Crivella, Ellen/PDX

From: Garton, Brittany/PDX
Sent: Tuesday, April 06, 2010 11:00 AM
To: Howie, Douglas (ECY)
Cc: Seidell, Nichole/PDX
Subject: RE: Teanaway Solar Reserve Hydrologic Analysis- Flow Resolution
Attachments: TSR_Short_Duration_Flows.xlsx

Doug-

Please see the attached spreadsheet with the results from running my HEC-HMS Model for the Teanaway Solar Reserve Project. I took your advice and ran the short duration (3-hour) storm as prescribed in the Eastern Washington Stormwater Management Manual rather than running a 6-hour event. Would you mind comparing these to your results to verify I am on the right track?

Thanks,
Brittany

Brittany Garton
Staff Engineer

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Suite 300
Portland, OR 97201
Direct 503.736.4108
Fax 503.736.2000
www.ch2mhill.com

From: Howie, Douglas (ECY) [mailto:doho461@ECY.WA.GOV]
Sent: Tuesday, March 30, 2010 4:06 PM
To: Garton, Brittany/PDX
Subject: RE: Teanaway Solar Reserve Hydrologic Analysis- Flow Resolution

No problem. Send me your results.

Doug

From: Brittany.Garton@CH2M.com [mailto:Brittany.Garton@CH2M.com]
Sent: Tuesday, March 30, 2010 3:50 PM
To: Howie, Douglas (ECY)
Subject: RE: Teanaway Solar Reserve Hydrologic Analysis- Flow Resolution

Thanks Doug.

Once I get this corrected, would you mind if we compared results again?

Brittany

From: Howie, Douglas (ECY) [mailto:doho461@ECY.WA.GOV]
Sent: Tuesday, March 30, 2010 3:28 PM
To: Garton, Brittany/PDX
Subject: RE: Teanaway Solar Reserve Hydrologic Analysis- Flow Resolution

Brittany:

Here is an excel file with the hyetograph for a 6-hour NRCS storm. This is the hyetograph you should be using when you simulate a 6-hour storm.

Call me if you have any questions.

Douglas C. Howie, P.E.
Stormwater Engineer
Department of Ecology, Water Quality Section
300 Desmond Dr. SE; PO Box 47600
Olympia, WA 98504-7600
(360) 407-6444 (voice)
douglas.howie@ecy.wa.gov

From: Brittany.Garton@CH2M.com [mailto:Brittany.Garton@CH2M.com]
Sent: Tuesday, March 30, 2010 11:03 AM
To: Howie, Douglas (ECY)
Cc: Nichole.Seidell@ch2m.com; McKinney, Charlie (ECY); Merz, Jonathan (ECY); Creech, Jane T. (ECY)
Subject: Teanaway Solar Reserve Hydrologic Analysis- Flow Resolution

Doug-

My name is Brittany Garton and I completed the Hydrologic Analysis for the Teanaway Solar Reserve Project. After visiting with Jane Creech and Charlie McKinney today, they notified me that you've been running an analysis of the 6-hour storm events and were coming up with very different numbers from what I provided in the report. I was hoping we could get together by phone and talk through the analysis to see if we can get to the bottom of why our flows aren't matching. Would you have some time this week to talk by phone about your analysis? Please let me know. My contact information is below.

Look forward to hearing from you!

Thanks,
Brittany

Brittany Garton
Staff Engineer

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From: Creech, Jane T. (ECY) [mailto:JTON461@ECY.WA.GOV]
Sent: Tuesday, March 30, 2010 10:46 AM
To: Garton, Brittany/PDX
Cc: Seidell, Nichole/PDX; Howie, Douglas (ECY); McKinney, Charlie (ECY); Merz, Jonathan (ECY)
Subject: Doug Howie contact info

Hi Brittany,

Here's the contact info for Doug Howie:

Douglas C. Howie, P.E.

Stormwater Engineer

Department of Ecology, Water Quality Section

300 Desmond Dr. SE; PO Box 47600

Olympia, WA 98504-7600

(360) 407-6444 (voice)

douglas.howie@ecy.wa.gov

Thanks,

Jane

Jane Creech
WA Dept of Ecology
Water Quality/Central Region
509-925-2557
jane.creech@ecy.wa.gov

Seidell, Nichole/PDX

From: Garton, Brittany/PDX
Sent: Friday, April 09, 2010 9:48 AM
To: Seidell, Nichole/PDX
Cc: Anderson, Mark/PDX
Subject: TSR Flow Check with Doug

WOOHOO!!!

I just got off the phone with Doug and our numbers look good! Can we celebrate now?? Just kidding. Now we can circle back with Jane and Charlie. I am wondering who should be involved and when we'd like to tackle this? Doug told me that if Jane has any concerns, that we can tell her to contact him. He is in agreement that this is all going to come down to design and he feels that the increases in peak flow and volume are something that can be mitigated.

Let me know how we should proceed. Have a good weekend!

Brittany

Brittany Garton
Staff Engineer

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Crivella, Ellen/PDX

From: Garton, Brittany/PDX
Sent: Monday, April 12, 2010 3:10 PM
To: Creech, Jane T. (ECY); McKinney, Charlie (ECY)
Cc: Seidell, Nichole/PDX
Subject: RE: Doug Howie contact info

Jane and Charlie-

I've finally gotten things straightened around with Doug Howie regarding my 6-hour storm events for the Teanaway Solar Reserve project and would just like to circle back with the two of you on the results of our conversations and model runs. I am out of the office on Thursday, but was wondering if you both had some time this week for a short phone call so I could update you on the outcome of my work with Doug. Please let me know if you are available and if you have any preference on day/time.

I look forward to talking with you both! Thanks,

Brittany

Brittany Garton
Staff Engineer

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www.ch2mhill.com

From: Creech, Jane T. (ECY) [mailto:JTON461@ECY.WA.GOV]
Sent: Tuesday, March 30, 2010 10:46 AM
To: Garton, Brittany/PDX
Cc: Seidell, Nichole/PDX; Howie, Douglas (ECY); McKinney, Charlie (ECY); Merz, Jonathan (ECY)
Subject: Doug Howie contact info

Hi Brittany,

Here's the contact info for Doug Howie:

Douglas C. Howie, P.E.

