MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Water Quality TWC Meeting

June 23, 2016

final acj 8-15-2016

ATTENDEES:

Bill Argentieri (SCE&G)
Ray Ammarell (SCE&G)
Steve Summer (SCANA)
Brandon Stutts (SCANA)
Caleb Gaston (SCANA)
Shane Boring (Kleinschmidt)
Henry Mealing (Kleinschmidt)
Bill Marshall (SCDNR)
Alex Pellett (SCDNR)
Ron Ahle (SCDNR)
Gerrit Jobsis (American Rivers)
Rusty Wenerick (SCDHEC)
Alison Jakupca (Kleinschmidt)

These notes are a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

At the last TWC meeting, the group discussed various ways to improve west channel water quality. These included:

- Creating a channel from the powerhouse tailrace to the west channel. SCE&G determined that this was not realistic due to dam safety issue with blasting and this method will not deliver water to the upper west channel due to elevation differences.
- Pump water from the forebay – this method would be unreliable (dependent on mechanical pumps) and would not deliver much flow – less than 25 cfs.
- Siphon system from the forebay – this method would also be unreliable because the reservoir level changes and not deliver much flow.
- Operation changes will be the best way to improve WQ in the west channel – during the summer, use controlled periodic spills to the west channel and prioritize any reservoir operation spills be released through gates 1-6.

Based on this information, SCE&G proposed to perform a west channel test spill demonstration for the TWC members to observe. These notes provide a summary of the test flow. Prior to the test, the attendees met at the Parr Dam and reviewed the agenda (attached) and discussed safety tips for the day.

The purpose of the flow demonstration was to observe conditions in the west channel area of the Broad River downstream of Parr Dam before, during, and after a relatively small amount of water was discharged into the channel using Parr Hydro spillway crest gates 1 and 2, which operate together as a pair. Performing periodic releases such as this is a potential operational measure for improving the water quality in the west channel during the term of the new license when it is issued.

Kleinschmidt

Test Description

The attendees met at the west end of Parr Dam between 8:00 and 8:30 AM. The group conducted a safety briefing and reviewed maps of the west channel area and several pools and shoals which are located just downstream of the dam (handout attached), and then walked along the canoe portage path to the riverbank and waded to a small sandbar which was used as an observation area during the demonstration. At 8:57 AM, the hydro staff were requested by phone to lower gates 1 and 2 to about 0.2 feet below the current reservoir elevation. By 9:00 AM, a spill flow had begun and after some minor gate adjustments to the gate position by the plant, a steady spill over the gates was occurring. The group waded upstream to observe the pools near the base of the dam beginning to fill and overflow into the upper portion of the west channel. As the water rose, the group made their way back downstream to observe the effects of the increasing flow in the small channels around the sandbar. The spill continued until about 10:19 AM, when the group was in agreement that approximately steady state stage and flow conditions existed in the upper reaches of the west channel. The plant staff was requested by phone to raise gates 1 and 2 back to their full up position. The group stayed at the sandbar until about 10:50 AM to observe the flow recession.

Recorded Data

The group recorded depths in one of the pools of the west channel via a temporary staff gage established prior to the spill demonstration. The recorded data is presented in Table 1 and Figure 1.

Table 1. Staff Gage Height in West Channel

Time (EDT)	Staff Gage Height (Inches)
0841	2.50
0915	5.50
0921	11.00
0936	15.5
0946	17.00
0956	17.25
1000	17.50
1005	18.00
1010	18.25
1019	18.75
1025	17.75
1026	16.75
1028	15.00
1029	14.50
1033	12.25
1037	10.50
1040	9.50
1044	8.50
1047	7.75
1049	7.50
1050	7.25
1056	6.75
1100	6.00

