows

The licensee [SMUD] shall, beginning as early as reasonably practicable within 3 months after license issuance, but not prior to the implementation of the new minimum streamflows, provide annual pulse flow events in Rubicon River below Rubicon River Reservoir Dam, Gerle Creek below Loon Lake Reservoir Dam, and South Fork Silver Creek below Ice House Reservoir Dam as specified in the following pulse flow schedule by water year type.

For compliance purposes, the point of measurement for each required pulse flow is included. All specified pulse flows are in cubic feet per second (cfs). Pulse flows do not need to be implemented in water years where natural spill events provide flows of equivalent magnitude and duration during either (1) spring snowmelt runoff or (2) a natural storm event that occurs in the months of January through May in the specific watershed in which a pulse flow is required.

The pulse flows specified in the following schedule may be temporarily modified if required by equipment malfunction or operating emergencies reasonably beyond the control of the licensee. If a pulse flow is so modified, the licensee shall provide Notice to *FS* [USFS], *FERC*, *CDFG*, *FWS* [USFWS], and *SWRCB* as soon as possible but no later than 10 days after such incident. The pulse flows specified may also be temporarily modified for short periods in non-emergency situations upon approval of *FS*, *FERC*, *CDFG*, *FWS*, and *SWRCB*.

Where facility modification is required to provide the specified pulse flows, the licensee shall make such modifications as soon as reasonably practicable and no later than 3 years after license issuance. Prior to such required facility modifications, the licensee shall make a good-faith effort to provide the specified pulse flows within the capabilities of the existing facilities.

Gerle Creek Below Loon Lake Reservoir Dam

The licensee shall provide pulse flows timed to coincide with spring snowmelt runoff as specified in the following schedule based on month and water year type. The pulse flows shall be measured at USGS gage 11429500, located approximately 0.3 mile downstream from Loon Lake Reservoir Dam.

Gerle Creek Below Loon Lake Reservoir Dam Pulse Flows			
	BN[1]	**AN[1]**	**WET[1]**
Day 1	125	200	600
Day 2	125	200	600
Day 3	180	250	740[2]
Day 4	125	200	600
Day 5	125	200	600

Notes:
[1] Water year types as defined in FERC License Appendix B Condition No. 27
[2] Or the maximum capacity of the outlet works, whichever is less

Prior to implementing the pulse flows in Gerle Creek below Loon Lake Reservoir Dam and within 2 years of license issuance, the licensee shall complete the following:

1. A sensitive site investigation that includes additional permanent cross-sections that characterize the upper and middle Rosgen Level 3 analysis reaches. Areas of unstable banks and downed logs that are obstructing streamflow shall be mapped. A professional riparian ecologist shall participate in the investigation.

2. Test pulse releases shall be made from the outlet works at different levels up to the prescribed 740 cfs or the maximum capacity of the outlet works, whichever is less, to determine the appropriate pulse flows for the desired channel conditions.

3. Analysis of the effects of the pulse flows on downstream features including bridges, campgrounds, and day-use areas for potential impacts from the pulse flows.

Once these items are completed, FS may adjust the prescribed pulse flows, if necessary, based on the results of the investigation and objectives of restoring the stream channel to a proper functioning condition. The final pulse flows shall not exceed those described in the pulse flow schedule.

Condition No. 31 – Monitoring Program

The licensee shall implement the following Monitoring Program after license issuance and through the term of the new license and any annual licenses, in coordination with *FS*, *CDFG*, *FWS*, and *SWRCB*.

The licensee shall ensure that the final monitoring plan for each element of the Monitoring Program is reviewed and approved by *FS*, *CDFG*, *FWS*, and *SWRCB* prior to implementation of the monitoring element, as described under each monitoring element.

FS, *CDFG*, *FWS*, and *SWRCB* have the flexibility to alter the monitoring program methodologies and frequencies of data collection if it is determined that: (a) there is a more appropriate or preferable methodology or site to use than that described in the individual elements of the monitoring program or (b) monitoring may be reduced or terminated because the relevant ecological resource objective has been met or no change in resource response is expected. Within the scope of the specified monitoring program, *FS*, *CDFG*, *FWS*, and *SWRCB* may select an equal number of alternative years to ensure that surveys occur during a range of water year types.

The licensee shall file with FERC by June 30 of each year an annual report fully describing the monitoring efforts of the previous calendar year. *FS*, *CDFG*, *FWS*, and *SWRCB* shall have at least 30 days to review and comment on the draft report prior to filing with FERC. The licensee shall provide copies of the annual report to *FS*, *CDFG*, *FWS*, and *SWRCB*.

The following guidelines shall be used in implementing the monitoring program: (a) monitoring and studies shall be relevant to the Project, (b) monitoring and studies shall be conducted such that they provide useful information for management decisions or establishing compliance with license conditions, and (c) monitoring and studies shall be as cost-effective as possible.

For purposes of the ecological resources adaptive management program, each year is defined on a calendar year basis (i.e., January through December). This monitoring program covers monitoring to be conducted during all years until a new license is issued. Where years are specified, Year 1 is the first year during which all initial minimum streamflows required by the license are implemented by May 1.

Geomorphology (Sensitive Site Investigation and Mitigation Plan Development)

Within 6 months of license issuance, the licensee shall develop a geomorphology sensitive site investigation and mitigation monitoring plan in consultation with *FS*, *CDFG*, *FWS*, and *SWRCB*. The licensee shall provide *FS*, *CDFG*, *FWS*, and *SWRCB* a 90-day review and approval period for the monitoring plan prior to implementation. The licensee shall implement the plan upon approval.

Method: A detailed investigation of fluvial geomorphic properties will be carried out in the Gerle Creek below Loon Lake Reservoir Dam, at LL-DG1 [*sic*, LL-G1] and LL-G2. Refer to Condition No. 28, Pulse Flows: Gerle Creek below Loon Lake Reservoir Dam.

Frequency: Years 1 and 2.

Rationale: The fluvial geomorphology study results indicated a problem with channel stability in the Gerle Creek channel(s), with an apparent imbalance in bedload and streamflow in these reaches, and a potential impact on fluvial processes downstream. There is a need to further investigate these sites to determine the most effective method of stabilization. Channel sites with identified problems may benefit from the implementation of channel stabilization techniques.

The SSIMMP relates to two other Plans required by the FERC License, as well as two of the other License conditions.

- WQC Condition 8.G and USFS Section 4(e) Condition 33 require, within two years of license issuance, SMUD to develop a stabilization plan for the LLD reach of Gerle Creek. The findings from the SSIMMP will be needed to develop the required stabilization plan.
- WQC Condition 8.H and USFS Section 4(e) Condition 31 require, within two years of license issuance, SMUD to develop in consultation with the Resource Agencies a geomorphology monitoring plan that provides for the continuing evaluation of representative channel areas, including LL-G1 and LL-G2 (Geomorphology Continuing Evaluation of Representative Channel Areas Plan). The monitoring carried out within this SSIMMP will support the monitoring that occurs within the Geomorphology Continuing Evaluation of Representative Channel Areas Plan; however, the Geomorphology Continuing Evaluation of Representative Channel Areas Plan is a separate plan from this SSIMMP.
- WQC Condition 5.D and USFS Section 4(e) Condition 34 require SMUD to maintain the reservoir level at Gerle Creek Reservoir at an elevation that provides fish passage into Gerle Creek from August to October. Sediment transported into the head of the reservoir during pulse flows could affect fish passage into Gerle Creek, so the findings of the SSIMMP will consider impacts to SMUD's ability to comply with WQC Condition 5.D and USFS Section 4(e) Condition 34.
- WQC Condition 9.I and USFS Section 4(e) Condition 32 provide the means for the Resource Agencies to modify required monitoring as described in WQC Condition 8 and USFS Section 4(e) Condition 31 if (1) the relevant ecological resource objectives have been met, (2) no change in resource response due to UARP operations is expected, or (3) applicable ecological resource objectives are not being met and will likely not be met without application of adaptive management measures. The findings from the SSIMMP will provide results and scientific information that support the adaptive management program.

SSIMMP Overview

The broad components of the SSIMMP, presented in sequential order (**Figure 1**), include:

- Re-establish sensitive sites and identify infrastructure evaluation sites
- Establish methods for geomorphic, riparian vegetation, and infrastructure evaluation monitoring
- Pre-test pulse release geomorphic and riparian vegetation monitoring at the sensitive sites, and erosion monitoring at the infrastructure evaluation sites
- Develop and apply a numerical hydraulic model
- Provide recommendations regarding pulse releases to Resource Agencies
- Test pulse releases and infrastructure evaluation site monitoring
- Post-test pulse release geomorphic and riparian vegetation monitoring at the sensitive sites
- Provide results of monitoring and associated analyses to Resource Agencies

Details about each of these components are presented in the following sections.