Stormwater Engineer

Department of Ecology, Water Quality Section

300 Desmond Dr. SE; PO Box 47600

Olympia, WA 98504-7600

(360) 407-6444 (voice)

douglas.howie@ecy.wa.gov

Thanks,

Jane

Jane Creech
WA Dept of Ecology
Water Quality/Central Region
509-925-2557
jane.creech@ecy.wa.gov

Seidell, Nichole/PDX

From: Garton, Brittany/PDX
Sent: Friday, April 16, 2010 10:55 AM
To: Seidell, Nichole/PDX
Cc: Anderson, Mark/PDX
Subject: Teanaway Solar Reserve DOE Follow-up Call

Nichole and Mark-

Just as a follow-up, here's what I discussed with Jane, Charlie, and Doug from DOE:

-I talked to them about why our flows were different before and let them know that everything now matches up and forwarded them the new flows.
-We talked about what the larger peak discharges mean and they agreed that this can all be mitigated with the right stormwater management design.
-I let them know that we'll be submitting an updated Hydrology report to the County. Jane inquired about the timeline and I told her I wasn't sure but would keep her in the loop. I told her that there was a possibility that the site design may be refined based on information that the wetlands group brought back and at that point, we would run the storm events with the updated numbers and possibly complete the rain-on snow analysis.
-DOE does support our findings and feels we'll be able to mitigate any impacts.
-Charlie inquired as to how we are going to be involved in this process as it moves forward with the Design-Build firm. I told them I was unsure of what our level of involvement will be but that we've discussed their concern with the client. He said he was pleased that we've at least been talking to the client about having a continued involvement in the project as it moves forward.
-Jane commented a few times that she was very happy the Doug and I had gotten the chance to work together and I got Doug to agree to be a resource for me if this Rain-on-Snow analysis ends up as a required activity from the County.
-Jonathan Merz and Bryan Neet (the NPDES guys from DOE) were invited to be on the call, but did not participate today.

That was pretty much it. Now I guess we have to circle back with the County?! I am praying that they change their minds about this rain-on-snow event analysis… But I have a feeling they won't budge… Nichole- Can you give me a timeline on when the County wants to see the updated report and how we should be proceeding from here?

Thanks and have a great weekend in the beautiful weather!

Brittany

Brittany Garton
Staff Engineer

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Crivella, Ellen/PDX

From: Garton, Brittany/PDX
Sent: Monday, April 26, 2010 9:38 AM
To: Seidell, Nichole/PDX
Cc: Anderson, Mark/PDX
Subject: Call with Doug D'Hondt from Kittitas County about TSR Additional Hydrology Report Work

Nichole-

Here's the notes I took about my phone call with Doug this morning:

Briefly chatted with Doug D'Hondt from Kittitas County about what the County is going to be looking for in the updated hydrology report. He mentioned 3 things:

- 25-year, 24-hour storm event pre-and post-development runoff rates and volumes
  - This is something we already knew the County was going to require from previous communications with them (it is part of their code requirements)
- 100-year, 24-hour storm event pre- and post-development runoff rates and volumes
  - This is a new storm event that hasn't been brought up by the County before. I was a bit surprised that this was mentioned. This came up at the end of our phone conversation when I asked Doug if there was anything else that he could think of that the County may ask us to include. He thought that this was a storm that people would be interested in seeing and said that it might be something that the County gets pushed into asking us for anyway. So, it's easy enough to run another storm through the model, so I'm thinking this is something we should include to prevent the county from coming back and asking for this information later.
- Rain-on-Snow Analysis
  - This wasn't a surprise request either. We knew the County would be requesting this information. They want us to use the methodology presented in the Eastern Washington Stormwater Management Manual in section 4.2.7 to calculate out the Rain-on-Snow volume.
    - I talked to Doug about the various precipitation data collection sites and told him what I'd found in regards to available information (being that all of the SNOTEL sites are located at elevations much higher than the site, so the data is not representative and that the NOAA site for Cle Elum, which is located at 1900 feet and has over 100 years worth of data is probably our best bet). He agreed. He didn't mention knowing of any other collections sites when I asked.
    - I told him that the NOAA site that we are using stops working in about 2003, so it doesn't cover the 2009 flooding event. He said that should be fine. He noted that there were other major flooding events in 1977, 1984, and 1996, and that 100 years worth of data should result in a representative analysis.
    - Section 4.2.7 of the Eastern Washington Stormwater Management Manual also has a section called "Additional Rain-on-Snow Considerations". I quizzed Doug about whether the Rain-on-Snow Analysis that the County is looking for is just the 4 step process that produces a volume, or whether I needed to go through the snowmelt piece that is presented in the "additional considerations" section. Doug said he is really just looking for the volume from the Rain-on-Snow Analysis, but that he would recommend also

going through the snowmelt procedure because we may eventually be required to provide this information as well.

In other words, there's one surprise regarding the 100-year, 24-hour storm, and I can include that analysis (it will probably take a whole 5 minutes to run) so that the County doesn't come back and ask us for that information later. I'm not sure whether we really need to go through the "additional considerations" piece of the rain-on snow analysis. I think this is something where the client could save some money because I didn't get the feeling from Doug that this was something that was important to include when I questioned him about it, but you'll have to let me know whether you feel like this is something we should include or not.

I am a little concerned that the County is leaning towards setting out flow requirements for the project based on my report. This is a concern that Mark voiced a few weeks ago. What we want them to write as a permit condition (which we've talked with the Department of Ecology about) is that the project must show no increase in peak flow or volume between pre-development and post-development. We don't want them to say something like "the project must not have a peak flow high than __" (fill in the blank with a number from my report). They need to base pre-and post-development runoff rate and volumes on a report that breaks the project site into smaller sub-basins than just the gross areas that I have used in my report. However, the County keeps asking for storm analyses that have to do specifically with events that they use for design purposes. Just thought I'd voice this concern.

Other than that, I'll wait for you to give me the go-ahead on completing the rain-on-snow analysis along with getting the updated site layout information from Ken. Let me know when you want me to get started. Also, did you follow-up by email with Jane on clarifying the difference between what our updated hydrology report will show, or did you want me to do that? I would be more than happy to write her a quick email to clarify based on the notes she sent back to us. Just say the word.