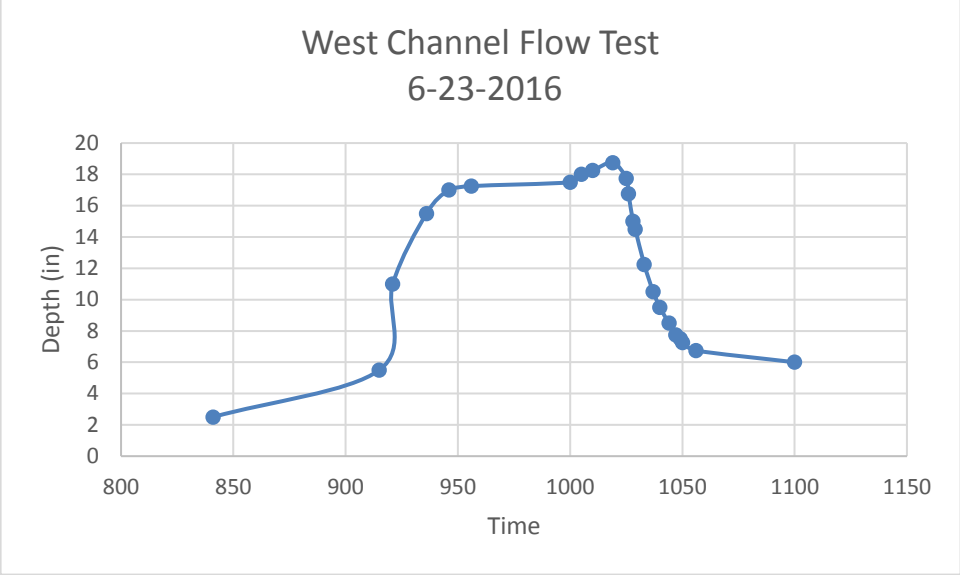

Figure 1. Staff Gage Height in West Channel

The plant staff also logged reservoir elevation and gate position at 30 minutes intervals during the demonstration, using the plant headwater gauge and gate position indicators (Table 2).

Table 2. Parr Reservoir Elevation and Gate Position During Spill Test

Time (EDT)	Plant Res. El.	Gate Tip El.
8:30	n/a	266.00
9:00	257.60	257.40
9:30	257.74	257.15
10:00	257.80	257.12
10:30	n/a	266.00

Using the data recorded in Table 2, discharge over gates 1 and 2 were computed using the sharp crested weir formula (Figure 2):

$$Q = C\ L\ H^{3/2}$$

Where

Q = discharge in cubic feet per second (CFS);

C = the weir coefficient of 2.50 from the gate design data for the gate tip elevation and headwater during the release (see chart on page 5);

L = the weir crest length in feet, in this case 400 feet.

H is the total head in feet (including velocity head) on the weir crest. Velocity head was negligible and head was computed as (Reservoir El. – Gate Tip El.).

