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Date:
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To:
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Technical Memorandum

Subject: RI Modification: Supplemental Surface Water Investigation Plan

This technical memorandum presents AECOM's recommended Remedial Investigation (RI) Modification to the approved Supplemental Surface Water Investigation Plan (SSWIP) dated January 30, 2018. This RI Modification was developed based on the findings of initial data collection tasks conducted under the SSWIP including thermal infrared (TIR) imaging and fiber-optic distributed temperature survey (DTS). The approved SSWIP proposed surface water sample transect locations, but indicated that these may change based on the results of the TIR and DTS data. This RI Modification presents those changes, in accordance with a WebEx-based presentation/teleconference meeting held April 17, 2018, and attended by the Nevada Division of Environmental Protection (NDEP), the Nevada Environmental Response Trust (NERT), Ramboll and AECOM.

SSWIP Scope Modification

Surface water sampling from 17 transect locations was proposed in the SSWIP. These proposed transect locations are shown on **Figure 1** and the rationale for their initial selection in the SSWIP is described in **Table 1**.

AECOM reviewed the results of the TIR and DTS and suggested modifications of the transect sampling and grab sampling locations to better capture the potential perchlorate inputs. The modified locations were selected based on thermal anomalies (i.e., locations with warmer or cooler water than surrounding surface water) in combination with perchlorate data from previous sampling events. **Figure 2** presents an overview of the proposed modified sample locations (transects and grab samples). A summary of changes to the transect and grab sample locations in the SSWIP is provided below, with references to attached **Tables 2, 3 and 4**, which provide more detailed rationale for removed transects, new sample locations, and unchanged locations, respectively.

Proposed Transect Locations

- Five transects were removed (**Table 2**):
 - Transect T4.75 was replaced with grab samples near the downstream warm anomalies
 - Transects T4.6 and T4.2 were removed since no changes in perchlorate were noted during previous sampling in this reach and no warm thermal anomalies were encountered during the DTS
 - Two transects were removed due to construction at Sunrise Mountain Weir (T6.35) and Historical Lateral Weir Expansion (T5.3).
- Two transects (T6.45 and T4.0) were moved slightly (**Table 2** and **Table 3**) to T6.5 and T3.9, respectively.

- One transect was added (**Table 3**) at T4.7
- Ten transects were not changed (T6.8, T6.55, T6, T4.85, T4.8, T4.65, T3.8, T3.75, T3.5 and T3.3) (**Table 4**)

Proposed Grab Sample Locations

- The grab sample location at North Shore Road (LW0.9) remains in the plan (**Table 4**)
- The grab sample in the C-1 Channel remains in the plan (sampled if water is present) (**Table 4**)
- Nine new grab sample locations were added (LW4.73S, LW4.73N, LW4.48S, LW4.48N, LW3.68, LW3.55, LW3.2, LW3.15, LW3.11) (**Table 3**)
- Three grab sample locations previously sampled by AECOM will be sampled (LWC3.7, LW3.4, LW3.1) (**Table 3**)

Grab samples will be collected from near-bottom depths to provide data consistent with the transect sampling. In addition, AECOM may collect up to six (6) additional grab samples within the study area of this RI Modification based on field conditions and observations. Those field conditions will largely be evaluated through the use of handheld water-quality probes (i.e., temperature and conductivity) to target areas experiencing the strongest potential influence from suspected nearby ground-water inflow.

The following presents discussions of the reaches of the LVW where several changes to the SSWIP are proposed:

Upper Narrows Weir to Sunrise Mountain Weir - **Figure 3** shows the proposed revised sample locations from Upper Narrows Weir to Sunrise Mountain Weir construction zone.

- The two transects added (T6.55 and T6.5) were placed through the warm anomaly and downstream of the anomalies (upstream of the construction zone).
- Transect T6.35 is removed because its proposed location is within the construction zone.

Calico Ridge Weir to Homestead Weir - **Figure 4** shows the proposed revised sample locations from Calico Ridge Weir to Homestead Weir.