Hope you have a wonderful week! Let me know if you have any questions.
Brittany

Brittany Garton
Staff Engineer

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Crivella, Ellen/PDX

From: Creech, Jane T. (ECY) [JTON461@ECY.WA.GOV]
Sent: Monday, April 26, 2010 11:21 AM
To: Garton, Brittany/PDX
Cc: McKinney, Charlie (ECY); Seidell, Nichole/PDX
Subject: RE: Teanaway Solar Reserve DOE Follow-up Call

Hi Brittany,

Thanks for the note.
That sounds fine to me.

Jane

From: Brittany.Garton@CH2M.com [mailto:Brittany.Garton@CH2M.com]
Sent: Monday, April 26, 2010 11:14 AM
To: Creech, Jane T. (ECY); Nichole.Seidell@ch2m.com
Cc: McKinney, Charlie (ECY)
Subject: RE: Teanaway Solar Reserve DOE Follow-up Call

Jane-

I wanted to make sure and clarify with you about what will be submitted in our updated hydrology report and what will have to come at a later time as the design of the project progresses. I apologize for any miscommunication about this through our phone conversation a few weeks ago.

The updated hydrology report that we will be submitting to the county will have the updated 6-hour storm event runoff numbers, 25- and 100-year, 24-hour storm events, as well as the rain-on-snow analysis (I confirmed the methodology and data station with Doug D'Hondt at the County this morning). The updated report will not break the site down into the smaller sub-basins. An analysis on the smaller sub-basins will be completed during the design phase of the project (following a determination from the County on the SEPA Checklist).

Please let me know if you have any other questions/concerns. Again, I apologize for the miscommunication. I didn't mean to mislead you in any way.

On another note, I may be in contact with Doug Howie soon regarding the Rain-on-Snow analysis. I really appreciate him offering his time to be a resource.

Thanks,
Brittany

Brittany Garton
Staff Engineer

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From: Creech, Jane T. (ECY) [mailto:JTON461@ECY.WA.GOV]
Sent: Wednesday, April 21, 2010 5:16 PM
To: Seidell, Nichole/PDX
Cc: Garton, Brittany/PDX; McKinney, Charlie (ECY)
Subject: RE: Teanaway Solar Reserve DOE Follow-up Call

Hi Nichole and Brittany,

Thanks for the note, and the chance to add my $0.02 worth. I thought our recent conversation was useful and productive, and I believe that what Brittany wrote below is a good overview of what was said. I added a few things (in red, inserted into Brittany's note below), just to ensure that we're all on the same page. Nothing new, all stuff we had discussed.

Have a great day,
Jane

From: Nichole.Seidell@ch2m.com [mailto:Nichole.Seidell@ch2m.com]
Sent: Wednesday, April 21, 2010 4:41 PM
To: Creech, Jane T. (ECY)
Cc: Brittany.Garton@CH2M.com
Subject: RE: Teanaway Solar Reserve DOE Follow-up Call

Hi Jane,

I am sorry I have not been available to be in on the calls with you and Brittany. I am confident that she has been leading the charge!

Brittany has pulled together these notes from the last conversation you had last week. Can you take a look at the items below and let me know if you have any edits to this summary?

Thanks so much for all of your work on this project! We appreciate the guidance.

-Nichole Seidell

From: Garton, Brittany/PDX
Sent: Friday, April 16, 2010 10:55 AM
To: Seidell, Nichole/PDX
Cc: Anderson, Mark/PDX
Subject: Teanaway Solar Reserve DOE Follow-up Call

Nichole and Mark-

Just as a follow-up, here's what I discussed with Jane, Charlie, and Doug from DOE:

-I talked to them about why our flows were different before and let them know that everything now matches up and forwarded them the new flows.
-We talked about what the larger peak discharges mean and they agreed that this can all be mitigated with the right stormwater management design, which will include installation of appropriate BMPs as well as a good BMP maintenance program.
-I let them know that we'll be submitting an updated Hydrology report to the County. Jane inquired about the timeline and I told her I wasn't sure but would keep her in the loop. I told her that there was a possibility that the site design may be refined based on information that the wetlands group brought back and at that point, we would run the storm events with the updated numbers and possibly complete the rain-on snow analysis. Also, the new modeling will include

dividing up the estimated flows by sub-basins (maybe 10-12 of them) to ensure that BMPs are appropriately sized and placed.
-DOE does support our findings and (with updated modeling and design, installation, and maintenance of appropriate BMPs) feels we'll be able to mitigate any impacts.
-Charlie inquired as to how we are going to be involved in this process as it moves forward with the Design-Build firm. I told them I was unsure of what our level of involvement will be but that we've discussed their concern with the client. He said he was pleased that we've at least been talking to the client about having a continued involvement in the project as it moves forward.
-Jane commented a few times that she was very happy the Doug and I had gotten the chance to work together and I got Doug to agree to be a resource for me if this Rain-on-Snow analysis ends up as a required activity from the County.
Ecology is also interested in the rain-on-snow analysis, so please do this even if the county doesn't request it.

Brittany

Brittany Garton
Staff Engineer

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Report

Teanaway Solar Reserve Hydrologic Analysis Kittitas County, Washington

Prepared for

Teanaway Solar Reserve, LLC

June 2010

Prepared by

CH2MHILL

Printed on
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Contents

Appendices

Tables

Figures (*Provided in Appendix A*)

1.0 Introduction

At the request of Teanaway Solar Reserve, LLC (TSR) a hydrologic analysis for the proposed project site has been completed and is described in this memorandum. Background information was collected on the existing site conditions and used to create a pre-development model using the U.S. Army Corps of Engineers HEC-HMS 3.1.0 software. A model was also created to simulate the proposed site conditions. The models were then used to determine pre- and post-development peak rainfall runoff rates and volumes for 2-, 10-, and 100-year 3-hour storm events and 10-, 25-, and 100-year, 24-hour storm events. The pre- and post-development runoff rates were then compared to determine the hydrologic impact of the development.