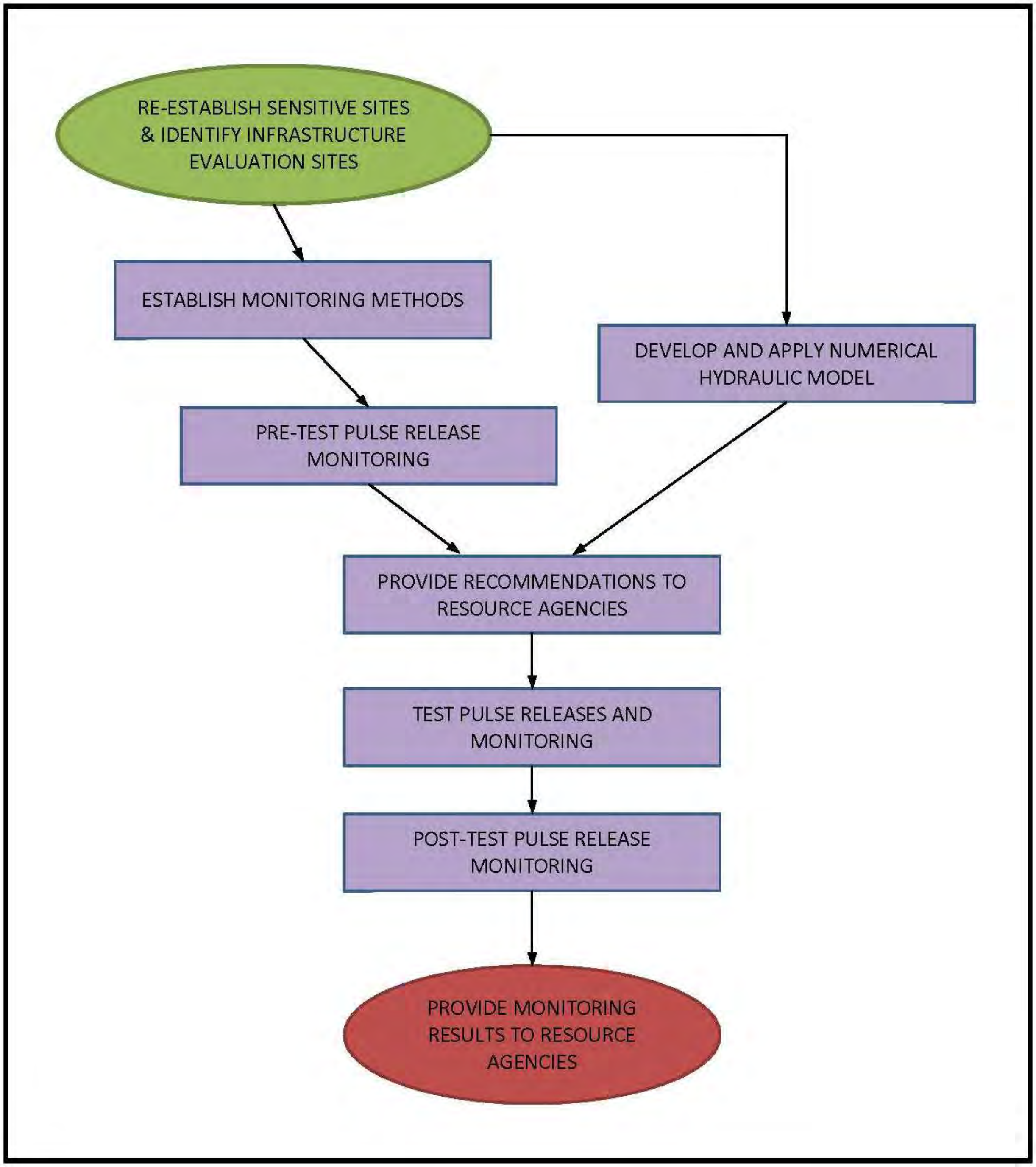

Figure 1. Schematic of SSIMMP Components

SSIMMP Components

Re-establish Sensitive Sites and Identify Infrastructure Evaluation Sites

As stated in the WQC Conditions and USFS Section 4(e) Conditions, the SSIMMP is required to include a detailed investigation of fluvial geomorphic properties at the upper and middle geomorphology sensitive sites on the LLD reach of Gerle Creek identified in the relicensing studies (LL-G1 and LL-G2, respectively). Thus, the first step in the Plan is re-establishing these two sensitive sites using information in the *Channel Morphology Technical Report* (DTA and Stillwater Sciences 2005). To address the requirement in USFS Section 4(e) Condition 2.B and WQC Condition 28 to analyze the effects and potential impacts of the pulse flows on downstream features including bridges, campgrounds, and day-use areas, infrastructure evaluation sites will be identified and monitored. As described later in this Plan SMUD will carry out more intensive geomorphic and riparian vegetation monitoring at the sensitive sites; limited monitoring (water-surface elevations or evidence of erosion) will be carried out at infrastructure evaluation sites. All sites (collectively referred to as study sites) are shown in **Figure 2** and described in **Table 1**.

The infrastructure evaluation sites were identified during fall 2012 reconnaissance based on the following observations:

1. Potential flooding during pulse flows of public and private infrastructure (campgrounds, day-use areas, cabins, roadways, and bridges)
2. Potential erosion during pulse flows of roadway embankments
3. Potential for pulse flows to scour bridge abutments

Thirteen infrastructure evaluation sites are identified (**Figure 2** and **Table 1**). Site 1 is a family camp on privately-owned property subject to potential flooding during pulse flows. Site 3 is the Wentworth Springs Campground with potential for flooding. Site 4 is a group of cabins on privately-owned property potentially subject to flooding. Sites 5 and 6 are along Wentworth Springs Road with potential for both erosion and flooding. Sites 8, 11, and 14 are bridges subject to potential flooding and/or abutment scour. Sites 9 and 10 are privately-owned property potentially subject to bank erosion, and eroded material has potential to cause sedimentation in Gerle Creek Reservoir. Site 12 is a dispersed camping area at risk of flooding. Site 13 is Airport Flat Campground with potential for flooding. Site 15 is an embankment in the Gerle Creek Campground with potential for erosion.

Once the sensitive sites are re-established and infrastructure evaluation sites identified, the extents of each site will be mapped and recorded. This mapping will provide a common reference for all future monitoring activities. Geomorphic and riparian vegetation monitoring using methods described in this Plan that are impractical at the time of survey work will not occur at sites flooded by the influence of beaver . For example, Site LL-G1 is currently inundated by downstream beaver dams. SMUD will initiate geomorphic and riparian vegetation monitoring at LL-G1 once the monitoring can be safely carried out and useful information collected; the Resource Agencies understand such conditions may not occur within the timeframe of the SSIMMP. Photo plots will still occur at sites flooded by the influence of beaver, as described in the *Morphologic Metrics* section, part f.

Table 1. Identified Study Sites along the LLD Reach of Gerle Creek

Site No. on Figure 2	Site Type	Potential Concerns
1	Infrastructure Evaluation	Flooding of family camp on private property
2	Sensitive	Geomorphic changes (LL-G1)
3	Infrastructure Evaluation	Flooding of Wentworth Springs Campground
4	Infrastructure Evaluation	Flooding of cabins on private property
5	Infrastructure Evaluation	Flooding of road and erosion of embankment
6	Infrastructure Evaluation	Flooding of road and erosion of embankment
7	Sensitive	Geomorphic changes (LL-G2)
8	Infrastructure Evaluation	Flooding of a bridge, erosion of abutments
9	Infrastructure Evaluation	Bank erosion on private property, downstream sedimentation
10	Infrastructure Evaluation	Bank erosion on private property, downstream sedimentation
11	Infrastructure Evaluation	Flooding of a bridge, erosion of abutments
12	Infrastructure Evaluation	Flooding of a dispersed camping area
13	Infrastructure Evaluation	Flooding of Airport Flat Campground
14	Infrastructure Evaluation	Flooding of a bridge, erosion of abutments
15	Infrastructure Evaluation	Erosion of embankment (Gerle Creek Campground)

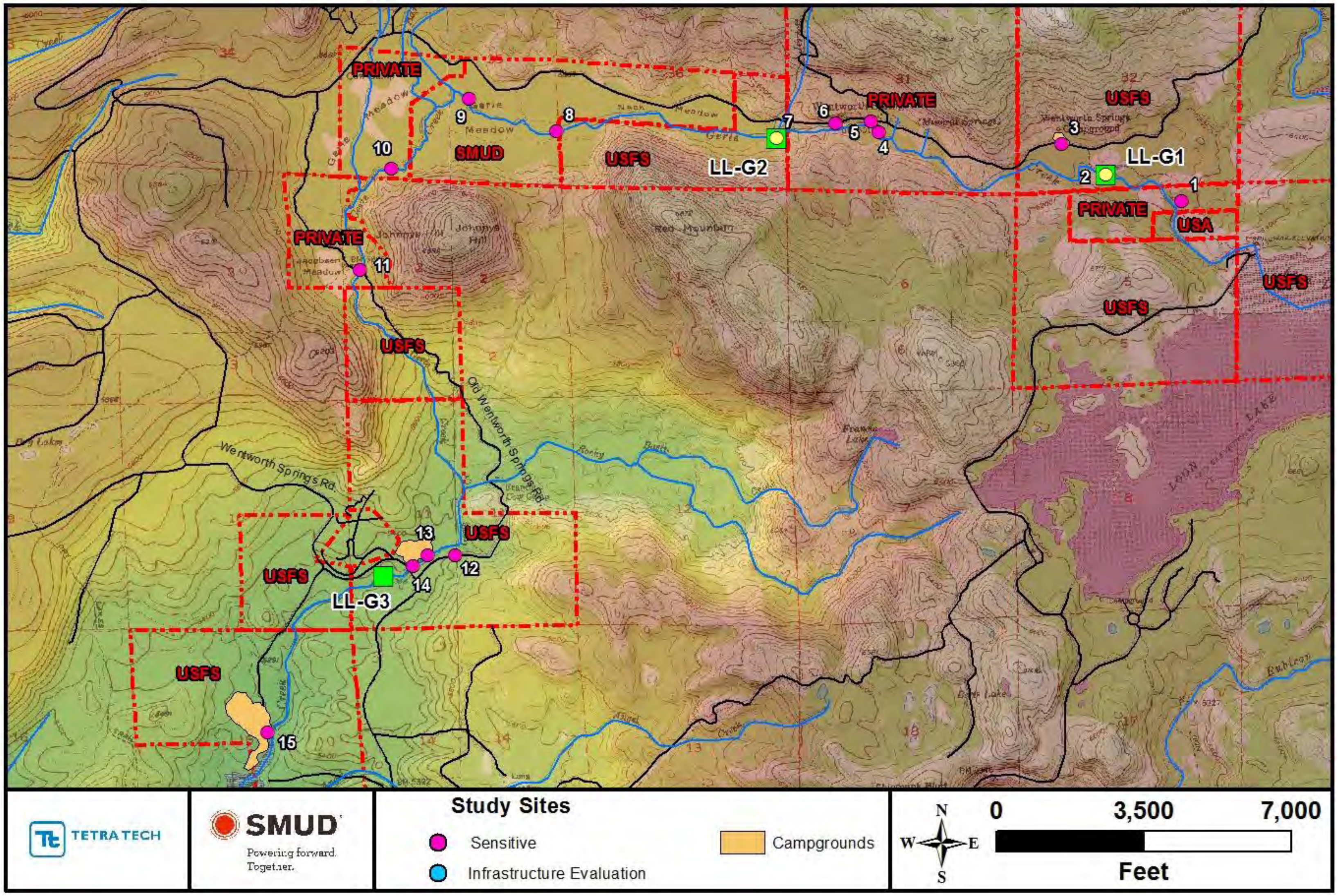

Figure 2. Identified Study Sites along the LLD Reach of Gerle Creek

Establish Methods for Geomorphic, Riparian Vegetation, and Infrastructure Evaluation Monitoring

The *Rationale Report* (CDFW 2007) includes geomorphic and riparian objectives that are applicable to the Gerle Creek Sensitive Site Investigation as follows:

Channel Morphology Objective

Maintain or restore channel integrity. Maintain, improve, or restore fluvial processes to provide for balanced sediment transport, channel bed material mobilization and distribution, and channel structural stability that contribute to diverse aquatic habitat and healthy riparian habitat.