- Transect T4.75, which passed directly through warm anomalies identified during the DTS, was removed and two grab samples at the anomalies were added.
- Transects were added immediately upstream (T4.8) and downstream (T4.7) of the anomalies.
- Previously sampled T4.65 was retained.
- The TIR and DTS data did not indicate warm anomalies in the reach between Lower Narrows Weir and Homestead Weir. Since perchlorate concentrations did not show increases between these weirs and there are no warm anomalies, transect T4.6 and T4.2 were removed. Two grab samples (LW4.48S and LW4.48N) were added to capture the cool anomaly on the south bank and a reference concentration on the north bank, respectively.
- Transect 3.9 was added immediately downstream of Homestead Weir to help determine if perchlorate is better mixed downstream of the weir.

Three Kids Weir to Rainbow Gardens Weir - **Figure 5** shows the proposed revised sample locations from Three Kids Weir to Rainbow Gardens Weir.

- Previously sampled transects T3.8 and T3.75, which are upstream and downstream of Three Kids Weir, respectively, were retained.

- Previously sampled transect T3.5 was retained. Perchlorate concentrations were higher at this transect in 2017 than T3.75, immediately upstream, and the channel has been reworked due to the storm-induced high water. This transect will be sampled for comparison to 2017 data.
- Transect T3.3 was added, which passes through a warm anomaly on the south bank upstream of Rainbow Gardens Weir.
- A grab sample will be collected at LWC3.7, a known seep previously sampled by AECOM.
- Two grab samples will be added: at LW3.68 (through a secondary warm anomaly downstream of LWC3.7 on the south bank) and LW3.55, which is in a side channel on the southern side of the Las Vegas Wash, downstream of the cluster of warm anomalies.

Rainbow Gardens Weir to Fire Station Weir - **Figure 6** shows detail of the proposed revised sample locations from Rainbow Gardens Weir to Fire Station Weir.

- No transects will be sampled from this reach.
- Previously sampled grab locations at LW3.4 and LW3.1 will be resampled.
- Two grab samples will be collected at new locations LW3.2 and LW3.15, located downstream of cool anomalies on the south bank.
- A grab sample location has been added immediately upstream of Powerline Crossing Weir (LW3.11).

Attachments

Tables

- Table 1. Surface Water Grab Samples and Transect Locations Proposed in the SSWIP
- Table 2. Surface Water Transect Locations Proposed for Removal or Adjustment
- Table 3. Proposed Additional Surface Water Grab Sample and Transect Locations
- Table 4. Surface Water Grab Sample and Transect Locations Retained from the SSWIP

Figures

- Figure 1. Transect and Grab Sample Locations as Proposed in SSWIP
- Figure 2. Revised Transect and Grab Sample Locations
- Figure 3. Revised Transect Locations - Upper Narrows Weir to Sunrise Mountain Weir Construction Zone
- Figure 4. Revised Transect and Grab Sample Locations - Calico Ridge Weir to Homestead Weir
- Figure 5. Revised Transect and Grab Sample Locations - Three Kids Weir to Rainbow Gardens Weir
- Figure 6. Revised Grab Sample Locations - Rainbow Gardens Weir to Fire Station Weir

Table 1
Surface Water Grab Samples and Transect Locations Proposed in the SSWIP
 NERT Remedial Investigation, Downgradient Study Area
 Henderson, Nevada