Using the Center for Watershed Protection's methodology presented in the Stormwater Management Manual for Eastern Washington in Section 4.2.7: Rain-on-Snow and Snowmelt Design, an analysis was also completed to determine the pre- and post-development rain-on-snow volumes.

2.0 Background

The proposed 982-acre project site is located approximately 4 miles northeast of Cle Elum, Washington, in Township 20N, Range 16E, within Sections 22, 23, and 27 (see Figure 1 in Appendix A for the site location). This site is located on the eastern slopes of the Cascade Mountains on Cle Elum Ridge, which runs generally east to west at elevations ranging from approximately 2,200 to 2,600 feet. The Teanaway River is approximately 1 mile to the northeast of Cle Elum Ridge. The site is accessed from Highway 970 by way of county roads such as Red Bridge Road, private roads such as Loping Lane, and Wiehl Road, which is a dedicated public road that is maintained privately and not by the county. A description of the existing conditions is provided below.

2.1 Watersheds

Rainfall runoff from the proposed project site flows down the ridge through unnamed streams and eventually discharges to the Teanaway River. The Teanaway River is located in the Yakima River Basin and flows to the Yakima River. At its confluence with the Yakima River, the Teanaway River has a drainage area of 207 square miles. The peak 100-year flow as listed in the Flood Insurance Study (FIS) produced by the Federal Emergency Management Agency (FEMA) in 1981 is 7,350 cubic feet per second (cfs) at its confluence with the Yakima River.

Flood Insurance Rate Maps (FIRMs) from FEMA were used to determine the areas of special flood hazard near the proposed project site. The most recent available mapping comes from the 1981 FIS (map numbers 5300950254B, 5300950258B, 5300950262B, and 5300950266B). The data provided by the FIRMs only show the extent of the 100-year floodplain of the Teanaway River. The Teanaway River floodplain is located just downstream of the proposed site. See Figure 2 in Appendix A for a map of the 100-year floodplain in the vicinity of the project.

2.1.1 January 2009 Flooding Event

A major rain-on-snow flood event occurred in January 2009 downstream of the proposed project site when heavy rain in the mountains and unseasonably warm temperatures turned the deep snow pack into flood waters. The flooding caused landslides and affected several landowners at the base of the ridge in the Teanaway River Valley. A letter written by GeoEngineers, Inc. on October 5, 2009, suggests that the cause of this flood event is most likely the result of anthropogenic activity down gradient from the project site rather than hydrologic issues on the proposed project site itself (see Appendix B).

Drainages from the project site have been characterized as ephemeral, vegetated swales. A field reconnaissance completed by a professional hydrologist from GeoEngineers after the flooding event showed the drainages that emanate from the project site were in stable condition. No excessive erosion, lateral shifting, or incision was evident in the drainages around the project site. This confirms that the drainages from the project site are hydraulically stable and capable of handling runoff from significant flooding events. The vegetation in the drainages helps reduce the velocity and erosional forces of the water as it runs off hill slopes and flows into concentrated areas.

Moreover, interviews with local residents were also conducted as a part of the field reconnaissance. One resident, a Mr. Jesse Geiger, told GeoEngineers personnel that another area resident had used excavating equipment to trench into and disturb the streambed of an unnamed small drainage in an effort to reroute flows into irrigation pipes and ultimately into an existing delivery system. According to Mr. Geiger, the channel was never armored or re-vegetated after the soil disturbance and channel realignment. As a result, high flows in January 2009 destabilized the unprotected channel and breached the weak soil dam that had been erected adjacent to Red Bridge Road. Notably, the condition of the channel upstream of the disturbed area was not subject to erosion or damage; rather, only the disturbed reach was destabilized, causing a debris torrent to spill into the road and the subsequent flooding and damage to the road. Field observations of the drainage correlate with the description of events recounted by area residents, as evidenced by comparing the condition of this drainage to the drainage adjacent to Wiehl Road.

2.2 Site-Specific Drainage Basins

There are two major drainage basins on the proposed project site. These drainage basins are referred to as the South drainage basin and the North drainage basin for the purposes of this report. Figure 3 in Appendix A is a map showing the location of the drainage basins on the proposed project site. Multiple drainage paths leave the site. Flow rates are comparative, but do not provide detail of flow distribution by sub-basin. Drainage basins were delineated for this analysis to assess the impact the project is expected to have on major receiving waters. A more detailed analysis of the small, natural drainage basins on the site will be completed during the design phase of the project.

The South drainage basin has an area of 723 acres and covers a majority of the proposed site. Rainfall runoff from this drainage basin generally flows south to the base of the ridge, where it then flows east along the north side of Red Bridge Road eventually discharging to the Teanaway River.

The North drainage basin has an area of 259 acres and is located in the northeast corner of the proposed project site with a few small areas along the northern border of the project site. Rainfall runoff from the North drainage basin flows to the north from the site and eventually discharges into the Teanaway River.

3.0 Model Methodology

The selected methodology chosen for this analysis is based on the Natural Resources Conservation Service (NRCS) Technical Release-55 (TR-55), which presents procedures to calculate stormwater runoff volumes and peak rates of discharge. To determine runoff from storm rainfall, this methodology uses a runoff curve number (CN) method. Determination of the CN depends on the watershed's soil and cover conditions, which the model represents as hydrologic soil group, cover type, and hydrologic condition.

The following subsections describe the existing and proposed conditions for the site that were used to create a model of the drainage basins.

3.1 Existing Conditions

3.1.1 Impervious Cover

Currently, no impervious area exists on the project site. The area is undeveloped ponderosa pine forest with dirt roadways.

3.1.2 Soil Infiltration and Drainage Characteristics

Soil types for the project site were determined using the NRCS web soil survey application. There are four types of soil located at the proposed project site: Nard ashy loam, 5 to 25 percent slopes; Nard ashy loam, 25 to 45 percent slopes; Teanaway loam, 3 to 10 percent slopes; and Teanaway loam, 25 to 50 percent slopes. All four soil types are in hydrologic soil group C. Soils in hydrologic soil group C have slow infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission, thus producing a moderate amount of rainfall runoff.