Sediment Transport Objective

Ensure delivery and transport of sediment are balanced so that the stream channel is not excessively aggrading or degrading over time, and particle size distribution allows for diverse bed form within the stream channel.

Stream Channel and Floodplain Objective

Ensure stream channels have appropriate cross-section size (width to depth) and stable stream banks, and floodplains and flood-prone areas have connectivity to the stream channel.

Riparian Habitat Objectives

- Maintain riparian vegetation in proper functioning condition.
- Maintain or restore riparian resources.
- Maintain or restore streamflow regime sufficient to sustain desired conditions of native riparian, aquatic, wetland, and meadow habitats.

As stated in the *Rationale Report*, it is recognized that factors beyond the licensee's control could affect attainment of these objectives and that some or all of the objectives may not be achievable within the protection, mitigation, and enhancement (PM&E) measures (e.g., pulse flows and channel stabilization).

Metrics

Two categories of metrics have been developed to guide the monitoring and assist in determining whether the Gerle Creek channel is moving toward meeting the above objectives: (1) morphologic metrics, and (2) riparian vegetation metrics. One category of metrics has been developed to evaluate infrastructure impacts: flooding/erosion.

Morphologic Metrics

The morphologic metrics will be used to quantify the initiation of bed material transport and to evaluate geomorphic changes to assist in (1) restoring the stream channel to proper functioning condition, and (2) developing appropriate stabilization measures to move the stream channel toward meeting the above objectives. The following steps will be used to establish morphologic metrics at the locations of the sensitive sites. A typical geomorphic site plan (**Figure 3**) is an example of where the monitoring could occur.

a. Establish local survey control (horizontal and vertical) and set permanent endpoint monuments at all channel cross sections (alternatively referred to as transects for the vegetation parameters). The monuments will allow for the most meaningful interpretation of repeat surveys. The cross section surveys will target (1) breaks in ground slope so that straight lines between surveyed points appropriately represent the cross section geometry, (2) geomorphic features such as top-of-banks, bankfull indicators, toe-of-banks, and the thalweg, and (3) edges of water. Cross-sections will allow for direct comparisons over time of changes in channel areas and form, flood-prone area, and movement of streambed and streambank material in response to the pulse flows. An initial number of cross sections at each site will be determined based on Harrelson et al. (1994). Monumented cross-sections used during the relicensing will be included to the extent possible. The final number of cross-sections for each reach will be established in consultation with the resource agencies. Topography of the floodplain will be derived from LiDAR mapping and merged with surveyed channel geometry for modeling purposes.
b. Identify locations to collect sediment samples (e.g., armored bed surface material, subsurface bed material, bank material, and/or mobile bar material). Volumetric samples will be collected when the maximum sediment size is less than approximately 1.5 inches; surface based methods described in Bunte and Abt (2001) will be used for gravel and coarser sediments. The particle size distributions will be determined and characteristic quantiles calculated (e.g., d_{50}, d_{84}, and d_{100}, where the subscript number indicates the percentage of material finer than the specified diameter). Gradations of the samples will be used to compare changes over time in response to the pulse flows.
c. Identify, monument, and survey longitudinal profiles along the top of bank, toe of bank, water surface, and thalweg. Comparing repeat surveys will indicate changes in profile and planform. Areas of unstable banks (as indicated by signs of erosion, slumps, or fractures) will be mapped along with logs that are obstructing streamflow.
d. Survey channel geometry at select cross sections and collect bed material samples to empirically calculate sediment supplies from Jarrett Creek. While the simulated hydraulics and in-channel monitoring will focus on sediment transport

capacity, an assessment of sediment supply will help determine the balance between transport capacity and sediment supply.

e. Map the alignments and elevation profiles of selected beaver dams that function as key hydraulic controls, pending safe access. These baseline data will provide a means for evaluating the ability of the pulse flows to remove or alter these beaver dams.
f. Establish and permanently photograph points to facilitate visual comparison of geomorphic conditions over time. Hall (2001) will be considered in the field procedures, concepts, and analyses associated with the photograph points.

Riparian Vegetation Metrics

Vegetative monitoring data will be collected within the Riparian and Greenline Study Areas (as defined below) at the geomorphic cross-sections/vegetative transects in the sensitive sites prior to initiation of the test pulse releases to document baseline conditions. The number of vegetation transects at each sensitive site will be the same as the number of geomorphic cross sections (as described in *Morphologic* Metrics part a) and the number will be determined based on the methods described above. Following the test pulse releases, each transect will be visited and the observed conditions will be compared to the baseline data. Data will be recorded for all parameters and will include observed changes. Photographs will be taken from each of the permanent photograph points during each visit to document any general site changes resulting from the test pulse releases.

The Riparian Study Area at each transect will be defined as the area 30 feet upstream and 30 feet downstream of each geomorphology cross section (**Figure 4**). Vegetation data will be collected in the riparian study area at every cross-section/transect. The Greenline Study Area will be located along the greenline, which is defined as "the first perennial vegetation that forms a lineal grouping of community types on or near the water's edge. Most often it occurs at or slightly below the bankfull stage." (Winward 2000). The Greenline Study Area will encompass the area 3 feet either side of the greenline, and will extend approximately 363 feet along each bank (**Figure 4**). At least one Greenline Study Area will be sampled for each sensitive site, depending on reach length (one greenline study aera for every ~500 feet of stream length). Greenline study areas are located independent of cross-sections/vegetation transects and multiple transects may be located within each Greenline.

The results of the riparian vegetation monitoring will be used to inform the development of appropriate stabilization measures at sensitive sites and to assess proper functioning condition of the stream channel and associated riparian vegetation, and will include analyses of such variables as inundation of riparian vegetation communities, extent and composition of vegetation along the greenline, diversity and abundance of riparian species, wetland indicator status, recruitment and age structure of woody riparian species, and rooting depth/contribution to bank stability.