Transect Identification or Grab Location	Location	Rationale for Location
LW0.9	Downstream of Lake Lake Vegas at North Shore Road	Long term monitoring location with perchlorate flux estimates. Data from this location will be compared to flux estimates in the Study Area
T3.3	Midway between T3.6 and the Rainbow Gardens Weir	Evaluate for water quality changes downstream of study area
T3.5	Mid-way between Three Kids Weir and Rainbow Gardens Weir	Evaluate water quality downstream of groundwater inputs near Three Kids Weir
T3.75	Immediately downstream of Three Kids Weir	Check for potential groundwater inputs along Three Kids Weir upstream of KM67 (2100 parts per billion of perchlorate)
T3.8	Immediately upstream of Three Kids Weir	Evaluate water quality entering Three Kids Weir
T4.0	Immediately downstream of the Homestead Weir	Identify the location of the perchlorate inputs in this area
T4.2	Upstream of Homestead Weir	Downgradient of western edge of Henderson Landfill Site near new USGS staff gage/seepage study
T4.6	Downstream of Lower Narrows Weir	Downgradient of middle portions of Henderson Landfill Site in region of observed perchlorate gain
T4.65	Upstream of Lower Narrows Weirs	Downgradient of middle portions of Henderson Landfill Site in region of observed perchlorate gain
T4.75	Downstream of Calico Ridge Weir	Downgradient of western edge of Henderson Landfill Site in region of potential perchlorate gain
T4.8	Immediately upstream of the Calico Ridge Weir	Evaluate water quality above the inputs observed below the Calico Ridge Weir
T4.85	Immediately downstream of Bostick Weir	Evaluate suspected increase in perchlorate concentrations immediately below Bostick Weir
T5.3	Downstream of Historic Lateral Weir Expansion	Mid-point between Pabco Road and Calico Ridge Weir
T6	Upstream of Pabco Road Weir	Downstream of Groundwater inputs from NERT Off-Site Study Area and Henderson wastewater treatment plants
T6.35	Downstream of Proposed Sunrise Mountain Weir	Downgradient of NERT Off-Site Study area near mapped location of KM71 seep (3,400 parts per billion)
T6.45	Upstream of the proposed Sunrise Mountain Weir	Identify the location of the perchlorate inputs observed between Upper Narrows Weir and T6.35
T6.55	Downstream of Upper Narrows Weir	Identify the location of the perchlorate inputs observed between Upper Narrows Weir and T6.35
T6.8	Upstream of Duck Creek Confluence Weir	Upper end of the Downgradient Study at new USGS Gage (09419698)

Note:

Location LW0.9 is a grab location.

Locations prefaced with "T" are transect locations.

Table 2
Surface Water Transect Locations Proposed for Removal or Adjustment
 NERT Remedial Investigation, Downgradient Study Area
 Henderson, Nevada

Transect Identification	Location	Original Rationale for Location	Rationale for Removal
T6.35	Downstream of Proposed Sunrise Mountain Weir	Downgradient of NERT Off-Site Study area near mapped location of KM71 seep (3,400 parts per billion)	Remove due to construction
T5.3	Downstream of Historic Lateral Weir Expansion	Mid-point between Pabco Road and Calico Ridge Weir	Remove due to construction
T4.75	Downstream of Calico Ridge Weir	Downgradient of western edge of Henderson Landfill Site in region of potential perchlorate gain	Replaced with grab samples at the warm anomalies
T4.6	Downstream of Lower Narrows Weir	Downgradient of middle portions of Henderson Landfill Site in region of observed perchlorate gain	No changes in perchlorate in this reach. No warm anomalies noted.
T4.2	Upstream of Homestead Weir	Downgradient of western edge of Henderson Landfill Site near new USGS staff gage/seepage study	No changes in perchlorate in this reach. No warm anomalies noted.
Transect Identification	Location	Original Rationale for Location	Rationale for Moving
T6.45	Upstream of the proposed Sunrise Mountain Weir	Identify the location of the perchlorate inputs observed between Upper Narrows Weir and T6.35	Relocate due to construction. Moved to T6.5 (see Table 3)
T4.0	Immediately downstream of the Homestead Weir	Identify the location of the perchlorate inputs in this area	Moved downstream to T3.9 to better capture perchlorate/anomaly patterns (See Table 3).

Table 3
Proposed Additional Surface Water Grab Sample and Transect Locations
 NERT Remedial Investigation, Downgradient Study Area
 Henderson, Nevada

