Barnes, Peter@Waterboards

From: John L <jhleete@frontiernet.net>
Sent: Saturday, February 21, 2015 1:49 PM
To: sherrie.thrall@almanorpost.com; Barnes, Peter@Waterboards; LACC Web Admin; sherrie.thrall@almanorpost.com
Subject: Caribou PH and penstocks
Attachments: GoogleEarth_Image.jpg; Fig 2-2.pdf

I have attached a copy of figure 2-2 from the Project No. 2105 Level 1 and Level 2 Report of 2007. It shows water average mean temperatures observed along the NFFR in July 2002, a dry year. A remarkable feature of the figure is a 4 deg.C increase of the water as it travels from the Butt Reservoir to the Caribou Power Houses. The figure also indicates that temperature at the end of the Poe Reach is 4 degrees above the goal of 20 deg.C. So if the water heating between the Butt Reservoir and the Caribou PH could be eliminated, it is possible that the goal would be satisfied. The water flows through tunnels that are a little less than two miles long and then through penstocks for about a half mile.

A Google Earth view of the penstocks that deliver the water to the Caribou #1 PH (power house) and the Caribou #2 PH is also attached. The view is looking North, so the penstocks are coming down a South-facing slope a few degrees West of due South. This is a bad orientation for exposure to direct radiation from the summer sun. In addition, some of the surrounding rock escarpment is light-colored and may also reflect heat onto the penstocks.

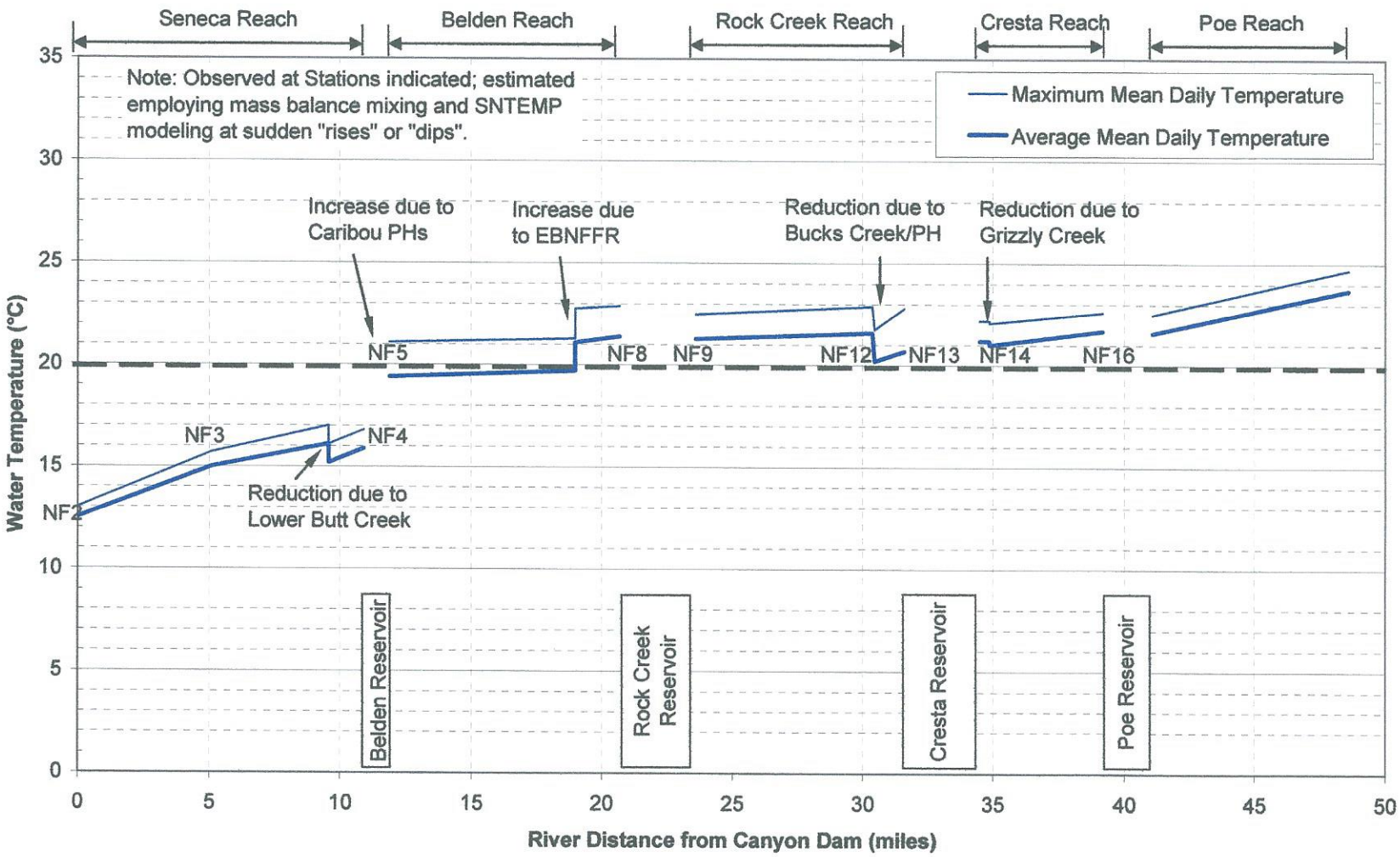
If the observed water heating is due to solar radiation, it should be relatively easy and cost effective to insulate the penstocks. This hypothesis can be easily tested by measuring the water temperature at each end of the penstocks on a hot sunny day.