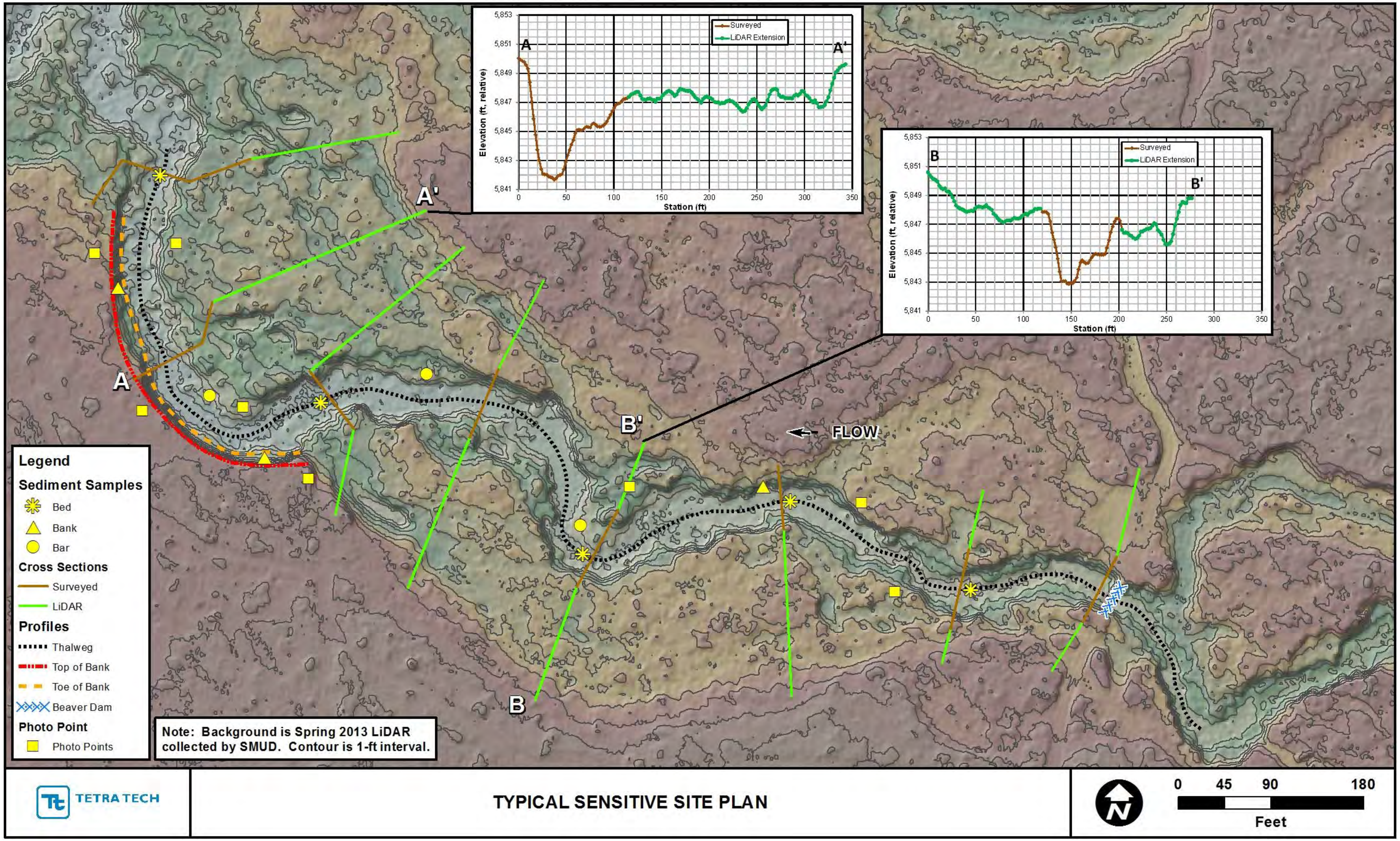

Figure 3. Typical Sensitive Site Plan

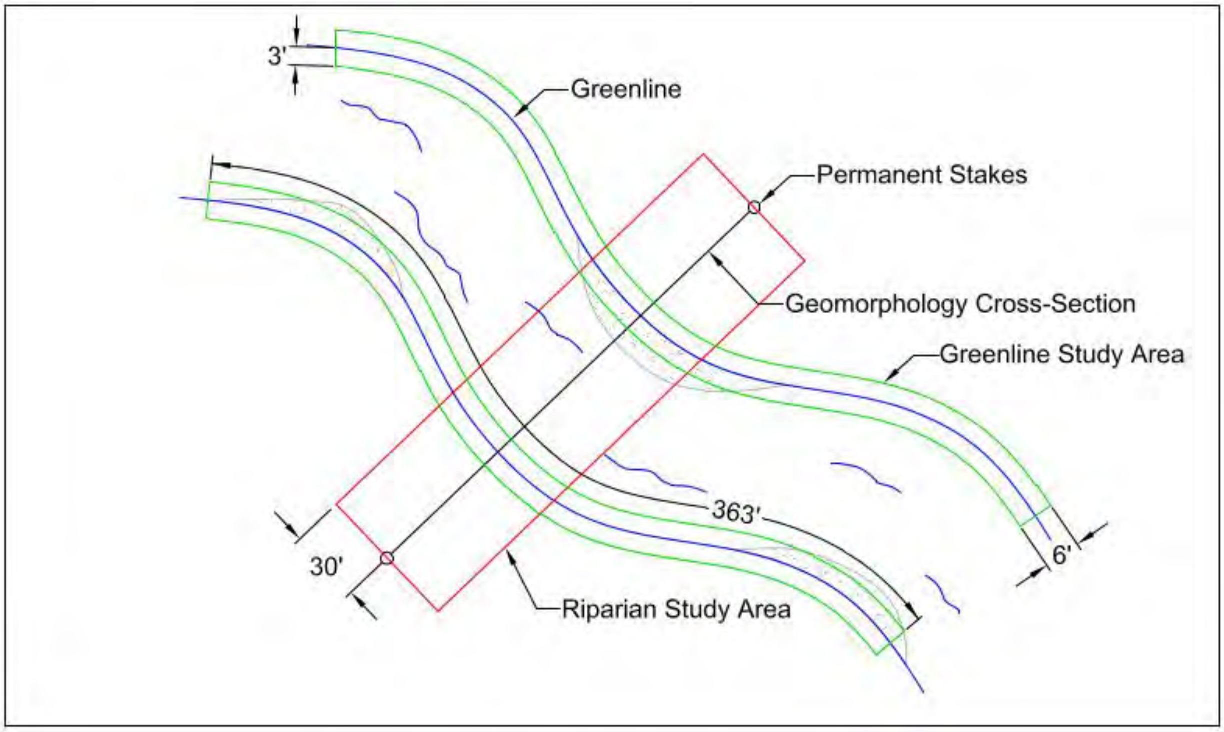

Figure 4. Schematic defining the Riparian Study Area and the Greenline Study Area relative to the creek alignment and a geomorphology cross section/vegetation transect

Riparian Study Area Metrics

All vegetation communities within the Riparian Study Area will be identified using *A Manual of California Vegetation, Second Edition* (Sawyer et al. 2009) and the boundaries of the vegetation communities will be mapped. All plant species observed within each vegetation community will be identified using *The Jepson Manual, Second Edition* (Baldwin et al. 2012). To enhance mapping accuracy, where possible, the boundaries of the vegetation communities will be mapped using a Trimble Geo XT GPS unit with floodlight technology, which enhances satellite reception under a tree canopy. Where satellite coverage cannot penetrate the canopy despite the floodlight technology, or where the vegetation is too dense to walk through, vegetation community mapping will be carried out on an aerial photograph. The following data will be collected:

a. Identify all plant species in each vegetation community mapped within the Riparian Study Area. Record the Braun-Blanquet (1932) cover class (0-5) for each species (**Table 2**).

Table 2. Braun-Blanquet (1932) Cover Estimate Scale		
Cover Class	**Percent Cover**	**Category**
0	<1	Present
1	1 – 5	Present
2	6 – 25	Co-Dominant
3	26 – 50	Dominant
4	51 – 75	Dominant
5	76 - 100	Dominant

b. Record age classes present for all woody dominant and co-dominant species according to the age classification in *Multiple Indicator Monitoring (MIM) of Stream Channels and Streamside Vegetation* (USDI 2011) (**Table 3**).

Table 3. Woody Species Age Classes (USDI 2011)		
Age Class	**Single Stem Species**	**Multi-stemmed Species**
Seedling	Stem is <1 m tall or <2.5 cm in diameter at 50% of height from ground level	1 stem <0.5 cm in diameter at the base and <0.5 m tall
Young	Stem is >1 m tall and 2.5 cm to 7.6 cm in diameter at 50% of height from ground level	2 to 10 stems less than 1 m tall or 1 stem >0.5 cm in diameter at the base and less than 1 m tall
Mature	Stem is > 1 m tall and >7.6 cm in diameter at 50% of height from ground level	>10 stems over 1 m tall

c. Record approximate percent vegetative cover in each of the herb, shrub, and tree layers for each vegetation community mapped within the Riparian Study Area.

Greenline Study Area Metrics

Greenline data will be collected roughly following the methodology detailed in *Monitoring the Vegetation Resources in Riparian Areas* (Winward 2000), with one modification as noted below. The first greenline transect will begin on the right bank, looking downstream, and will proceed down the greenline using the step transect approach. When conducting a step transect, the vegetation community at each step (approximately every 2.5 feet) is recorded until the end of the transect. Given the likely consistent nature of the vegetation communities within the Greenline Study Area, the dominant plant species at each step will also be recorded. For each greenline transect, enough steps will be taken to cover approximately 363 feet along each side of the stream. Once the transect on the right bank is complete, the creek will be crossed, and the process will be repeated for 363 feet upstream on the opposite bank. The total number of steps of each vegetation community type and plant species encountered along the greenline on both sides of the creek will be tallied and percent composition for each type will be computed as described in *Monitoring the Vegetation Resources in Riparian Areas* (Winward 2000).

The beginning and end points of the greenline transects on each bank will be mapped using the Trimble GeoXT, and will be further marked in the field with a permanent monument. In addition, the distance from the end of the geomorphology cross section to the greenline on each bank will be measured and recorded.

Photographic Monitoring

Permanent photograph points for each vegetation transect will be established prior to monitoring; each point will be mapped using a Trimble GeoXT GPS unit. Concepts presented in Hall (2001) will be considered in the photographic monitoring methodology. Locations for photographic monitoring will include the following, at a minimum: (1) beginning and end points of the greenline transects, looking downstream and upstream, respectively, (2) looking across the creek channel from each bank on the geomorphology cross sections; and (3) from each end of the geomorphology cross section, looking along the cross section towards the opposite end.

Flooding/erosion Metrics

The flooding/erosion metrics will establish measurable indicators of hydraulic damage (flooding or erosion) associated with the pulse flows at infrastructure evaluation sites (e.g., roadways, bridges, campgrounds, private camp areas and structure, and day-use areas). A typical infrastructure evaluation site plan (**Figure 5**) is an example of where the monitoring could occur.

a. Establish indicators and establish criteria for assessing potential damage based on the indicators. For flooding, such an indicator will be a threshold water-surface elevation so that water-surface elevations above this threshold are expected to cause flooding damage, but below this threshold, no flooding damage is expected. For erosion, the indicator will be either visual observation of erosion or a hydraulic metric (e.g., threshold shear stress, velocity, or stream power), and the criterion will parallel the flooding criterion.
b. Apply the numerical hydraulic model to quantify these indicators under existing conditions and pulse flows. Spatial extent of potential damage as it relates to stream stage and discharge will also be quantified and described (i.e. in terms of affected infrastructure and/or facilities).
c. Compare simulated indicator values to established criteria (e.g. Fischenich 2001) to characterize potential for damage.

Pre-Test Pulse Release Monitoring

Prior to initiating the test pulse releases SMUD will carry out geomorphic and riparian vegetation monitoring at the sensitive sites and erosion monitoring at the infrastructure evaluation sites with the objective of establishing baseline conditions. The geomorphic and riparian vegetation methods presented in the previous section will be used at the two sensitive sites shown in **Figure 2** and **Table 1** (with the exception of sites that are impractical at the time of survey work due to flooding of influence of beaver); visual observations of erosion will be made at the thirteen infrastructure evaluation sites shown in **Figure 2** and **Table 1**. If scour holes or other features are observed, the geometry of these features will be surveyed (such as depth, length, width, and position) Since it has been nearly 20 years since an annual maximum peak flow measured at the USGS gage below Loon Lake Reservoir Dam (USGS No. 11429500) has exceeded 200 cfs (the minimum pulse flow prescribed in WQC Condition 2.B and USFS Section 4(e) Condition 28 for Below Normal years), these baseline conditions are important for characterizing the effects of the regulated hydrology on the geomorphology, riparian vegetation, and erosion at the study sites.