3.1.3 Slopes

Slopes in the South drainage basin were estimated to range between 3 and 26 percent. Slopes in the North drainage basin were estimated to range between 3 and 31 percent. Topographic maps were used to calculate the time of concentration for each basin. Time of concentration calculations are provided in Appendix C.

3.1.4 Vegetated Cover

Per Kittitas County zoning, the site is currently zoned Forest and Range (F&R). Since the early 1900s, this site has been repeatedly selectively logged. Harvests have occurred in the 1920s, 1950s, 1980s, and 2000s. Pre-commercial thinning occurred in the decades between logging. Prior to 1900, the site had a fire frequency of 9 to 12 years, indicating that a healthy understory and small trees did not exist, creating a park-like stand of larger trees that were fire resistant to low-intensity, periodic fires. The site was most recently selectively logged in 2001, and existing site vegetation consists of low grasses, shrubs, and trees. Shrubs and riparian communities are predominantly snowberry and rose bushes. Herbaceous plant communities are predominantly lupine, yarrow, arrowleaf balsamroot, and various grass species. Wetland plant communities are dominated by rushes sedges, wild onion, and various other grass species.

Table 1 is a summary of CNs based on hydrologic soil group and vegetative cover type from *Technical Release 55: Urban Hydrology for Small Watersheds* (NRCS 1986). The woods-grass combination was used to determine the existing curve number for the site. The existing site's CN of 72 was computed for an area with 50 percent woods and 50 percent grass (pasture) cover in good condition.

TABLE 1
Runoff Curve Numbers (TR-55)

Cover Description		Curve Numbers for Hydrologic Soil Group			
Cover Type	**Hydrologic Condition**	**A**	**B**	**C**	**D**
Pasture, grassland, or range-continuous forage for grazing [a]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Woods- grass combination (orchard or tree farm) [b]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods [c]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[d]	55	70	77

[a] Poor: <50% ground cover
Fair: 50 to 75% ground cover
Good: >75% ground cover

[b] CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[c] Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

[d] Actual curve number is less than 30; use CN=30 for runoff computations.

3.2 Proposed Conditions

The purpose of the proposed project is to generate up to 75 direct current megawatts (MWdc) of photovoltaic (PV) solar energy for distribution to utilities and communities seeking to optimize their renewable and sustainable energy sources. The proposed project area consists of 982 acres. Based on site surveys, the project will utilize approximately 477 acres within the proposed project area. Solar arrays will be placed on approximately 399 acres. The remaining acres are currently undeveloped open space, which will be preserved as part of the wildlife mitigation plan for the project. The proposed project will consist of the following key components:

- Solar modules
- Power inverter enclosures
- Power transformers
- Underground electrical conductors
- Electrical substation and switchyard
- Operations and maintenance (O&M) building supervisory control and data acquisition (SCADA) system
- Overhead interconnection transmission line
- Access and maintenance roads

3.2.1 Impervious Cover

A small increase in impervious area on the proposed project site (less than one acre) is expected from the following proposed improvements: solar modules, power inverter enclosures, and the O&M facility. Other project components such as access roads and a 6-acre graveled substation that reduce the infiltration capability of the soil are accounted for in the change in CN. A conceptual site plan and corresponding areas were provided to CH2M HILL by Studio GREENE. These areas were used to determine the impervious area for the site. Impervious surfaces and their corresponding areas are shown in Table 2.

TABLE 2
Project Impervious Surfaces and Areas

Impervious Surface	Area (SF)	Area (ac)
Array Fields		
Solar Modules	12,665	0.291
Field Inverters	6,400	0.147
Field Transformers	3,840	0.088
BPA Substation		
Concrete Pads	7,000	0.161
BPA Control House	1,800	0.041
Tower and Transmission Pole	100	0.002
BPA Switchgear Building	1,080	0.025
BPA Fence (Footings)	3,000	0.069
Operations and Maintenance Building	1,000	0.023
Transmission Structure	800	0.023

Notes:
SF = square feet
ac = acres

An assumption for calculating the impervious area created by solar panels was used for this analysis. The impervious area created by a solar panel was considered to be the area of the foundation of the panels, not the panels themselves. While solar panels do generate concentrated runoff on the panel surfaces, the panels are considered a disconnected impervious surface because the infiltration capability of the soil is only affected by the foundation. Flow spreaders can be used to distribute the concentrated flow from the panels evenly over the ground surface.

Because impervious area from the site is disconnected, the resulting impacts calculated in this analysis are conservative. A more detailed analysis of the small, natural drainage basins on the site that will be completed during the design phase of the project will likely reveal lesser impacts. The detailed analysis completed during design will be used to select the appropriate stormwater Best Management Practices (BMP) that are best suited to protect each drainageway and minimize the impacts of the project to the maximum extent practicable.

3.2.2 Vegetated Cover

The construction of the proposed solar reserve would result in a reduction of the ponderosa pine forest canopy. Project elements that will affect the vegetated cover are shown in Table 3. The CN for the solar array field is based on a CN for grassland in fair condition. Areas were based on a conceptual site plan and corresponding areas that were provided to CH2M HILL by Studio GREENE.

TABLE 3
Project Elements Creating a Change in Vegetated Cover

Project Element	Area (SF)	Area (ac)	Curve Number Used
Roads (Graveled)			
Primary Roads (20 foot width)	549,680	12.6	89
Secondary Roads (16 foot width)	260,160	5.97	89
BPA Substation			
Graveled Area	112,000	2.57	89
Roads	40,000	0.918	89
Array Fields			
Solar Array Field	17,380,440	399	79

4.0 Climate

The NRCS classifies storms in the project vicinity as being Type 1A. Total precipitation amounts in the vicinity of the project were taken from National Oceanic and Atmospheric Administration (NOAA) Atlas 2. Precipitation amounts were modified using guidance provided by the Stormwater Management Manual for Eastern Washington. The 3-hour short-duration storm distribution was run for the 2-, 10-, and 100-year storm events and the regional storm distribution was run for the 10-, 25-, and 100-year storm events. The short-duration event simulates a storm that is 3 hours in length and is representative of a thunderstorm. The regional storm distribution simulates a storm that is longer than 24 hours in duration and represents a general storm. To calculate the precipitation depth for the regional storm, the 24-hour depths were increased by 16 percent per guidance provided by the Stormwater Management Manual for Eastern Washington. The storm depths used in the analysis are shown in Table 4.