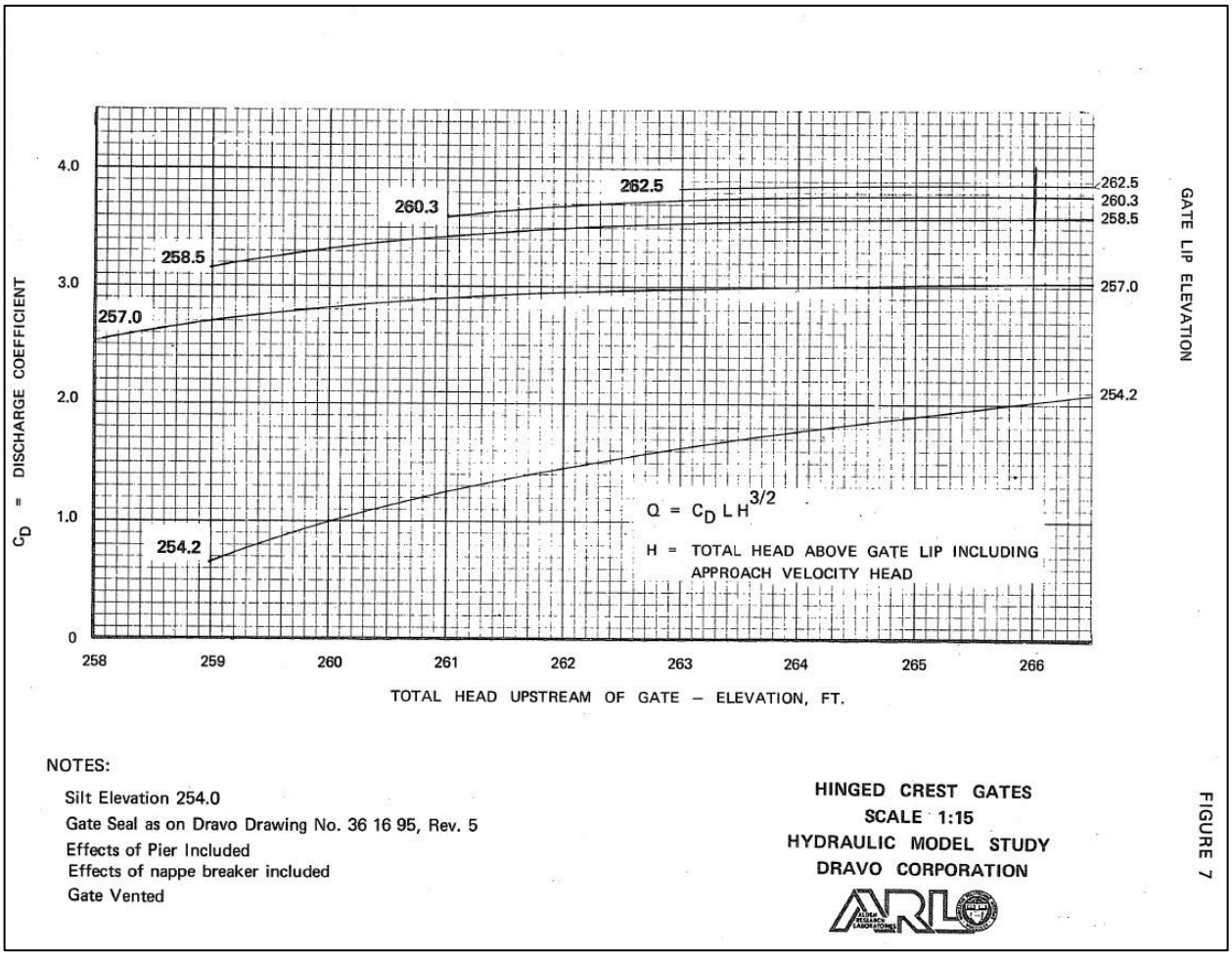

Figure 2. Sharp Crested Weir Formula

The calculated discharge during the demonstration is provided in Table 3 below.

Table 3. Calculated Discharge During Flow Test

Time (EDT)	Calculated Gate Discharge (CFS)
8:30	0
9:00	89
9:30	453
10:00	561
10:30	0

After the demonstration was completed, provisional data from the USGS streamflow gage at Alston, SC was downloaded to see if the release from gates 1 and 2 was evident at the gage location about 1 mile downstream of the dam. An increase in flow was recorded at the Alston gage beginning about 90 minutes after the flow release began. Figure 3 shows the calculated flow over the gates and the flow recorded at the Alston gage site during and after the demonstration.

Figure 3 indicates that prior to the release, the discharge from Parr Hydro was about 730 to 740 CFS. The maximum flow recorded at the Alston gage during the release was 888 CFS at 11:30 AM, an increase of about 150 CFS above the pre-release flow. By 3:30 PM, the flow at Alston had receded to a steady value of 752 CFS. The peak flow increase measured at the Alston gage site was quite a bit less than the maximum flow released over gates 1 and 2, due to the storage routing effects of the pools and channel section in the west channel. The increased flow at the Alston site was also evident in the gage data for several hours after the gate had been raised and the flow release stopped, as the west channel reach released some of the stored water.