Transect Identification or Grab Sample Location	Location	Rationale for Location
Transects		
T6.5	Upstream of the proposed Sunrise Mountain Weir	Identify the location of the perchlorate inputs observed between Upper Narrows Weir and T6.35. This is previously sampled T6.45 moved upstream outside the Sunrise Mt Weir construction zone
T4.7	Downstream of Calico Ridge Weir	Downgradient of the warm anomalies and the small island in the LVW. Use to determine concentrations in mixed zone
T3.9	Immediately downstream of the Homestead Weir	Identify the location of the perchlorate inputs in this area. This is previously sampled T4.0 moved downstream.
Grab Sample Locations (New)		
LW4.73S	Second anomaly downstream of Calico Ridge Weir	Sample south bank anomaly
LW4.73N	Second anomaly downstream of Calico Ridge Weir	Sample north bank anomaly
LW4.48S	Cool anomaly downstream of Lower Narrows Weir	Sample immediately downstream of south bank cool anomaly
LW4.48N	Across from cool anomaly downstream of Lower Narrows Weir	Provide reference concentration to the cool anomaly on the south bank.
LW3.68	Downstream of Fire Station Weir on south bank near warm anomaly	Warm anomaly on south bank downstream of LWC3.7
LW3.55	Downstream of Fire Station Weir	Downstream of warm anomalies on south bank in side channel
LW3.2	Downstream of Rainbow Gardens Weir	Downstream of cool anomaly on south bank
LW3.15	Downstream of Rainbow Gardens Weir	Downstream of cool anomaly on south bank
LW3.11	Downstream of Rainbow Gardens Weir	Sample immediately prior to Powerline Crossing Weir
Grab Sample Locations (Previously Sampled by AECOM in 2016 and 2017)		
LWC3.7	Downstream of Three Kids Weir at historic seep	Revisit seep location from previous surface water sampling programs (May and December 2016; February 2017)
LW3.4	Downstream of Rainbow Gardens Weir	Revisit surface water sampling location from previous surface water sampling programs (May and December 2016; February 2017)
LW3.1	Downstream of Fire Station Weir	Revisit surface water sampling location from May 2016 surface water sampling program

Notes:

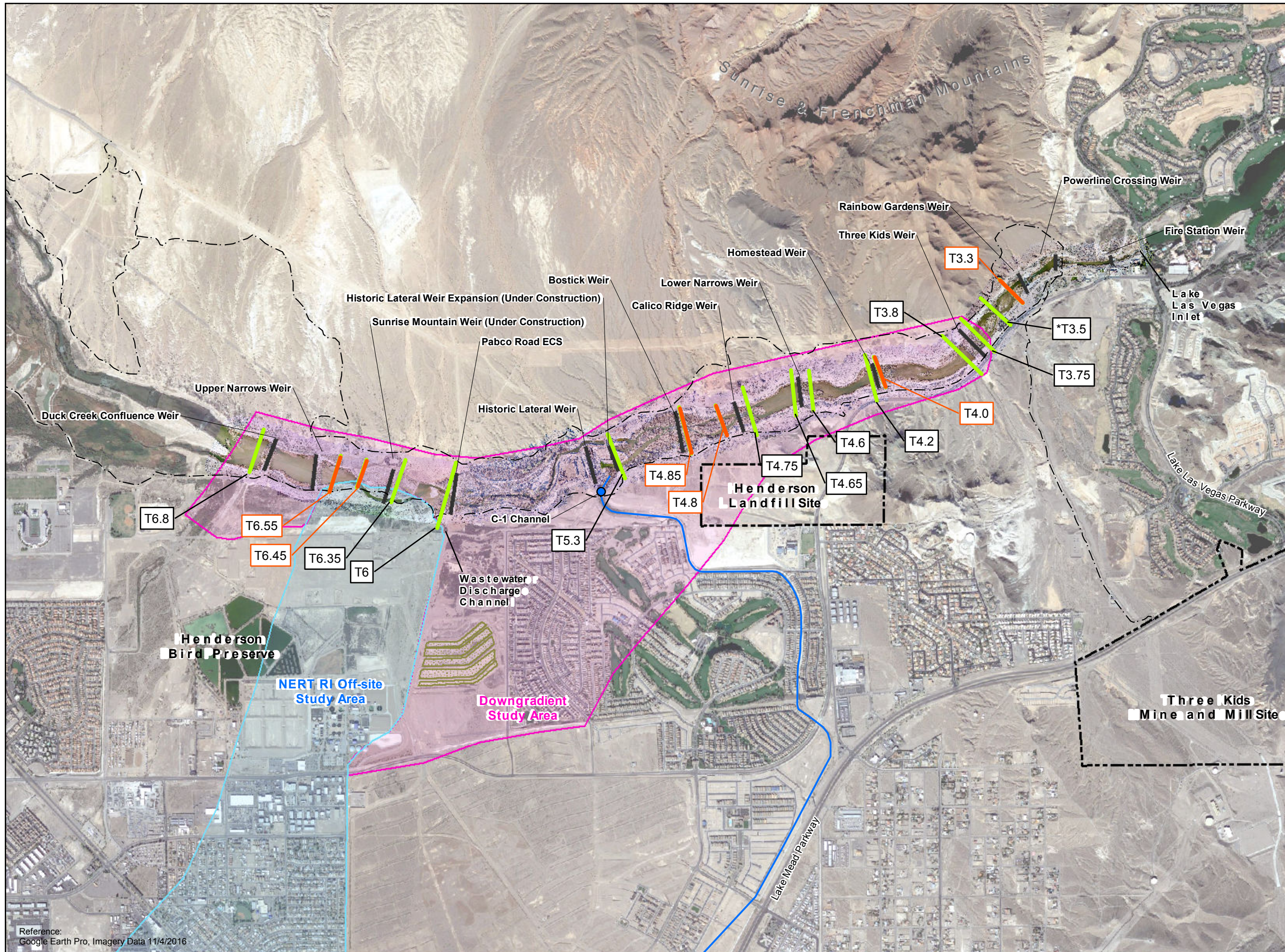
Locations prefaced with "LW" or "LWC" are grab sample locations.
 Locations prefaced with "T" are transect locations.