Develop and Apply a Numerical Hydraulic Model

Based on observations made during the fall 2012 reconnaissance, SMUD confirmed the value of using a numerical hydraulic model to simulate how pulse flows and estimates of tributary flow accretions move downstream through the LLD reach of Gerle Creek. The numerical hydraulic model will be developed based on existing topography. The model will be calibrated and validated to measurements of high-water marks and measured flows during snowmelt runoff. Once the model is successfully validated, it will be applied to quantify flows and water-surface elevations throughout the modeled reaches of Gerle Creek. These outputs will be simulated for the pulse flows to evaluate potential flooding/erosion concerns at infrastructure evaluation sites prior to the test pulse releases as well as the stage-discharge relationship and extent of floodplain inundation (if any) at the sensitive sites. There is no plan to utilize the hydraulic model after the sensitive site investigation is complete.

The numerical hydraulic model will be developed to simulate channel processes governing the routing (i.e., translation and attenuation) of flows through the LLD reach of Gerle Creek. Specifically, a single model will be developed from the outlet works of Loon Lake Reservoir Dam to about a few hundred feet downstream of the Airport Flat Campground (i.e., the extent of the LLD reach of Gerle Creek containing the 15 study sites). The steps below apply to the development and application of the hydraulic model.

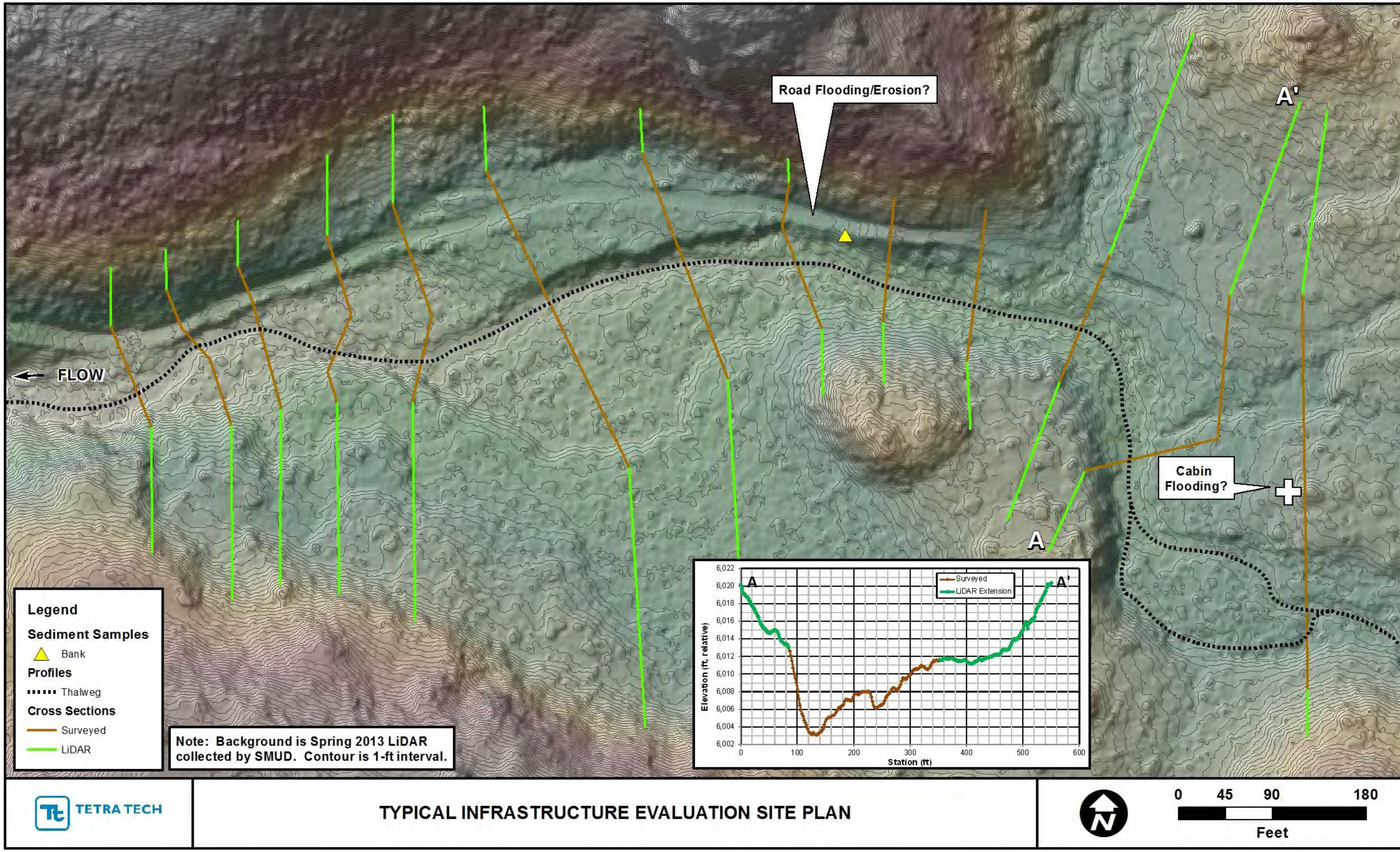

Figure 5. Typical Infrastructure Evaluation Site Plan

a. Acquire a detailed topographic survey (i.e., LiDAR) of the valley containing the LLD reach of Gerle Creek. LiDAR mapping was collected mid-April 2013, the timing of which minimized the undesirable influences of snow cover and high water-surface elevations in the channel.
b. Near sensitive sites and infrastructure evaluation sites, collect surveys of channel geometry that were obscured in the LiDAR mapping by water in the channel. The channel surveys will be merged with the LiDAR topography to develop complete cross section geometry.
c. Use the current version of the U.S. Army Corps of Engineers' HEC-RAS modeling software to simulate the unsteady-flow routing of pulse flows through the LLD Reach of Gerle Creek. Quantify relationships between inflows, hydrologic storage volume, and outflows at hydrologic storage areas (e.g., stream segments impounded by beaver dams, or stream segments upstream of natural constrictions in valley topography). Incorporate these relationships in the numerical model to simulate effects on the routing of pulse flows as they progress downstream.
d. Calibrate the numerical model using surveyed water-surface elevations and flow measurements collected during spring snowmelt runoff. Validate the numerical model using either (1) a second set of surveyed water-surface elevations and flow measurements collected during spring high flows, or (2) surveys and flow measurements collected during the test pulse releases. The calibration process will confirm the parameterization of the model; the validation process will confirm the accuracy of the model. The calibrated and validated model will provide confidence in the results of simulations.
e. Apply the numerical model to quantify pulse flow hydrographs released from LLD throughout the LLD reach of Gerle Creek. Initially apply the model only to evaluate the pulse flows specified in the FERC license. Subsequent simulations will incorporate estimates of flow accretions associated with snowmelt runoff; the uncertainty in these estimates can be input to the model to assess the effects, if any, of the pulse flows on the study sites. The model will also provide insight into the sensitivity of responses to the pulse flows by considering estimates of flow accretions associated with spring snowmelt runoff.
f. The validated model will be used to inform the maximum test pulse release (up to the maximum prescribed in the FERC license) not expected to cause flooding or erosion impacts to downstream features such as campgrounds, day-use areas, cabins, roadways, and bridges; in the evaluation and design of stabilization/mitigation measures to address potential impacts associated with the pulse flows; and as an aid in evaluating the possible tradeoffs between potential negative and positive effects (e.g. potential damage to infrastructure versus potential inundation of riparian vegetation) of implementing flows of specific magnitudes.

Provide Recommendations Regarding Pulse Flows to Resource Agencies

The results of the hydraulic model, simulating various magnitudes of pulse releases up to the maximum prescribed in the FERC license, will be presented to the Resource Agencies prior to initiating test pulse releases. This will allow SMUD and the Resource Agencies to discuss any potential flooding or erosion impacts, and consider the magnitude of the potential impacts. Concerns about the recommendations can be discussed so that the initial test pulse release, and potential subsequent releases, can be agreed upon.

Test Pulse Releases and Flooding/Erosion Monitoring

After the Resource Agencies and SMUD convene and agree upon a test pulse flow magnitude or test pulse flow magnitudes, SMUD will initiate test pulse releases, ideally timed to coincide with the spring 2016 snowmelt runoff. During each release, SMUD will monitor (1) the infrastructure evaluation sites to check if any flooding or erosion impacts are apparent and (2) the sensitive sites to validate water surface elevations and extent of inundation. SMUD will visually monitor water-surface elevations for comparisons to established thresholds (i.e., surveyed reference marks) to evaluate flooding impacts. SMUD will visually monitor potential erosion areas and survey erosion features of concern following the recession of the test pulse release water-surface to evaluate erosion impacts.

Post-Test Pulse Release Monitoring

Following the test pulse releases, SMUD will carry out geomorphic and riparian vegetation monitoring at the sensitive sites and erosion monitoring at the infrastructure evaluation sites. The geomorphic and riparian vegetation methods presented in a previous section will be used at the sensitive sites shown in **Figure 2** and **Table 1**; visual observations of erosion will be made at the thirteen infrastructure evaluation sites shown in **Figure 2** and **Table 1**. If scour holes or other features are observed, the geometry of these features will be surveyed (such as depth, length, width, and position). This monitoring will occur as soon as it can safely be carried out following the test pulse release and useful information collected. Data collected may be useful for comparison to future monitoring carried out under the Geomorphology Continuing Evaluation of Representative Channel Areas Plan and Riparian Vegetation Monitoring Plan to the degree that they align with the sites and methodologies specific to those plans.

Provide Results of Monitoring and Associated Analyses to Resource Agencies

The results of the pre-test pulse release monitoring, results of the monitoring during the test pulse releases, results of the post-test pulse release monitoring, and analyses of the monitoring data will be provided to the Resource Agencies for their consideration in determining the appropriate magnitude of pulse flows (WQC Condition 2.B and USFS Section 4(e) Condition 28) and the most effective method of stabilizing LL-G1 and LL-G2 (WQC Condition 8.G and USFS Section 4(e) Condition 31). The results will be presented discretely for the three components of WQC Condition 2.B and USFS Section 4(e) Condition 28: (1) the sensitive site investigation, (2) test pulse releases, and (3) the analyses of the effects of the pulse flows on downstream features.