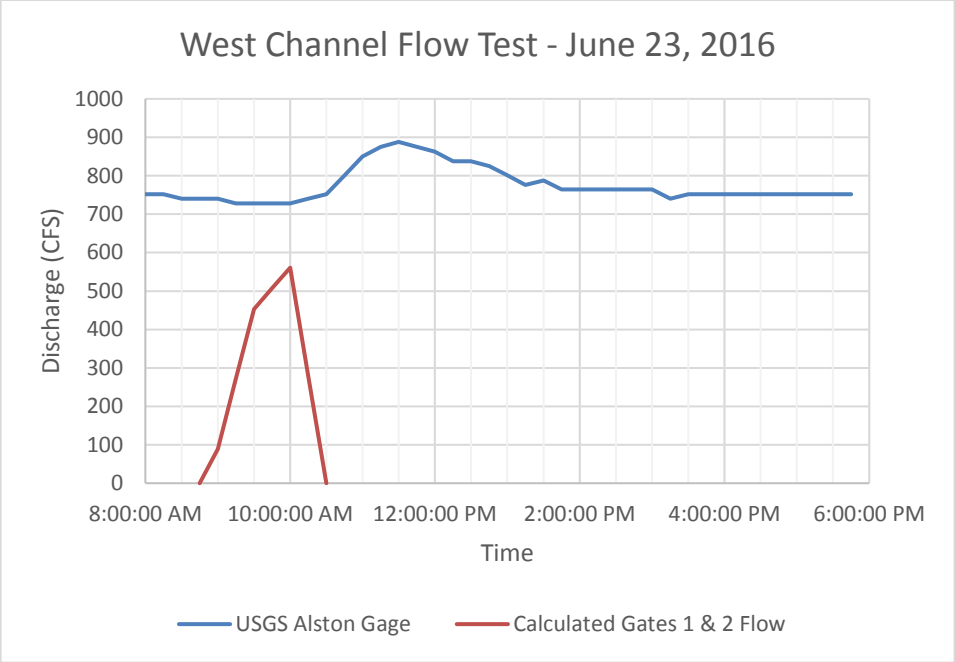

Figure 3. Alston Gage Versus Calculated Releases from Gates 1 & 2

Volume of Water Released

The estimated volume in acre-feet of water released using gates 1 and 2 was calculated from the flow data in Table 3 and is provided in Table 4. A total of about 46 acre feet is estimated to have been released during the demonstration.

Table 4. Volume Computation from Calculated Gate Flow

Time (EDT)	Gates 1 and 2 Flow (CFS)	Volume Released (Ac-Ft)
8:30	0	0
9:00	89	1.9
9:30	453	11.2
10:00	561	20.9
10:30	0	11.6
	Total:	**45.6**

A similar volume computation was performed on the Alston gage flow data for the period 10:30 AM to 3:15 PM. The tabulated flow and volume computed are provided in Table 5.

Table 5. Volume Computation at Alston Gage Site

Time EDT	Flow (CFS)	Increase Above Baseflow (CFS)	Volume of Increased Flow (Ac-Ft.)
10:15	740	0	0
10:30	752	12.00	0.25
10:45	801	61.00	0.75
11:00	850	110.00	1.77
11:15	875	135.00	2.53
11:30	888	148.00	2.92
11:45	875	135.00	2.92
12:00	863	123.00	2.66
12:15	838	98.00	2.28
12:30	838	98.00	2.02
12:45	825	85.00	1.89
13:00	801	61.00	1.51
13:15	776	36.00	1.00
13:30	788	48.00	0.87
13:45	764	24.00	0.74
14:00	764	24.00	0.50
14:15	764	24.00	0.50
14:30	764	24.00	0.50
14:45	764	24.00	0.50
15:00	764	24.00	0.50
15:15	740	0.00	0.25
		Total Volume:	**26.85**

The data in Table 5 indicate that not all the water released over the gates made it to the Alston gage site. This is possibly due to some water being retained in the pool areas in the west channel, since these pools were relatively empty at the start of the demonstration and were filled by the release.