TABLE 4
Total Precipitation Storm Events

Storm Event	Precipitation (inches)
2-year, 3-hour	0.64
10-year, 3-hour	0.91
100-year, 3-hour	1.47
10-year, 24-hour	2.90
25-year, 24-hour	3.48
100-year, 24-hour	4.35

Data gathered from the Natural Resources Conservation Service (NRCS) Temperature and Precipitation Summary (TAPS) station WA1504 show the climate in Cle Elum consists of mild summers and cold winters. Temperatures range from an average January minimum of 21.2 degrees Fahrenheit (°F) to an average August maximum of 80.0°F. The average annual precipitation is 23.09 inches, with the majority occurring from November through March. Table 5 presents average monthly precipitation and snowfall data for Cle Elum.

TABLE 5
Average Annual Precipitation, Cle Elum, Washington (1971 - 2000)

Month	Average Precipitation (in)	Average Total Snowfall (in)
January	3.80	24.6
February	2.51	14.7
March	1.67	6.2
April	1.16	0.8
May	0.93	0.2
June	0.96	0.0
July	0.46	0.0
August	0.58	0.0
September	0.93	0.0
October	1.76	0.5
November	3.90	12.6
December	4.43	27.0
Annual Average	**23.09**	**86.5**

5.0 Drainage Basin Modeling

The background information described above was used to create basin models using the U.S. Army Corps of Engineers Hydrologic Modeling System HEC-HMS 3.1.0. This software was used to determine the pre- and post- development runoff rates and volumes from the project area for the 2-, 10-, and 100-year, 3-hour storm events to determine the impacts the development will have on hydrology of the two drainage basins on the site and the surrounding area. The 10-, 25-, and 100-year regional storm events were also used to illustrate the effect of longer duration storm events.

The 2-, 10-, and 100-year, 3-hour storm events were used with the NRCS storm distribution Type 1A to calculate the runoff from the drainage basins for the existing and proposed conditions in the North and South drainage basins. The 10-, 25-, and 100-year, regional storms were also used to illustrate the effect of a longer duration storm event. A summary of the areas and curve numbers used in the model are shown in Table 6. The peak rainfall runoff rates and volumes for the existing and proposed conditions are shown in Tables 7 and 8, respectively.

TABLE 6
Areas and Curve Numbers used in the HEC-HMS Model

Conditions	Drainage Basin	Impervious Area (ac)	Impervious Area Curve Number	Pervious Area (ac)	Pervious Area Curve Number [a]
Existing Conditions					
	North	0	98	259	72
	South	0	98	723	72
Proposed Conditions					
	North	0.06	98	258.94	73
	South	0.81	98	722.19	76

[a] Values of proposed conditions are weighted per values shown in Table 3.

TABLE 7
Existing Site Rainfall Runoff and Volume Calculations from HEC-HMS Model

Drainage Basin	Storm	Peak Discharge (cfs)	Total Runoff Volume (cf)
North Drainage Basin	2-year, 3-hour Storm	0.00	0
	10-year, 3-hour Storm	0.72	4,071
	100-year, 3-hour Storm	24.71	98,285
	10-year, Regional Storm	21.77	693,667
	25-year, Regional Storm	39.85	1,027,117
	100-year, Regional Storm	71.54	1,587,806
South Drainage Basin	2-year, 3-hour Storm	0.00	0
	10-year, 3-hour Storm	1.92	11,364
	100-year, 3-hour Storm	58.90	274,364
	10-year, Regional Storm	55.96	1,923,489
	25-year, Regional Storm	102.01	2,849,855
	100-year, Regional Storm	183.89	4,408,120

TABLE 8
Proposed Site Rainfall Runoff and Volume Calculations from HEC-HMS Model

Drainage Basin	Storm	Peak Discharge (cfs)	Total Runoff Volume (cf)
North Drainage Basin	2-year, 3-hour Storm	0.05	141
	10-year, 3-hour Storm	1.01	7,221
	100-year, 3-hour Storm	29.40	113,422
	10-year, Regional Storm	24.78	738,165
	25-year, Regional Storm	43.77	1,082,042
	100-year, Regional Storm	76.53	1,656,542
South Drainage Basin	2-year, 3-hour Storm	0.53	1,942
	10-year, 3-hour Storm	10.36	61,649
	100-year, 3-hour Storm	109.23	465,033
	10-year, Regional Storm	89.52	2,445,290
	25-year, Regional Storm	144.34	3,486,976
	100-year, Regional Storm	237.38	5,196,333

The existing site rainfall runoff and volume calculations were used as a baseline for determining the increase in rainfall runoff and volume expected as a result of the construction of the proposed project.

Rainfall runoff and volume are expected to increase in both the North and South drainage basins. Due to the small amount of construction in the North drainage basin, peak rainfall runoff rates and volumes are expected to increase on a much smaller scale when compared to the increases in the South drainage basin. See Table 9 for a summary of the increase by drainage basin.

TABLE 9
Summary of Peak Discharge and Volume Increases by Basin

Drainage Basin	Storm	Increase in Peak Discharge (cfs)	Increase in Total Runoff Volume (cf)
North Drainage Basin	2-year, 3-hour Storm	0.05	141
	10-year, 3-hour Storm	0.29	3,150
	100-year, 3-hour Storm	4.70	15,137
	10-year, Regional Storm	3.01	44,498
	25-year, Regional Storm	3.92	54,925
	100-year, Regional Storm	4.99	68,736
South Drainage Basin	2-year, 3-hour Storm	0.53	1,942
	10-year, 3-hour Storm	8.44	50,285
	100-year, 3-hour Storm	50.34	190,669
	10-year, Regional Storm	33.55	521,801
	25-year, Regional Storm	42.32	637,121
	100-year, Regional Storm	53.49	788,213

The largest increase in peak discharge for the storm events occurred during the 100-year regional storm in the South drainage basin (53.49 cfs). At the point of discharge to the Teanaway River, the total contributing drainage basin area is 195 square miles. Using a direct proportion of drainage basin area to flow (FEMA data reports recorded the total size of the drainage basin to be 207 square miles and have a 100-year discharge of 7,350 cfs), the flow in the Teanaway River at the discharge point is expected to be approximately 6,924 cfs during a 100-year storm event. An increase of 53.49 cfs results in a 0.77 percent increase in flow during the 100-year short duration storm event. From a flooding standpoint, this increase is determined to be negligible when compared to the contribution of the entire watershed at the point of discharge from the project area.