Table 4
Surface Water Grab Sample and Transect Locations Retained from the SSWIP
 NERT Remedial Investigation, Downgradient Study Area
 Henderson, Nevada

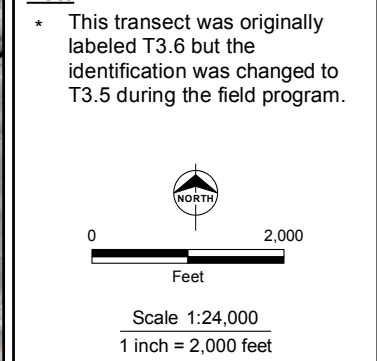
Transect Identification or Grab Sample Location	Location	Rationale for Location
T6.8	Upstream of Duck Creek Confluence Weir	Upper end of the Downgradient Study at new USGS Gage (09419698)
T6.55	Downstream of Upper Narrows Weir	Identify the location of the perchlorate inputs observed between Upper Narrows Weir and T6.35. Ensure this crosses the anomaly on the south bank.
T6	Upstream of Pabco Road Weir	Downstream of Groundwater inputs from NERT Off-Site Study Area and Henderson wastewater treatment plants
T4.85	Immediately downstream of Bostick Weir	Evaluate suspected increase in perchlorate concentrations immediately below Bostick Weir
T4.8	Immediately upstream of the Calico Ridge Weir	Evaluate water quality above the inputs observed below the Calico Ridge Weir
T4.65	Upstream of Lower Narrows Weirs	Downgradient of middle portions of Henderson Landfill Site in region of observed perchlorate gain
T3.8	Immediately upstream of Three Kids Weir	Evaluate water quality entering Three Kids Weir
T3.75	Immediately downstream of Three Kids Weir	Check for potential groundwater inputs along Three Kids Weir upstream of KM67 (2100 parts per billion of perchlorate). This transect includes the approximate area of historic grab sample location LW3.75.
T3.5	Mid-way between Three Kids Weir and Rainbow Gardens Weir	Evaluate water quality downstream of groundwater inputs near Three Kids Weir
T3.3	Midway between T3.6 and the Rainbow Gardens Weir	Evaluate for water quality changes downstream of study area. Sample warm anomaly on south bank.
C-1	C-1 Channel	Capture any inputs from off-site (grab sample if flowing)
LW0.9	Downstream of Lake Lake Vegas at North Shore Road	Long term monitoring location with perchlorate flux estimates. Data from this location will be compared to flux estimates in the Study Area

Notes:

Locations C-1 and LW0.9 are grab sample locations.
 Locations prefaced with "T" are transect locations.



- Legend**
- Proposed Transects (Previously Sampled in February 2017)
 - Proposed Additional Transects
 - Approximate C-1 Channel Sample Point; may change based on presence of water
 - Weir
 - Northern Rapid Infiltration Basins
 - Wetlands Trail
 - Channels
 - NERT RI Downgradient Study Area
 - NERT RI Off-site Study Area
- Note**
- * This transect was originally labeled T3.6 but the identification was changed to T3.5 during the field program.