As far as I can tell, a passive thermal solution to the NFFR water temperature problem has not yet been considered.

John Leete

4/4/2012 12:34 pm
8 am
12 pm
Caribou Rd
© 2015 Google
Google earth
1993
Imagery Date: 5/27/2014 40°05'14.58" N 121°08'53.99" W elev 3301 ft eye alt 5241 ft

Figure 2-2 Observed and Estimated July 2002 (Dry Year) Water Temperature Profile along NFFR (Observed Average Mean Daily Temperature at BD1 (Belden Forebay) = 21.5°C)



Barnes, Peter@Waterboards

From: John L <jhleete@frontiernet.net>
Sent: Tuesday, February 24, 2015 10:31 AM
To: sherrie.thrall@almanorpost.com; Barnes, Peter@Waterboards; Aaron Seandel; Alan Dubroff
Subject: Fwd: Caribou PH and penstocks
Attachments: GoogleEarth_Image.jpg; Fig 2-2.pdf

Perhaps I was not clear in my prior email. There would be no need to take additional cold water from Lake Almanor if we can simply reduce the solar heating of the water after it leaves the lake - no thermal curtains, no additional flow through Canyon Dam. All that may be needed is insulation of the penstocks that carry the water to the power houses. This should be much less expensive and possibly more effective than the alternatives being considered.

John Leete

-------- Forwarded Message --------
Subject: Caribou PH and penstocks
Date: Sat, 21 Feb 2015 13:48:35 -0800
From: John L <jhleete@frontiernet.net>
To:sherrie.thrall@almanorpost.com, Peter Barnes <Peter.Barnes@waterboards.ca.gov

I have attached a copy of figure 2-2 from the Project No. 2105 Level 1 and Level 2 Report of 2007. It shows water average mean temperatures observed along the NFFR in July 2002, a dry year. A remarkable feature of the figure is a 4 deg.C increase of the water as it travels from the Butt Reservoir to the Caribou Power Houses. The figure also indicates that temperature at the end of the Poe Reach is 4 degrees above the goal of 20 deg.C. So if the water heating between the Butt Reservoir and the Caribou PH could be eliminated, it is possible that the goal would be satisfied. The water flows through tunnels that are a little less than two miles long and then through penstocks for about a half mile.