Schedule

The FERC license for the UARP was issued July 23, 2014; therefore, the schedule follows from this date and accounts for the timelines in the license. It is important to note that due to access and safety issues, the field season along the LLD reach of Gerle Creek only reliably extends from June through September, with May and October as "shoulder" months; November through April cannot be considered for safe and reliable access. **Table 4** presents the schedule.

Table 4. SSIMMP Schedule	
2013	
May	Completed LiDAR topographic survey
July	Released *Framework of Plan for SSI, PFT, and MM* for resource agency review
October	Issuance of SWRCB *Water Quality Certification*
November	Field meeting with Resource Agencies to initiate informal consultation on the *Framework*
	Begin Resource Agency review of *Framework*
November - December	Initiate preparation of the *DRAFT SSIMMP*
2014	
February 3	Receive Resource Agency comments on *Framework*
February	Begin addressing Resource Agency comments on *Framework*
July 23	Issuance of FERC License for UARP
Mid-October	Release *Draft SSIMMP*
	Begin 30-day Consultation Group review and comment of *Draft SSIMMP*
Mid-December	End 30-day Consultation Group review and comment period

2015	
January	Address comments on *Draft SSIMMP*
January 23	Begin 90-day Resource Agency review and approval period
April 23	End 90-day Resource Agency review and approval period
April-May	Address comments on *Draft SSIMMP*
May 21	Submit *Final SSIMMP* for FERC approval
May - June	Develop numerical hydraulic model
May - June	Collect hydraulic measurements (flow and water-surface elevation hydrographs) during snowmelt runoff for use in calibrating (and validating, if a second survey can be carried out) the numerical hydraulic model
July	Initiate implementation of FERC approved *SSIMMP*
July - August	Pre-test pulse releases monitoring at study sites
August - October	Calibrate numerical hydraulic model; validate if validation dataset available
November - December	Provide recommendations to Resource Agencies
2016	
April - May	Collect hydraulic measurements (flow and water-surface elevation hydrographs) during snowmelt runoff for use in validating the numerical hydraulic model (assume no earlier opportunities were available)
May - July	Release test pulses and monitor study sites
July	Post-test pulse releases monitoring at study sites
July 23	Provide final monitoring results and recommendations to Resource Agencies and FERC

Plan Revisions

If SMUD, USFS, CDFW, or SWRCB collaboratively determine that revisions should be made to the plan, SMUD will make any revisions to the Plan in coordination and consultation with the listed resource agencies. Any revisions to the plan must be approved by USFS, CDFW, and SWRCB. Any revisions shall be filed with FERC for approval prior to implementing.

SMUD®

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Appendix A – Descriptions of Gerle Creek below Loon Lake Reservoir Dam, including Sites LL-G1 and LL-G2

The *Channel Morphology Technical Report* (DTA and Stillwater Sciences 2005) documents the geomorphic condition of river reaches as characterized during the FERC relicensing process of SMUD's UARP and PG&E's Chili Bar Project. A specific objective of the study documented in the *Channel Morphology Technical Report* was the identification and classification of potential response reaches. These reaches were of interest because the effects of dams and flow regulation on channel morphology were expected to be more pronounced in response reaches (DTA and Stillwater Sciences 2005).

The following is extracted from the *Channel Morphology Technical Report*.

> The entire Loon Lake Dam (LLD) Reach of Gerle Creek was broadly characterized primarily using remotely-sensed data to identify potential response reaches. In reaches where more than one potential response reach was identified, potential response reaches were prioritized where geomorphic response to UARP operations was most likely to be evident. Upstream-most potential response reaches were selected to measure potential scour below UARP dams, and because effects of the dams can be more difficult to observe as new sources of sediment and water are supplied by tributaries downstream of a dam. Response reaches located toward the downstream end of a stream reach were prioritized if the combination of reduced peak flows and potentially increased sediment supplies from tributaries could cause excess fine sediment deposition. Three potential response reaches located along the Loon Lake Dam (LLD) Reach of Gerle Creek were designated as response sites for further study: LLD Reach Upper Site (LL-G1), LLD Reach Middle Site (LL-G2), and LLD Reach Lower Site (LL-G3). The designation of these sites as response reaches was based on the application of the Montgomery and Buffington (1997) classification according to dominant channel morphology.

One caveat offered in the technical report related to the classification of the dominant channel morphology is the influence of the underlying metamorphic and igneous complex that creates the Sierra Nevada range and foothills. Segments of bedrock channels with alluvial deposits were distinguished from bedrock-controlled segments as potential response reaches, because, as argued by McBain and Trush (2004) as cited in DTA and Stillwater Sciences (2005), bedrock channels [of the Sierra Nevada] are often highly dynamic depositional environments where large-scale geomorphic controls such as bedrock and boulders control the deposition of finer material as nested features. It is not stated whether this caveat is applicable to the three response sites identified along the LLD Reach of Gerle Creek. The morphological descriptions and channel condition assessments for each of these three response sites are provided in the *Channel Morphology Technical Report*.

As noted in the *Channel Morphology Technical Report*, the geomorphic condition of the LLD Reach of Gerle Creek is dynamic. Approximately a decade passed between the field work performed for the relicensing studies and the reconnaissance conducted October 30, 2012 to November 1, 2012 to characterize the current conditions of the LLD Reach of Gerle Creek (Exhibit 1). The characterization was compared to the previously documented morphological descriptions and channel condition assessments to establish a framework for the development of the required SSIMMP.

Three key findings of the reconnaissance related to LL-G1 and LL-G2 are:

1. The morphology of the valley containing the LLD Reach of Gerle Creek exhibits indicators of historical glaciations, which appear to substantially influence current channel morphology, sediment supply, hydraulics, sediment delivery to Gerle Creek, and sediment transport capacity.
2. The recent influence of beavers appears to be accelerating the dynamic geomorphic conditions of the LLD Reach of Gerle Creek.
3. The application of the Montgomery and Buffington (1997) classification system as the basis for identifying response reaches in the relicensing studies (DTA and Stillwater Sciences 2005) may have overly simplified the potential for responses of channel morphology to changes in hydrology and sediment supply.

These findings strongly influenced the approaches presented in the SSIMMP. Additional information relative to each finding follows.

1. *<u>Influence of Historical Glaciations</u>*

The *Channel Morphology Technical Report* includes two observations relative to glacial influences on the LLD Reach of Gerle Creek:

- The Gerle Creek watershed is underlain by Mesozoic granitic and dioritic rocks, glacial moraine deposits, and minor outcrops of the Jurassic metasedimentary rocks of the Sailor Canyon Formation.
- Gerle Creek flows through a wide and swampy Holocene alluvial valley (Neck Meadow and Gerle Meadow) that is surrounded by moderately sloping and glaciated hillsides.

During the fall 2012 reconnaissance, the influence of the glacial moraine deposits noted in DTA and Stillwater Sciences (2005) became clearer. As shown in Photograph 24 on **Exhibit 1**, a breached moraine was identified at the downstream end of Gerle Meadow, just downstream from the new bridge crossing of Old Wentworth Springs Road. This moraine likely impounded a frontal lake during glacial recessions occurring in interglacial periods of the late Pleistocene epoch (0.01 M to 1.8 M years ago). When the moraine was intact, the lake likely inundated all of Gerle Meadow and Neck Meadow to the current location of the falls just upstream of the confluence of Jarrett Creek (Photograph 17 on **Exhibit 1**). The current meadows appear to be the lacustrine deposition that formed the historical lake bed. It is likely that this lake formed and drained multiple times through the glacial and interglacial periods. The lacustrine deposits may have been reworked by glaciers when the lake was drained, and these deposits may be mixed with additional sediment loads from the surrounding hillslopes. The lag deposit of boulders remaining in the breached moraine provides the hydraulic control for Gerle Creek through Gerle Meadow (**Figure A-1**). This lag deposit controls the elevation of the channel bed at the downstream end of Gerle Meadow. The response of the morphology of Gerle Creek through Gerle Meadow to pulse flows released from LLD will be directly influenced by the hydraulic control imposed by the lag deposit in the breached moraine. Since LL-G2 is located at the upstream end of Neck Meadow (Photograph 18 on **Exhibit 1**), likely on coarse sediments comprising a depositional fan at the confluence of Jarrett Creek, none of the three response sites (i.e., LL-G1 through LL-G3) are located in the glacio-lacustrine deposits through Gerle Meadow or Neck Meadow. Due to the fine-grained nature of these deposits that now make up the bed and banks of Gerle Creek through the meadows, additional response sites in Gerle Meadow and/or Neck Meadow are recommended to determine appropriate pulse flows, monitor geomorphic responses to the pulse flows, and assess potential impacts to private property and infrastructure.

Figure A-1. Upstream View of the Boulder Lag Deposit that Provides Hydraulic Control Upstream into Gerle Meadow.

Assuming Gerle Meadow and Neck Meadow now exist in the glacio-lacustrine deposits induced by impoundment and draining of a historical lake behind a glacial moraine, the glacial influences on the valley morphology likely affect the sediment supply to Gerle Creek. Some of the primary tributaries to Gerle Creek (i.e., Jarrett Creek, Barts Creek, and Dellar Creek) traverse the meadows for at least a few hundred feet before joining Gerle Creek. The transition from the higher gradient, confined tributary valleys to the lower gradient, unconfined meadows abruptly reduces the sediment transport capacity of the tributaries. Depositional fans were observed during the fall 2012 reconnaissance where these tributaries flow onto the meadows. These fans confirm a reduction in the delivery of sediment from the tributary watersheds into Gerle Creek. While the sediment supply from these tributary watersheds is expected to be relatively low due to the thin soil profiles on the glacially scraped hillslopes (**Figure 2**), the further reduction in the sediment delivery to Gerle Creek due to the storage in depositional fans on the glacio-lacustrine terraces directly affects the relationships between sediment supply and sediment transport capacity in Gerle Creek.

Figure A-2. Glacially-scraped Hillslopes in the Gerle Creek Watershed below Loon Lake.