August Spillway Water Quality Testing

SCE&G proposes to pass a spillway flow of approximately 25 acre ft. over a several hour period during the August 2016 Water Quality testing. During the first week of monitoring the water quality HOBOs will be deployed with no planned spill - only gate leakage. The first day of monitoring during the second and third weeks, the HOBOs will be cleaned, data retrieved, replaced in the channel, and a crest gate spill will be released. During the subsequent days of monitoring each week, the HOBOs will document how quickly the temp and DO deteriorate in the West Channel. This should provide us with a reference point to discuss the frequency of spills potentially needed to create water quality improvements in the West Channel.

ACTION ITEMS:

- SCE&G and Kleinschmidt will prepare and implement the west channel water quality testing in August 2016 over a three-week period.
- Kleinschmidt will summarize the data and submit it to the TWC for review and comment. This information will be added to the West Channel Water Quality Report as an addendum.

Attachments

West Channel Spill Demonstration – June 23, 2016

At the March 23, 2016 TWC meeting, the TWC discussed several options to deliver flow to the West Channel area. SCE&G evaluated each of those options for reliability, cost, and safety.

Flow Delivery Evaluation

- Create a channel from the tailrace to the West Channel. Not realistic – dam safety issue with blasting – expensive – will not deliver water to the upper West Channel due to elevations.
- Pumping will be expensive – unreliable – and not deliver much flow
- Siphon system will also be unreliable because the reservoir level changes
- Operation changes will be the best way to improve WQ in the West Channel

Operation Changes

- SCE&G will prioritize operation of the spillway gates to 1 - 6 – June through September. If there is excess water that will require a spill, it will be passed through gates 1-6 unless there is a mechanical/project need to use gates 7 - 10.
- SCE&G will provide a periodic spillway release to refresh the West Channel.

August Testing Plan

- During August 2016, we will reset the HOBO monitors in the West Channel for three weeks to address two topics:
- During the first week, we will collect data for one week with clean calibrated HOBO monitors to verify the temperature (temp) and dissolved oxygen (DO) values observed during the August 2015 collections.
- During the second and third weeks, we will collect HOBO data with a test spillway release to determine the temp and DO response.
- After testing, we will provide an update to the TWC on the results of the additional collections.

Parr West Channel Pool Storage Estimate

To improve water quality in the West Channel, we assume that there should be some regular exchange of water within the West Channel. The overall area can be broken into two major portions – the smaller and shallower upstream pools and the large deeper downstream pool. Using available data for these areas, the volume of the upstream pools and the downstream pool were estimated.

Upstream Pools

There are approximately five primary smaller pools in the upstream portion of the West Channel (Figure 1). Based on the data collected in these areas, we estimated a pool volume at a flow of approximately 50 cfs, which is the approximate leakage through gates 1-6. The estimates of pool

volume range in size from 0.2 to 4.9 acre-ft (Table 1). Therefore a spillway release of at least 10.3 acre-ft should provide some substantial water exchange in these upstream pools.

Table 1. Estimated Volume of Five Major Pools in the Upstream Portion of the West Channel

Pool #	Area (sq ft)	Depth at 50 cfs (ft)	Pool Volume (cubic ft)	Pool Volume (acre ft)
1	29,394	3.1	91,121	2.1
2	3,760	2.3	8,648	0.2
3	39,255	1.5	58,882	1.4
4	35,952	3.1	75,499	1.7
5	119,771	1.8	215,588	4.9
Total				10.3