A Google Earth view of the penstocks that deliver the water to the Caribou #1 PH (power house) and the Caribou #2 PH is also attached. The view is looking North, so the penstocks are coming down a South-facing slope a few degrees West of due South. This is a bad orientation for exposure to direct radiation from the summer sun. In addition, some of the surrounding rock escarpment is light-colored and may also reflect heat onto the penstocks.

If the observed water heating is due to solar radiation, it should be relatively easy and cost effective to insulate the penstocks. This hypothesis can be easily tested by measuring the water temperature at each end of the penstocks on a hot sunny day.

As far as I can tell, a passive thermal solution to the NFFR water temperature problem has not yet been considered.

John Leete

Barnes, Peter@Waterboards

From: John L <jhleete@frontiernet.net>
Sent: Tuesday, March 10, 2015 6:24 PM
To: sherrie.thrall@almanorpost.com; Barnes, Peter@Waterboards; Aaron Seandel; Alan Dubroff
Subject: Additional thoughts on passive thermal solution

Appendix C of the Project 2105 Level 1 and 2 Report includes measures to reduce warming of the water along the NFFR by "increasing shading through planting of vegetation". These are summarized in the following table.

Measure #	Location on NFFR	Estimated Temp Reduction (deg. C)
3	Seneca Reach	0.4
6	Belden Reach	small
7	East Branch FR	0.3
13	Rock Creek Reach	0.5
15	Cresta Reach	0.5
17	Poe Reach	0.8
	Total	2.8

The reference points out that shading will be more important with cooler water flowing through these parts of the system because there will be a larger gradient with the ambient temperature of the air at the surface. In a dry year (2002) there was a mean temperature of 24 deg at the end of the Poe Reach, 4 degrees above the goal. Shading would provide 70% of the needed reduction in warming.

If insulation of the penstocks could provide the remaining 30%, the downstream temperature goal would be satisfied with passive thermal measures alone!

John Leete

Barnes, Peter@Waterboards

From: John L <jhleete@frontiernet.net>
Sent: Wednesday, March 18, 2015 12:09 PM
To: Barnes, Peter@Waterboards
Subject: Re: Additional thoughts on passive thermal solution

Mr. Barnes,
Please note that I realized an addition error in the message. The corrections are a total estimated temperature reduction of 2.5 degrees, which amounts to 63% of the 4 degrees needed. The corrected message is shown below.

I received the following response from Tom Jereb explaining why shading was dropped from consideration. It probably does not warrant being in the record.
John Leete

John, I received your forwarded message and thought it would be good if I gave you information on the alternative of planting of vegetation to create shading. PG&E studied this concept and found it to be not feasible for the East Branch and North Fork Feather River.

Because of the east-west orientation of the East Branch and North Fork Feather River, the river gets direct overhead sun/heating during the Summer. Shading the river would require large trees on the river edge with overhanging canopy.

Natural uncontrolled periodic high flood flows control the primary geographic features and the resultant riverside vegetation/majority canopy cover of the East Branch and North Fork Feather River. Large riverside trees are not there today because of this natural uncontrolled periodic high flood flow condition. Therefore, PG&E has concluded it is not feasible to plant trees as they would not grow and survive natural high flood flows.

I hope this helps. Please feel free to contact me with any questions you may have.

Tom Jereb

On 3/17/2015 2:08 PM, Barnes, Peter@Waterboards wrote:

> Mr. Leete,

Thank you. I will make sure to add this information to the record. Please let me know if you have any additional comments or questions.

Peter Barnes

From: John L [mailto:jhleete@frontiernet.net]
Sent: Tuesday, March 10, 2015 6:24 PM
To: sherrie.thrall@almanorpost.com; Barnes, Peter@Waterboards; Aaron Seandel; Alan Dubroff
Subject: Additional thoughts on passive thermal solution

Appendix C of the Project 2105 Level 1 and 2 Report includes measures to reduce warming of the water along the NFFR by "increasing shading through planting of vegetation". These are summarized in the following table.