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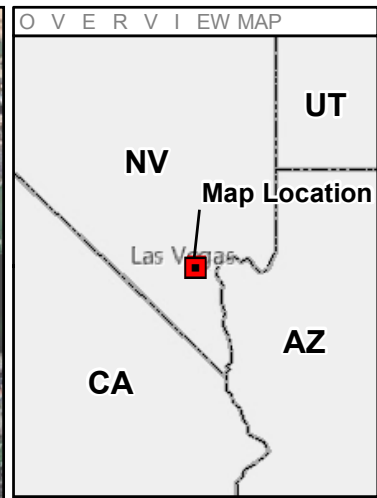
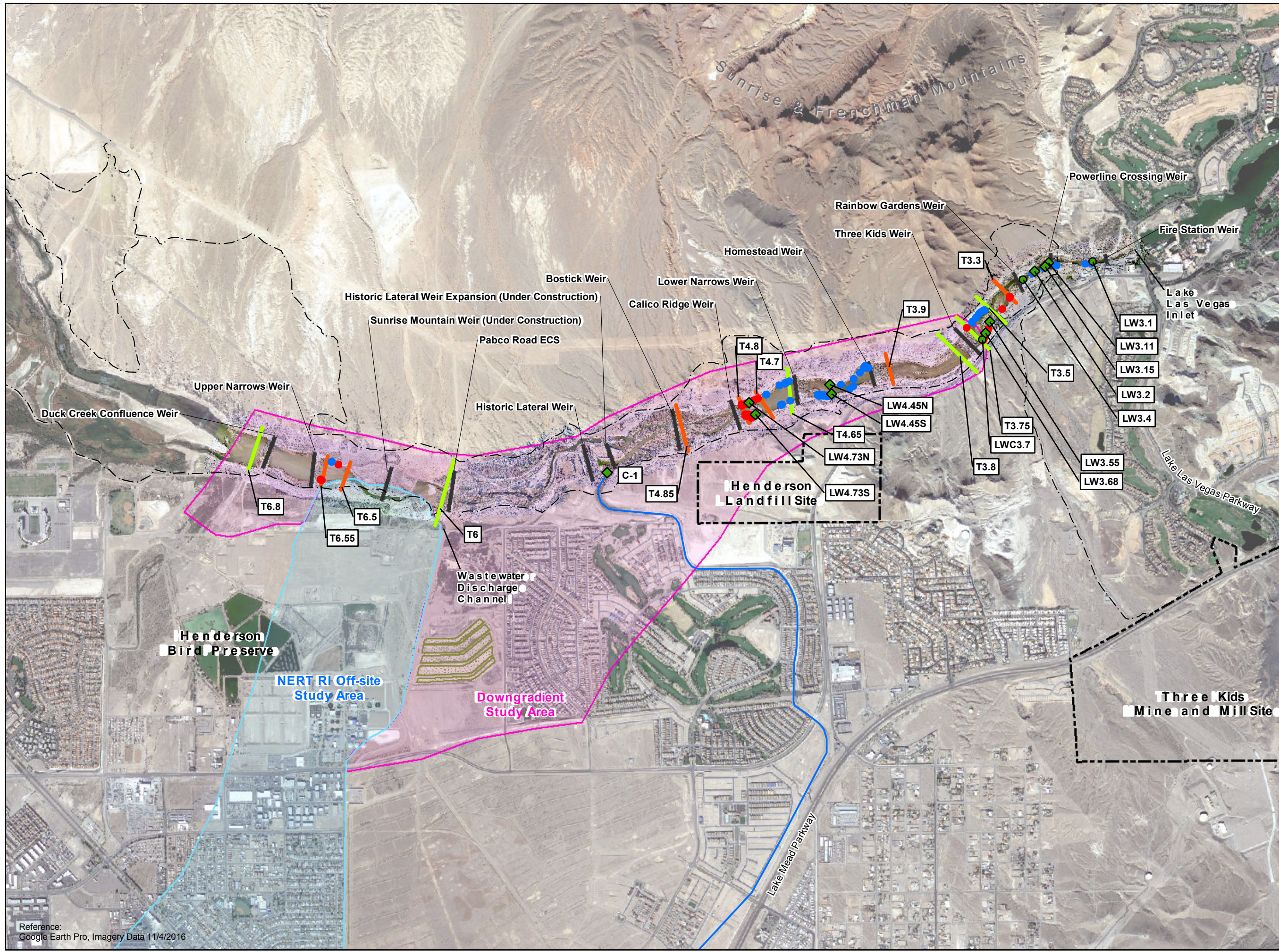
NERT RI
Downgradient Study Area