A second breached glacial moraine was identified just downstream of the confluence of Rocky Basin Creek with Gerle Creek (Photograph 26 on **Exhibit 1**). It appears that this moraine was breached in response to one of the lake draining episodes during the breaching of the moraine at the downstream end of Gerle Meadow. A boulder-dominated cascade typifies the morphology of Gerle Creek between these two breached moraines (Photograph 25 on **Exhibit 1**). Just upstream of the Rocky Basin confluence, the valley widens and Gerle Creek flows across a boulder-dominated fan. These boulders were likely transported downstream when the upstream moraine breached, releasing a catastrophic drainage of the lake, but the boulders were deposited when they entered the lake impounded by the downstream moraine. When the downstream moraine breached, hydraulic capacity associated with the draining of the upstream lake was likely sufficient to transport sediments finer than boulders farther downstream such that the current fan dominated by boulders was all that remained. It is extremely unlikely that the greatest pulse flows released from LLD could affect the morphology of the channel between the breached moraines, and there are no bank erosion or flooding concerns through this reach; as a result, no additional response sites are recommended in this area.

2. *Influence of Beavers*

Beaver activity was observed during the fall 2012 reconnaissance along the valley bottom containing Gerle Creek. The upstream extent of the beaver activity was observed immediately downstream of the Green Family Camp (Photograph 3 on **Exhibit 1**); the downstream extent was observed at a transition from a lower gradient, unconfined valley to a higher gradient, confined valley (Photograph 11 on **Exhibit 1**). Based on reconnaissance conducted in 2010 by SMUD staff, the increase in beaver activity in this area is pronounced. For example, the LL-G1 site was inaccessible during the fall 2012 reconnaissance because the entire valley bottom was inundated by beaver dams. As the beavers dam Gerle Creek, the dams create backwaters that inundate riparian areas and floodplains. The inundation kills trees (Photograph 6 on **Exhibit 1**), which increases the supply of logs for the beavers to enhance and reinforce dams. The currently inundated areas could act as detention basins when pulse flow tests are released. Similar to a stormwater detention basin, the beaver dams can attenuate peak pulse flows by storing the inflowing volume then gradually releasing it. The numerical hydraulic modeling included in the SSIMMP is a useful tool for evaluating the influence of the beavers on the pulse flows.

3. *Relicensing Classification of Response Reaches*

The *Channel Morphology Technical Report* documents a heavy reliance on the Montgomery and Buffington (1997) classification of channel-reach morphology in mountain drainage basins to identify response reaches in the LLD Reach of Gerle Creek. The underlying hypothesis of this classification is that channel-reach morphology represents a configuration of stable energy dissipation for the imposed sediment supply and transport capacity, thereby implying a fundamental link between channel processes and form (Montgomery and Buffington 1997). As defined by Montgomery and Buffington response reaches exhibit low ratios of sediment transport capacity to sediment supply (i.e., less than one), and the geomorphic response of the channel becomes progressively more responsive to altered discharge and sediment supply with: (1) a decreasing ratio of sediment transport capacity to sediment supply, (2) smaller bed material grain sizes, and (3) less channel confinement. At the conceptual level, based on typical reach processes, characteristics, and locations within a drainage basin, Montgomery and Buffington (1997) identify plane-bed, pool-riffle, and dune-ripple channels as potential response reaches. However, the authors caution that plane-bed and pool-riffle channels exhibit a mixture of supply- and transport-limited characteristics depending on the degree of bed-surface armoring. The authors further note that while reach-level channel morphology provides a general indication of differences in response potential, specific responses depend on the nature, magnitude, and persistence of an alteration in flow or sediment supply, as well as external influences such as riparian vegetation, LWD loading and retention, bank materials, and historical alterations. Thus, applying the Montgomery and Buffington (1997) classification of channel-reach morphology based simply on dominant channel morphology as broadly characterized using remotely-sensed data to identify potential response reaches as appears to have been done in the relicensing geomorphology study could produce erroneous expectations of response to altered hydrology and sediment supply. The error could be compounded if the magnitude of the alternations is not carefully considered against the sediment transport regime, the mobility thresholds of the bed material, the confinement of the channel, and external influences.

The three response sites identified along the LLD Reach of Gerle Creek, LL-G1, LL-G2, and LL-G3, were respectively categorized in the *Channel Morphology Technical Report* as pool-riffle, plane-bed, and pool-riffle channels. Site LL-G1 was inundated by a beaver pond during the fall 2012 reconnaissance; under these conditions it is not expected to exhibit a representative response to the pulse flows. The LL-G2 site was visited during the fall 2012 reconnaissance (Photograph 18 on **Exhibit 1**), and a variety of observations indicated that this particular plane-bed channel may not be highly responsive to the proposed pulse flows (e.g., surface bed-material dominated by coarse gravels and cobbles, low bank heights with established, woody, riparian vegetation on a hydraulically-connected floodplain, LWD jams forcing flows onto the unconfined floodplain). Site LL-G3 will not be further considered per the *Settlement Agreement*. Between site LL-G2 and the downstream end of Gerle Meadow, the following examples of geomorphic conditions observed during the fall 2012 reconnaissance indicate greater potential for responses to the proposed pulse flows:

- Bed material dominated by sands and fine gravels, indicating greater likelihood of mobilization,
- Depositional bars in the channel indicative of sediment supply exceeding transport capacity (i.e., a lower ratios of sediment transport capacity to sediment supply),
- Channels incised in a relatively unconfined valley bottom, limiting the hydraulic connection between the channel and the floodplain and increasing channel capacity,
- Increasing bank heights that reduce the influence of root strength in relatively non-cohesive bank materials,
- LWD jams that initiate channel avulsions and local widening,
- A relatively low-sinuosity planform, and
- Tributary drainages that could increase pulse flows timed to coincide with the spring snowmelt.

Based on these observations, additional response reaches are warranted to better characterize the response of the free-formed channels in the LLD Reach of Gerle Creek to the proposed pulse flow releases from Loon Lake Dam.

Conditions during Relicensing

Based on what was learned during the relicensing studies about the geomorphic condition of Gerle Creek below Loon Lake Reservoir Dam, and specifically sites LL-G1 and LL-G2, the Resource Agencies established the following existing conditions in Gerle Creek below Loon Lake Reservoir Dam (CDFG 2007):

- Brown trout, a non-native but desirable fish species, are abundant in this reach.
- Rainbow trout, a native fish species, also occur in this reach but not in desired biomass numbers.
- Aquatic species passage upstream from Gerle Reservoir into Gerle Creek needs to be maintained for brown trout spawning.
- This reach includes one of three identified alluvially controlled response reaches in the Project.
- The stream channel is aggrading and has lateral scour pools.
- The stream banks are highly unstable, contributing a high amount of fine material in the stream channel system.
- Inundation of low terraces and flood-prone areas is infrequent during the growing season.
- Lack of high-velocity flows within the bankfull channel results in encroachment.
- Temperatures below Loon Lake Reservoir Dam are somewhat reflective of natural conditions until July and August, when releases from Loon Lake cool the water in this reach to temperatures that are not reflective of natural conditions.
- There is macroinvertebrate bioassessment impairment immediately downstream of the Loon Lake Reservoir Dam; however, there is recovery of composite metric scores farther downstream in this reach.
- An occurrence of Stebbin's phacelia is located near the dam at the west edge of Loon Lake Reservoir.
- Fish populations do not meet biomass and other fish metrics objectives.

Desired Conditions at time of Relicensing Studies

The desired conditions in Gerle Creek below Loon Lake Reservoir Dam are (CDFG 2007):

- Provide habitat for healthy rainbow trout and desired non-native brown trout populations.
- Provide aquatic species passage upstream out of Gerle Reservoir to provide for brown trout spawning.
- Provide habitat for healthy mountain yellow-legged frog populations.
- Provide cold freshwater habitat.

- Move sediment through system to improve channel condition in Gerle Meadow area.
- Rehabilitate the stream channel and improve stream bank stability.
- Ensure low terraces and flood-prone areas are inundated during the growing season.
- Provide flows to reduce riparian encroachment.

Rationale for Pulse Flows

The *Rationale Report* (CDFG 2007) includes the following general rationale for pulse flows and specific rationale for pulse flows in Gerle Creek below Loon Lake Reservoir Dam.

General Rationale

> Through the geomorphology and hydrology studies, reaches with apparent imbalance between sediment supply and peak flows were identified. Pulse flows were prescribed for three reaches where there is evidence of channel shape, form, and capacity being impacted, and which experience high attenuation of peak flows, with infrequent spill flow events with effective discharges.
>
> The intent of introducing pulse flow events to the channel is to: (a) more closely mimic the timing and duration of peak flows that would occur under an unimpaired hydrograph; (b) initiate transport of bedload material, which would assist in improving habitat conditions for aquatic species; and (c) facilitate flooding of the streamside riparian community at the appropriate time of year.
>
> Pulse flows are designed to occur with a frequency that mimics the natural hydrograph in timing, and to some extent, in magnitude. Pulse flows are designed to be of a magnitude that would occur within the natural hydrograph with a high frequency, filling the channel to bankfull and slightly above at least every 1 to 5 years. The use of bankfull (assumed to be a 1.5-year peak flow frequency) as an objective in designing pulse flows is targeted at filling the channel and inundating all available aquatic habitat during the growing and spring spawning season.
>
> Incipient motion analyses for bedload presented in the *Channel Morphology Technical Report* (DTA and Stillwater Sciences 2005) were considered in designing the prescribed peak flows. The prescribed peak flows were also designed to:
>
> - Fit within the bankfull channel and local flood-prone area, as determined by examining cross-sectional data in the *Channel Morphology Technical Report*.

- Transport bedload that was characterized in the *Channel Morphology Technical Report*, timed with the delivery of bedload from tributary channels during spring runoff events or winter storm events.
- Maintain a properly functioning riparian community.
- Transport and distribute large woody debris in the channel.
- Occur within the natural hydrograph in timing and duration.
- Fit within the balance of meeting other needs within the system for recreation, hydroelectric generation, and aquatic ecosystem beneficial uses.

The measures associated with pulse flows allow for the use of the stream to improve channel condition by restoring and maintaining fluvial geomorphological processes and, in particular, to establish a balanced transport of sediment.