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17	Poe Reach	0.8
	Total	2.5

The reference points out that shading will be more important with cooler water flowing through these parts of the system because there will be a larger gradient with the ambient temperature of the air at the surface. In a dry year (2002) there was a mean temperature of 24 deg at the end of the Poe Reach, 4 degrees above the goal. Shading would provide 63% of the needed reduction in warming.

If insulation of the penstocks could provide the remaining 37%, the downstream temperature goal would be satisfied with passive thermal measures alone!

John Leete

Barnes, Peter@Waterboards

From: John L <jhleete@frontiernet.net>
Sent: Wednesday, March 18, 2015 12:38 PM
To: sherrie.thrall@almanorpost.com; Alan Dubroff; Aaron Seandel; Barnes, Peter@Waterboards; TAJ3@pge.com
Subject: Fwd: Re: Caribou PH and penstocks

NFFR folks,
I am forwarding correspondence from the PG&E UNFFR Project Manager, Tom Jereb. The water passes through the penstocks so quickly when operation at full capacity that it warms up very little. So I guess that my penstock insulation idea doesn't hold water, so to speak.
John Leete

-------- Forwarded Message --------
Subject: Re: Caribou PH and penstocks
Date: Fri, 13 Mar 2015 17:15:11 -0700
From: John L <jhleete@frontiernet.net>
To: Jereb, Thomas <TAJ3@pge.com>

Mr. Jereb,

Thank you for the info. I thought I was onto something - but not so.

The numbers are impressive. 1464 cfs through a 4.49 ft diameter pipe (1.37 m) is moving about 63 miles per hour. (I don't know why one would use an average diameter to calculate the transport time unless the penstock is the large diameter for half of its length and the small diameter for the other half.) All of that kinetic energy in the penstock in addition to the head must be great for generating electricity.

Do you want me to email a retraction/explanation to the others that I sent this to?

John Leete
Dynamics Department Manager, Retired
TRW Space and Defense

On 3/13/2015 12:49 PM, Jereb, Thomas wrote:

> John, I received your e-mail and have consulted with my engineers. The 4 degrees difference is primarily due to the fact that Prattville intake takes warmer surface water from Lake Almanor while the Canyon Dam outlet takes cold deep water from Lake Almanor. There is measurable water warming that occurs as the water travels through Butt Valley Reservoir (solar radiation adsorbed by reservoir surface area of 1600 acres or 69,696,000 sq. feet). The retention time for water traveling through Butt Valley Reservoir is 14 to 32 days depending on operating conditions.
>
> Water flowing through the Caribou intakes (Butt Valley Reservoir) to the Caribou powerhouses (1&2) remains, for the most part, below the ground surface as it is conveyed in concrete lined tunnels (each about 1.7 miles long). This tunnel water

emerges above ground for an approximate distance of 0.35 miles (563.3 m) as it travels through the Caribou 1 and Caribou 2 powerhouse penstocks.

When underground, this water does not gain heat, rather the cooler ambient temperature of the rock surrounding the tunnels creates a situation where the conduit is a heat source, which loses heat to the cooler rock. So there may be a very slight decrease in water temperature as it travels through the tunnels.

When this water reaches the 0.35 mile long penstocks, during the period when the ambient air temperature is greater than the water temperature in the conduit, the surrounding air becomes the heat source and the penstock the heat sink. However, water temperature increases are miniscule as water moves through the penstock because:
1. Any particle of water is in the penstock for a very short period of time (i.e., ~ 56 s in Caribou 2 penstock), and
2. At any given time only a small volume of the water in the penstock is in close proximity of the penstock walls, as it travels through the penstock in ~56 s.
Given that the water travels through a much longer distance in the tunnels than penstocks, the small heat loses in the tunnel are likely to be larger than the small heat gain in the penstock, with a resulting net heat loss (albeit very small) as water travels from the intakes to the penstock outlet.