**TRANSECT AND GRAB
SAMPLE LOCATIONS AS
PROPOSED IN SSWIP**

Date: 4/20/2018 Project: 60477365

AECOM Figure 1

Reference:
Google Earth Pro, Imagery Data 11/4/2016



Legend

- Warm DTS Anomaly
- Cool DTS Anomaly
- Proposed Transects (Previously Sampled in February 2017)
- Proposed Additional Transects
- Proposed Grab Sample (Previously Sampled in 2016)
- ◆ Proposed Additional Grab Sample
- Weir
- Northern Rapid Infiltration Basins
- - - Wetlands Trail
- Channels
- NERT RI Downgradient Study Area
- NERT RI Off-site Study Area

0 2,000
Feet

Scale 1:24,000
1 inch = 2,000 feet

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NERT RI
Downgradient Study Area

**REVISED TRANSECT
AND GRAB SAMPLE
LOCATIONS**

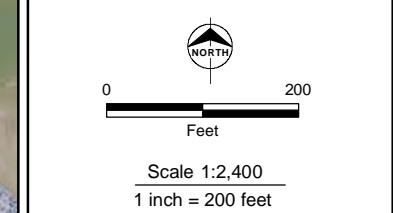
Date: 4/20/2018 Project: 60477365

AECOM Figure 2

Reference:
Google Earth Pro, Imagery Data 11/4/2016



- Legend**
- Warm DTS Anomaly
 - Cool DTS Anomaly
 - Previously Sampled in February 2017
 - Proposed Transects (Previously Sampled in February 2017)
 - Proposed Additional Transects



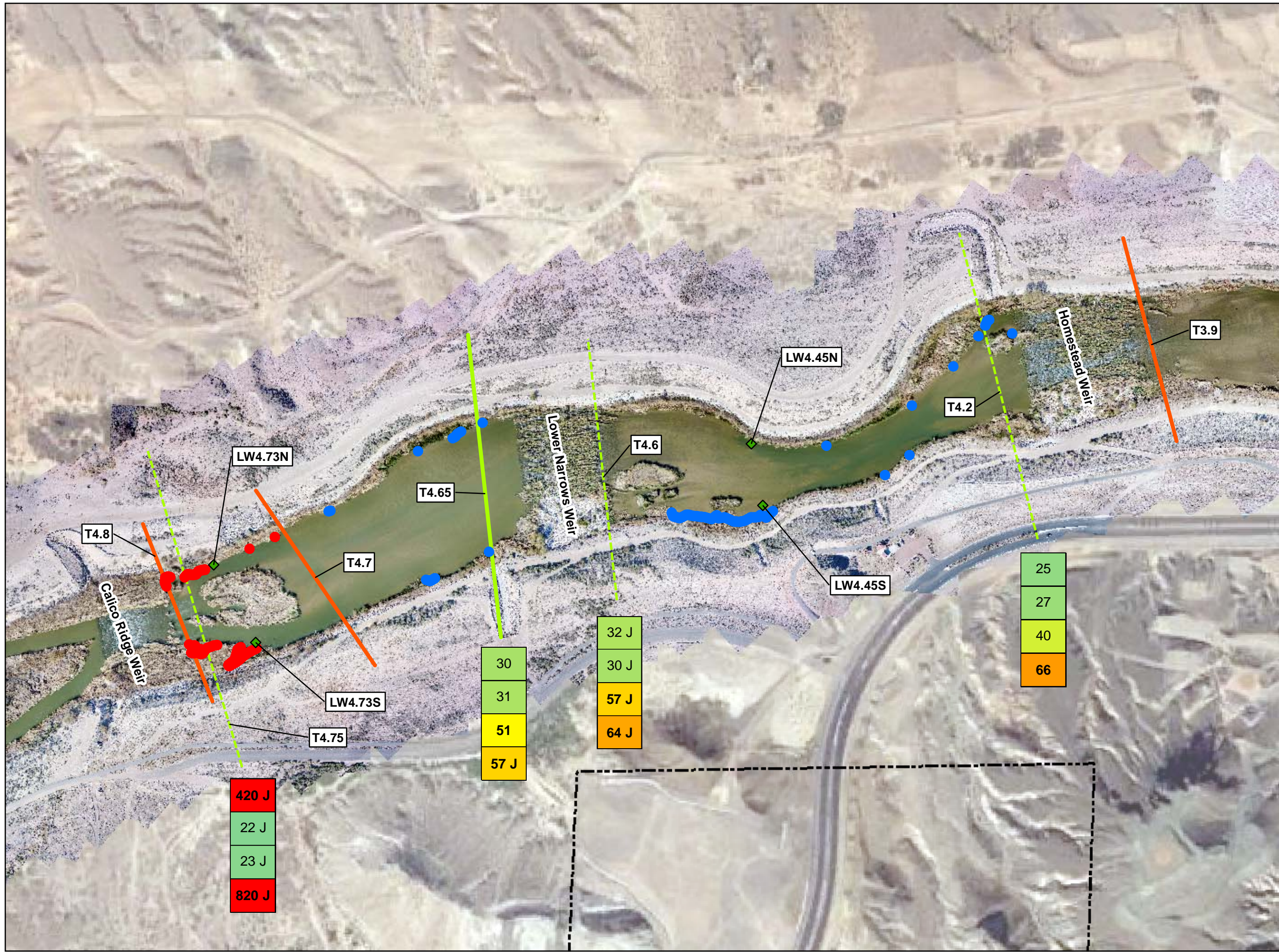
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NERT RI
Downgradient Study Area