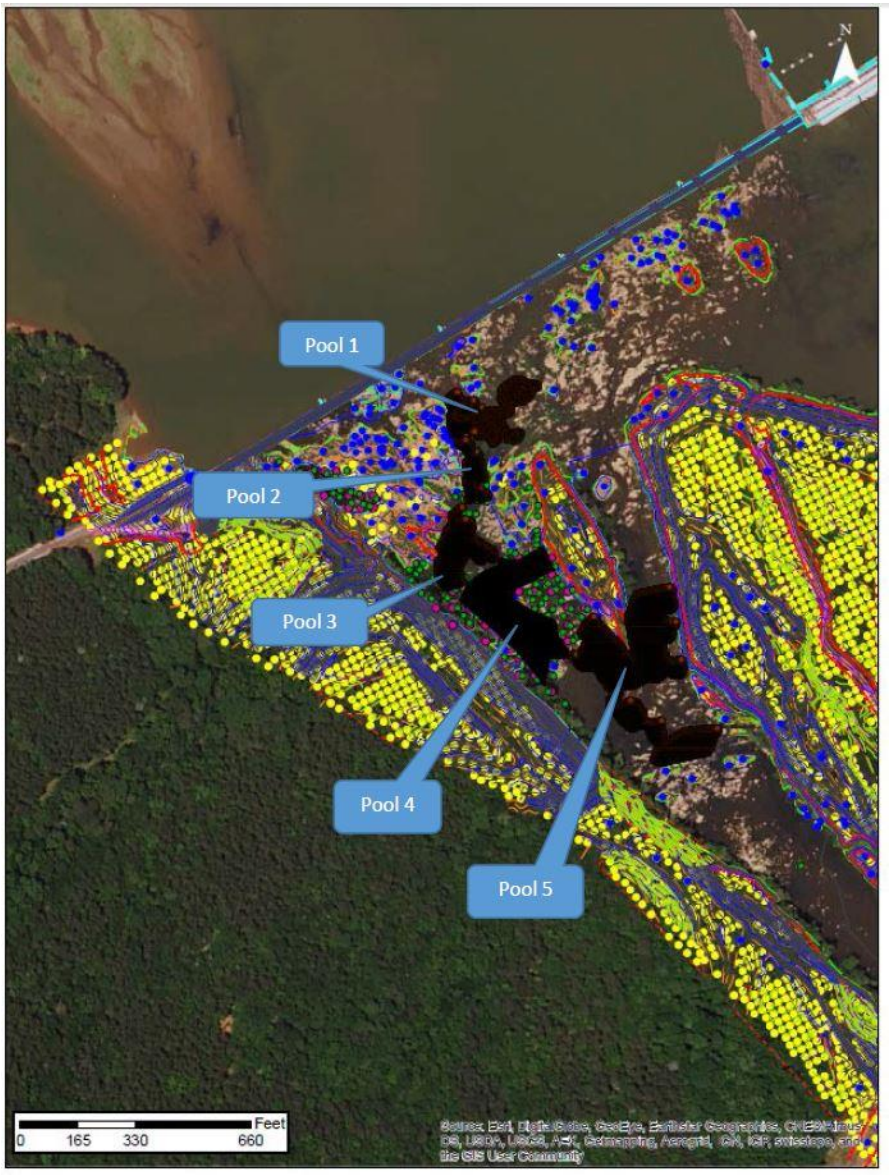

Figure 1. West Channel upstream pools.

Kleinschmidt

Downstream Pool

The downstream section of the West Channel is comprised of one large pool that is much larger and deeper than the upstream pools. Using Google Earth Pro, we created a polygon of this pool and estimated that the surface area is 26.4 acres (Figure 2). A Sontek River M9 Acoustic Doppler Current Profiler (ADCP) was used to collect depth soundings along the thalweg of this pool at leakage flow. Based on the ADCP profile, we estimate that the average depth is approximately 4 feet, which yields a volume of 105.6 acre ft. Therefore it would require a spillway release of at least 100 acre ft to provide some exchange of water in this downstream pool.