<u>Rationale for Pulse Flows in Gerle Creek</u>

> The channel is in poor condition and needs the reintroduction of pulse flows. Many downed logs are in the channel, and a high level of fine bedload exists. Channel banks are unstable, due to lack of transport of the bedload and the lateral scour pools created as the channel attempts to flow around the logs. The BEHI for LL-G1 identified the banks as highly erodible. There is a high interest in providing high quality rainbow trout and brown trout habitat in this reach, and pulse flows are expected to improve habitat quality.
>
> The range of pulse flows for the different year types is expected to redefine the Gerle Creek stream channel below Loon Lake Reservoir Dam, sort spawning gravels, and transport bedload and fines.
>
> The pulse flows are timed to occur during the snowmelt runoff, when Barts and Dellar Creeks, Rocky Basin Creek, and Jarrett Creek are also running higher. There are substantial fines in the Gerle Creek channel, and one of the goals is to move these fines through the channel. The pulse flows are expected to move these fines and material that is sized 95 to 205 mm based on the incipient motion study in the *Channel Morphology Technical Report*. It is important to move the fines and other material to remove sediment from spawning materials and to sort spawning gravels.

<u>Stabilization Plan Rationale</u>

The *Rationale Report* (CDFG 2007) includes the following rationale for the Gerle Creek Stabilization Plan.

> See rationale for pulse flows. Although it is expected that modified minimum streamflows and pulse flows will result in beneficial effects to the degraded channel conditions in Gerle Creek, based on the problems occurring in the

channel, stabilization work in addition to these streamflows is needed to improve conditions in the channel. The sensitive site investigation and channel stabilization plan will be completed before introduction of the new pulse flows. The prescribed pulse flows may be changed, if the results of the plans indicate another flow would be more appropriate. Flows would not be increased, due to facility constraints.

Literature Cited

CDFG. 2007. *Upper American River Project, FERC No. 2101 and Chili Bar Hydroelectric Project, FERC No. 2155 Rationale Report for Relicensing Settlement Agreement.* Filed with FERC by the California Department of Fish and Game (CDFG) on January 31, 2007. 310 p.

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151 FERC ¶ 62,197
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Sacramento Municipal Utility District Project No. 2101-105

ORDER MODIFYING AND APPROVING SENSITIVE SITE INVESTIGATION AND MITIGATION MONITORING PLAN PURSUANT TO ARTICLE 401(A)

(Issued June 18, 2015)

1. On May 21, 2015, Sacramento Municipal Utility District (licensee) filed its Sensitive Site Investigation and Mitigation Monitoring Plan with the Federal Energy Regulatory Commission (Commission) pursuant to Article 401(a) of the Upper American River Project license.[1] The project is located on the Rubicon River, Silver Creek, and South Fork American River in El Dorado and Sacramento counties, California and occupies lands within the Eldorado National Forest.

REQUIREMENTS

2. Article 401(a), in part, requires the licensee to file, for Commission approval, a Sensitive Site Investigation and Mitigation Monitoring Plan (Plan) for Gerle Creek within 10 months of licensee issuance, or May 23, 2015. The Plan is also required by the project's Water Quality Certification (WQC), Condition Nos. 1 and 8(g), and the U.S. Forest Service (FS) 4(e) Condition Nos. 28 and 31.7.[2] These requirements specify that the Plan should include a detailed investigation of fluvial geomorphic properties in Gerle Creek, a tributary to the South Fork Rubicon River, before and after post-test pulse flow releases from Loon Lake Dam. The Plan relates to two other plans required by the project license, as well as two other license conditions in the project's WQC and U.S. Forest Service 4(e) Conditions, but should not be confused with these other requirements. Specifically, the Plan will assist in the development and/or implementation of the Stabilization Plan for Gerle Creek and the Geomorphology Continuing Evaluation of Representative Channel Areas Plan. The licensee must develop the Plan in consultation

[1] Order Issuing New License. 148 FERC ¶ 62,070 (issued July 23, 2014).

[2] The water quality certification and U.S. Forest Service 4(e) Conditions were incorporated into the project license via Appendices A and B, respectively.

with the FS, U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (DFW), and the State Water Resource Control Board (SWRCB).

LICENSEE'S PLAN

3. The licensee's proposed Plan consists of eight main components, which are summarized below.

4. The first component would involve re-establishing two sensitive sites that were identified during previous geomorphological studies conducted by the licensee as part of relicensing in 2005. The licensee would eventually monitor these sites, which are located on the upper and middle reach of Gerle Creek, below Loon Lake Dam for geomorphic change. Additionally, the licensee would identify infrastructure evaluation sites that it would later monitor (see discussion below) in order to determine the effects of pulse flows. The selection of infrastructure sites would be largely based on a reconnaissance survey that the licensee conducted in 2012, and will include bridges, campgrounds and day-use areas. The licensee anticipates selecting a total of 13 infrastructure evaluation sites. Once the sensitive sites are re-established and the infrastructure sites are identified, the licensee would map and record the locations of the sites for future reference.

5. Next, the licensee would establish methods for geomorphic, riparian vegetation, and infrastructure monitoring. The monitoring methods would be based on the licensee's monitoring objectives and evaluation metrics, both of which are discussed in the Plan.

6. Prior to pulse release testing, the licensee would complete three components of the Plan. The first of the three components involves pre-test release monitoring, which entails geomorphic and riparian vegetation monitoring at the sensitive sites and erosion monitoring at the infrastructure evaluation sites. This monitoring will provide baseline data and document existing scour features that could be further impacted by the release of pulse flows. Following this component, the licensee would develop and apply a numerical hydraulic model that would use existing conditions to simulate how pulse flows and tributary flow accretions move downstream through the reach of Gerle Creek below Loon Lake Dam. The licensee would use the output of the model to evaluate potential flooding and erosion concerns at the infrastructure evaluation sites prior to the test pulse releases. The licensee would also use the model to evaluate the stage-discharge relationship and extent of floodplain inundation (if any) at the sensitive sites. Next, the licensee would present the results of the model to the resources agencies. Together, the licensee and resource agencies would discuss any potential flooding or erosion impacts that might be caused by the test pulse flows, and agree upon the magnitude of initial and subsequent test pulse flow releases.

7. Upon reaching an agreement with the resource agencies on the magnitude of test pulse flow releases, the licensee would initiate a test pulse flow release, which, ideally, would be timed to coincide with the spring 2016 snowmelt runoff. During each release,

the licensee would monitor: 1) the infrastructure evaluation sites to determine if flooding or erosion impacts are apparent; and, 2) the sensitive sites to validate water-surface elevations for comparison to established thresholds (i.e., surveyed reference marks) in order to evaluate flooding impacts.

8. Following each release, the licensee would conduct geomorphic and riparian vegetation monitoring at the sensitive sites and erosion monitoring at the infrastructure evaluation sites using the same methods employed during pre-pulse release monitoring. Additionally, all scour features would be surveyed to further characterize the extent of scour. The licensee would later use this information in its Geomorphology Continuing Evaluation of Representative Channel Areas Plan and Riparian Vegetation Monitoring Plan.

9. The licensee would compile and analyze the results of pre- and post-test pulse flow release monitoring and provide the data to the resource agencies for use in determining the appropriate magnitude of pulse flows and the most effective method of stabilizing the sensitive sites. Based on the schedule included in the Plan, the licensee would provide the final monitoring results to the resource agencies and the Commission by July 23, 2016.

AGENCY CONSULTATION

10. The licensee provided its Plan to the FS, FWS, DFW, and SWRCB for review and approval on October 13, 2014. The licensee revised its Plan based on comments provided by FS, DFW, SWRCB and re-filed it with the agencies for approval on May 7, 2015. The licensee has received approval from all consulted parties on its Plan.

DISCUSSION AND CONCLUSIONS

11. The licensee's Plan should provide a comprehensive program to evaluate the effect of test pulse flow releases on sensitive sites and important infrastructure sites at the project. The data collected under the Plan should aid in developing appropriate and effective pulse flow releases from Loon Lake Dam into the reach of Gerle Creek immediately downstream of the dam.

12. As proposed, the licensee would file its monitoring results with the resource agencies and Commission concurrently. The Plan should be modified such that the Commission receives the final report after the resource agencies have had an opportunity to provide comments and recommendations. In order to allow the licensee ample time to receive and address agency comments, and revise the report accordingly, the licensee should file the final report, including its consultation record, with the Commission by October 1, 2016. For any agency recommendations that is not incorporate into the report, the licensee should explain its reasons for not including them, using project-specific information, in its filing with the Commission.

13. Sacramento Municipal Utility District's proposed Sensitive Site Investigation and Mitigation Monitoring Plan fulfills the requirements of the 401 (a) in part, Water Quality Certification Condition Nos. 1 and 8(g), and the U.S. Forest Service 4(e) Condition Nos. 28 and 31.7, and as modified, should be approved.

The Director orders:

(A) Sacramento Municipal Utility District's (licensee) Sensitive Site Investigation and Mitigation Monitoring Plan (Plan), filed on May 21, 2015, pursuant in part to Article 401 (a), Water Quality Certification Condition Nos. 1 and 8(g), and the U.S. Forest Service 4(e) Condition Nos. 28 and 31.7 for the Upper American River Project (FERC No. 2101), as modified in paragraph (B), is approved.

(B) The licensee must file its final report under the Plan, including its consultation record with the resource agencies, with the Commission by October 1, 2016. For any agency recommendations that the licensee does not incorporate into the report, it must include its reasons for excluding them, using project-specific information, in its filing with the Commission.

(C) This order constitutes final agency action. Any party may file a request for rehearing of this order within 30 days from the date of its issuance, as provided in section 313(a) of the Federal Power Act, 16 U.S.C. § 825*l* (2012), and the Commission's regulations at 18 C.F.R. § 385.713 (2014). The filing of a request for rehearing does not operate as a stay of the effective date of this order, or of any other date specified in this order. The licensee's failure to file a request for rehearing shall constitute acceptance of this order.

Thomas J. LoVullo
Chief, Aquatic Resources Branch
Division of Hydropower Administration
and Compliance

Document Content(s)