Increases in rainfall runoff rates and volumes experienced by the onsite natural drainages will be managed using infiltration to the maximum extent practicable and stormwater BMPs will be implemented if necessary.

5.1 Stormwater BMPs

Stormwater BMPs will be chosen based on site-specific conditions during design and on their ability to function with and protect the natural watershed. Specific BMPs will be outlined in the National Pollutant Discharge Elimination System (NPDES) permit and the Stormwater Pollution Prevention Plan (SWPPP) that will be submitted to the Washington State Department of Ecology prior to construction of the project.

There are three basic types of stormwater BMPs: source control, water quality treatment, and flow control. Source control BMPs are measures that are directed toward pollutant-generating activities that will help prevent pollution or other adverse effects of stormwater. Water quality treatment BMPs remove pollutants from stormwater by filtration, biological uptake, adsorption, and gravity settling. The need for water quality BMPs is based on the types of pollutants generated by a project and the vulnerability of the receiving waters to the pollutants of concern. Flow control BMPs control the rate, frequency, and/or flow duration of stormwater runoff through infiltration, evaporation, or detention facilities with infiltration being the preferred method wherever possible. The concept of detention is to collect runoff from a developed area and release it at a slower rate than it would typically run off the site.

Stormwater management involves careful application of source controls, site design principles, and construction techniques in order to protect a watershed. Some potential stormwater BMPs for the site include, but are not limited to, infiltration ponds; infiltration trenches; infiltration swales; large, extended-detention wet ponds; and extended-detention wetlands. Facilities will be designed in accordance with the standards outlined in the Eastern Washington Stormwater Management Manual in order to protect water quality in the receiving waters and reduce the impacts of development on the watershed. Guidance on stormwater BMPs and Low Impact Development (LID) were provided by the Washington Department of Ecology; however, they were not included in the list of facilities above. Stormwater BMPs provided in the Eastern Washington Stormwater Management Manual were more applicable to the rural setting of the project and also account for location and climate in the project area.

6.0 Rain-on-Snow Analysis

A rain-on-snow event occurs when rain falls onto frozen or saturated ground with a pre-existing snow pack. The rain causes the snow to melt, and with the frozen or saturated ground acting like an impervious surface, additional runoff volume is generated. Rain-on-snow events pose a significant flood hazard, such as occurred in 2009. A rain-on-snow analysis was completed for existing and proposed conditions to determine the impacts the development may have on rain-on-snow volumes. The methodology used for the rain-on-snow analysis is outlined in the Eastern Washington Stormwater Management Manual Section 4.2.7. It is a four-step procedure that was originally prepared by the Center for Watershed Protection.

The dataset used for the analysis was downloaded from the Cle Elum National Weather Service Cooperative Station from the NOAA Regional Climate Center's Applied Climate Information System. The dataset contains daily statistics on precipitation, snowfall, and snow depth for Cle Elum, Washington. Detailed information about the station is shown in Table 10. This station provided the most representative data for the project area, both in terms of proximity to the site, elevation, and available data record.

TABLE 10
Rain-on-Snow Dataset Information

Station:	Cle Elum
State:	Washington
ID:	451504
Latitude:	47.19 degrees
Longitude:	-120.91 degrees
Elevation:	1900 feet
Station Period of Record:	Jan. 1899 – Nov. 2009

Two runoff distributions were tabulated: one for months with snow on the ground (winter) and one for months without snow on the ground (summer). In order to determine the months that were included in the winter and summer runoff distributions, historical monthly snowfall averages were reviewed. At the project area, the months November through March typically have snow on the ground, while April through October do not. The criteria for determining the two distributions was any months that have averages of less than 1-inch of snow were grouped into the summer category.

The data were sorted (based on the months for the two distributions) to form separate data sets for winter and summer. Per the rain-on-snow analysis methodology, days that recorded snowfall events and days that had less than 0.1 inches of recorded precipitation were filtered out of the dataset. The remaining summer precipitation events were then modified using the following equation to determine the amount of runoff a summer storm would generate.

$$R = 1.0 * P * (0.05 + 0.9 I)$$

Where R is runoff, P is the precipitation from the runoff distribution for the summer months, and I is the impervious percentage. An impervious percentage of 0 was used to model existing site conditions, while a percentage of 2.34 percent was used to model post-development conditions. Table 11 below lists the project elements and areas that were used to determine the impervious percentage for post-development conditions. The impervious percentage for post-development conditions accounts for 22.95 acres of impervious area over the 982 acres project area. This is a conservative estimate, as some of the project features are graveled areas that will allow for small amounts of infiltration.

TABLE 11
Project Elements and Areas

Project Element	Area (SF)	Area (ac)
Array Fields		
Solar Modules	12,665	0.291
Inverters	6,400	0.147
Transformers	3,840	0.088

TABLE 11
Project Elements and Areas

Project Element	Area (SF)	Area (ac)
Roads (Graveled)		
Primary Roads (20 foot width)	549,680	12.62
Secondary Roads (16 foot width)	260,160	5.972
BPA Substation		
Graveled Area	112,000	2.571
Concrete Pads	7,000	0.161
Roads	40,000	0.918
BPA Control House	1,800	0.041
BPA Switchgear Building	1,080	0.025
Tower and Transmission Pole	100	0.002
Fence	3,000	0.069
Operations and Maintenance Building	1,000	0.023
Transmission Pole	800	0.018

The summer and winter distributions were then combined and ranked. Following the Section 4.2.7 guidance, the 90th percentile value provided a runoff depth that was used to determine the volume of runoff that would result from a rain-on-snow event. This analysis was completed for pre- and post-development. The analysis resulted in the same pre-and post-development runoff depth of 0.5 inch. When applied over the entire site, the expected volume of runoff during a rain-on-snow event is 1,778,700 cubic feet, or 40.83 acre-feet.