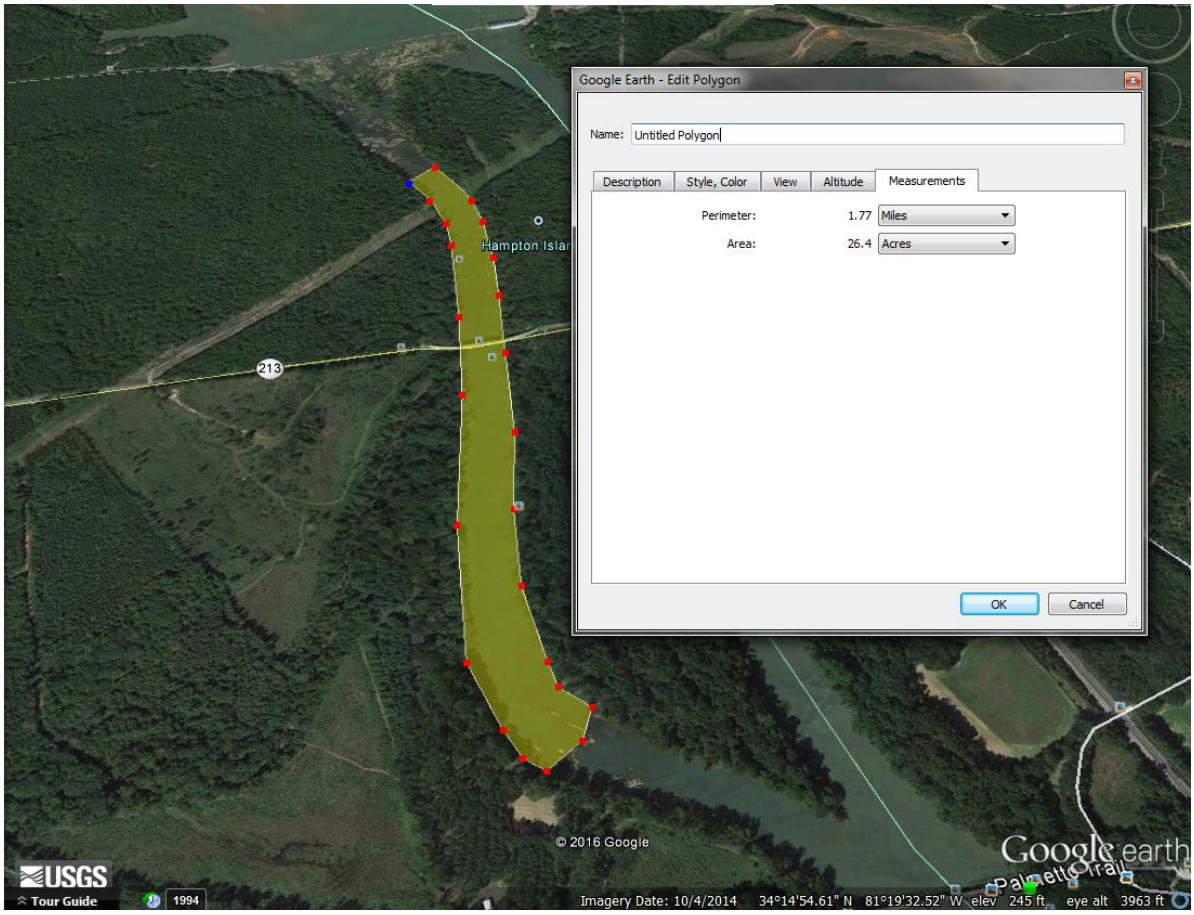

Figure 2: West Channel Downstream Pool Estimated Area Measurement

August Spillway Test Flow

Based on the pool volume information presented in this memo, SC&EG proposes to pass a spillway flow of approximately 25 acre ft. over a three hour period during the August 2016 testing. During the first week of monitoring the HOBOs will be deployed with no planned spill - only gate leakage. The first day of monitoring during the second and third weeks, the HOBOs will be cleaned, data retrieved, replaced in the channel, and a crest gate spill will be released. During the subsequent days of monitoring each week, the HOBOs will document how quickly the temp and DO deteriorate in the West Channel. This should provide us with a reference point to discuss the frequency of spills potentially needed to create water quality improvements in the West Channel.