Calculations
The travel time for water in the 563.3 m long Caribou 2 penstock can be calculated with the following information:
~ Average Diameter of Penstock = 2.86 m (90") (Note diameter ranges between 1.37 m to 3.20 m)
Flow rate = 41.46 m3/s (1464 cfs)
Velocity of Flow through penstock =(4 * Flow rate)/(P *diamter^2) = 10.1 m/s
Travel time (0ver 563.3 m) = 55.7 seconds

I hope this answers your question. I am happy to discuss this further with you if you wish. Feel free to e-mail me or call me at (415) 973-9320.

Also, thank you for participating in the relicensing process.

Tom Jereb

From: John L [mailto:jhleete@frontiernet.net]
Sent: Wednesday, March 11, 2015 11:29 PM
To: Jereb, Thomas
Subject: Fwd: Caribou PH and penstocks

-------- Forwarded Message --------

Subject: Caribou PH and penstocks
Date: Sat, 21 Feb 2015 13:48:35 -0800

From: John L <jhleete@frontiernet.net>
To: sherrie.thrall@almanorpost.com, Peter Barnes <Peter.Barnes@waterboards.ca.gov>, LACC Web Admin <lacc@frontiernet.net>, sherrie.thrall@almanorpost.com

Dear Mr. Jereb,
Aaron Seandel recommended that I send copies of two emails to you that I sent to others involved with Project 2105. I learned after I wrote this that the 4 deg increase at the Belden forebay is mostly due to warm water coming from Prattville. Nevertheless, I think that a passive thermal effort to reduce NFFR water heating may solve the downstream temperature issue and allow PG&E to continue using the Caribou PHs as in the past.

I have attached a copy of figure 2-2 from the Project No. 2105 Level 1 and Level 2 Report of 2007. It shows water average mean temperatures observed along the NFFR in July 2002, a dry year. A remarkable feature of the figure is a 4 deg.C increase of the water at the Caribou Power Houses. The figure also indicates that temperature at the end of the Poe Reach is 4 degrees above the goal of 20 deg.C. So if the water heating between the Lake Almanor and the Caribou PH could be reduced, it would certainly help meet the goal.

The water flows through tunnels that are a little less than two miles long and then through penstocks for about a half mile. A Google Earth view of the penstocks that deliver the water to the Caribou #1 PH (power house) and the Caribou #2 PH is also attached. The view is looking North, so the penstocks are coming down a South-facing slope a few degrees West of due South. This is a bad orientation for exposure to direct radiation from the summer sun. In addition, some of the surrounding rock escarpment is light-colored and may also reflect heat onto the penstocks. If the observed water heating is due to solar radiation, it should be relatively easy and cost effective to insulate the penstocks. This hypothesis can be easily tested by measuring the water temperature at each end of the penstocks on a hot sunny day. As far as I can tell, a passive thermal solution to the NFFR water temperature problem has not yet been considered.

John Leete

Barnes, Peter@Waterboards

From: John L <jhleete@frontiernet.net>
Sent: Wednesday, March 18, 2015 1:21 PM
To: Barnes, Peter@Waterboards; sherrie.thrall@almanorpost.com; Aaron Seandel; Alan Dubroff; TAJ3@pge.com
Subject: NFFR Shading

NFFR folks,
The correspondence below is from Tom Jereb explains why shading was dropped from the measures considered for NFFR cooling. So I was apparently barking up the wrong tree.

Tom,
In the NFFR region, the sun reaches an elevation angle of about 73 degrees at midday in mid-summer, so an east-west river doesn't quite get direct overhead solar radiation.

I had a chance to look at the 2004 Settlement Agreement and think that you have done an amazing job getting all of the disparate government agencies and special interest groups to agree to anything, let alone such a complex subject.
John Leete

John, I received your forwarded message and thought it would be good if I gave you information on the alternative of planting of vegetation to create shading. PG&E studied this concept and found it to be not feasible for the East Branch and North Fork Feather River.

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Tom Jereb