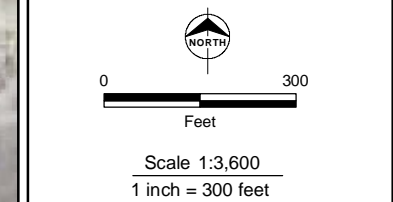
**REVISED TRANSECT
LOCATIONS -
UPPER NARROWS WEIR
TO SUNRISE MOUNTAIN
WEIR CONSTRUCTION
ZONE**

Date: 4/20/2018 Project: 60477365

AECOM **Figure 3**



- Legend**
- Warm DTS Anomaly
 - Cool DTS Anomaly
 - - - Previously Sampled in February 2017
 - - - Proposed Transects (Previously Sampled in February 2017)
 - Proposed Additional Transects
 - ◆ Proposed Additional Grab Sample



NERT RI
Downgradient Study Area

REVISED TRANSECT AND GRAB SAMPLE LOCATIONS - CALICO RIDGE WEIR TO HOMESTEAD WEIR

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AECOM Figure 4

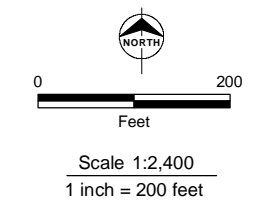


- Legend**
- Warm DTS Anomaly
 - Cool DTS Anomaly
 - Proposed Transects (Previously Sampled in February 2017)
 - Proposed Additional Transects
 - Proposed Grab Sample (Previously Sampled in 2016)
 - ◆ Proposed Additional Grab Sample

46 J
32 J
45 J
57 J

38	37
47	
66	
98	
140	
73	

85
31
51 J
63 J



NERT RI
Downgradient Study Area

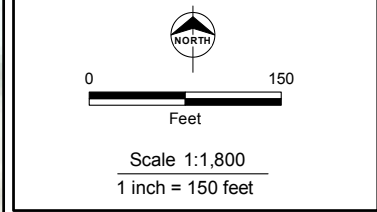
REVISED TRANSECT AND GRAB SAMPLE LOCATIONS - THREE KIDS WEIR TO RAINBOW GARDENS WEIR

Date: 4/20/2018 Project: 60477365

AECOM Figure 5



- Legend**
- Cool DTS Anomaly
 - Proposed Grab Sample (Previously Sampled in 2016)
 - ◆ Proposed Additional Grab Sample



NERT RI
Downgradient Study Area

**REVISED GRAB SAMPLE
LOCATIONS -
RAINBOW GARDENS WEIR
TO FIRE STATION WEIR**

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AECOM Figure 6