As a result of this analysis, the magnitude of runoff from a rain-on-snow event is not expected to significantly increase from construction of the project. Due to limited infiltration capacity during a rain-on-snow event, the site is expected to generate a similar volume of runoff at build-out as would be generated with the current site conditions.

7.0 Construction- and Operation- Related Stormwater Impacts

This section addresses specific concerns related to the stormwater impacts from construction and operation of the Teanaway Solar Reserve facility.

7.1 Teanaway River Total Maximum Daily Loads

Section 303(d) of the federal Clean Water Act requires states to periodically prepare a list of all surface waters in the state whose beneficial uses are impaired by pollutants. Waters placed on the 303(d) list require the preparation of Total Maximum Daily Loads (TMDLs). TMDLs are used to set and implement standards to clean up the polluted waters. TMDLs identify the maximum amount of a pollutant allowed to be released into a waterbody so as not to impair uses of the water, and allocate that amount among various sources.

The Teanaway River has a TMDL for temperature. From July through September stream temperatures in the Teanaway River basin often exceed Washington State water quality standards. Temperature increases in streams can occur for a variety of reasons. Some examples include the loss of vegetation along streams that used to shade the water, impervious area that causes rainfall to increase in temperature before it runs off into a stream, and sediment transport that results in reduced channel width-to-depth ratios.

The Teanaway River is also included in the Upper Yakima Suspended Sediment, Turbidity, and Organochlorine Pesticide TMDL. Suspended sediments and turbidity are caused by erosion of earthen roads and stream banks, and by the discharge of agricultural return flows to the river that are full of sediment. Organochlorine pesticides are also transported by suspended sediment.

In accordance with the standards outlined in the Teanaway Temperature TMDL and Upper Yakima Suspended Sediment, Turbidity, and Organochlorine Pesticide TMDL and the stormwater requirements for Eastern Washington, BMPs will be implemented to prevent soil erosion and any downstream turbidity during construction and operation of the Teanaway Solar Reserve facilities. These BMPs will be outlined in the National Pollutant Discharge Elimination System (NPDES) permit and the Stormwater Pollution Prevention Plan (SWPPP) that will be submitted to the Washington State Department of Ecology prior to construction of the project. The project is highly unlikely to increase temperature in the Teanaway River due to the disconnected nature of impervious area, flow paths on the site, and distance from the project site to its discharge into the Teanaway River.

7.2 Vegetation Management

Routine vegetation management will be required to ensure vegetation growth does not interfere with the operation of any equipment on the Teanaway Solar Reserve project site. Woody vegetation removal and ongoing management will be necessary to prevent interference with solar arrays. Measures will be implemented to protect herbaceous plant cover on site, including under solar arrays. These measures include ongoing vegetation removal that will be limited to woody vegetation that could potentially interfere with safe and effective project operations and preventing non-native plant invasion into the project area.

For a list of BMPs that will be implemented during construction and operation of the Teanaway Solar Reserve, please refer to Attachment G, *Vegetation Management Plan*. The use of herbicides in accordance with the BMPs and requirements of the local, state, and federal jurisdictions is not expected to affect stormwater quality in the project area.

7.3 Improvements to Loping Lane and Wiehl Road

The Teanaway Solar Reserve site will be accessed via Kittitas County and private roads that interconnect with Highway 970. Loping Lane, a private road, and Wiehl Road, a privately maintained public road, will be used to access the site during construction and operation of the project. Currently, Loping Lane and Wiehl Road generally consist of gravel and dirt; the portions of Loping Lane and Wiehl Road that will be used during construction and operation will need to be improved pursuant to County requirements.

With several drainages in close proximity to the roads, stormwater drainage infrastructure will be necessary if Loping Lane and Wiehl Road are improved. All drainage improvements will be designed and constructed in accordance with the Eastern Washington Stormwater Management Manual and the requirements of local, state, and federal jurisdictions. BMPs will also be implemented to prevent soil erosion and any downstream turbidity during construction and operation.

8.0 Summary

Background information was collected on the existing and proposed site conditions for the Teanaway Solar Reserve Project and used to create models of the existing and proposed conditions for the two drainage basins on the project area. The NRCS *Technical Release 55* (*TR-55*) methodology was the selected method for the analysis to determine the increase in rainfall runoff and volume from the project area. To determine runoff from storm rainfall, this methodology uses a runoff CN method. Determination of the CN depends on the watershed's soil and cover conditions, which the model represents as hydrologic soil group, cover type, and hydrologic condition.

Once all of the inputs were determined for the existing and proposed conditions in each drainage basin, models were built using the U.S. Army Corps of Engineers HEC-HMS 3.1.0 software. The models were then used to determine pre- and post-development peak rainfall runoff rates and volumes for 2-, 10-, and 100-year 3-hour and 10-, 25-, and 100-year regional storm events. Peak runoff rates and volumes are expected to increase minimally as a result of the development of the site. The increases are negligible when compared to the contribution of the entire watershed at the point of discharge to the Teanaway River. Moreover, mitigation of the hydrologic impacts, if any, from the increased runoff rates and volumes for local drainages will be mitigated through infiltration to the maximum extent practicable and stormwater BMPs will be implemented if necessary. These measures will be designed and constructed in compliance with the Eastern Washington Stormwater Management Manual.

Rain-on-snow events pose an existing risk of flooding; however, the magnitude of runoff from a rain-on-snow event is not expected to significantly increase as a result of the project. Due to limited infiltration capacity during a rain-on-snow event, the post-development site is expected to generate a similar volume of runoff as would be generated with current site conditions.

Significant stormwater impacts from construction and operation of the Teanaway Solar Reserve facility are not expected. Nevertheless, any impacts will be adequately addressed through the State NPDES permitting program and the implementation of Best Management Practices. Vegetation management through the use of Department of Ecology-approved herbicides is not expected to affect stormwater quality. All stormwater drainage improvements associated with the Teanaway Solar Reserve project will be designed and constructed in accordance with the Eastern Washington Stormwater Management Manual and the requirements of local, state, and federal jurisdictions to reduce the impacts of the project to the maximum extent practicable.

9.0 References

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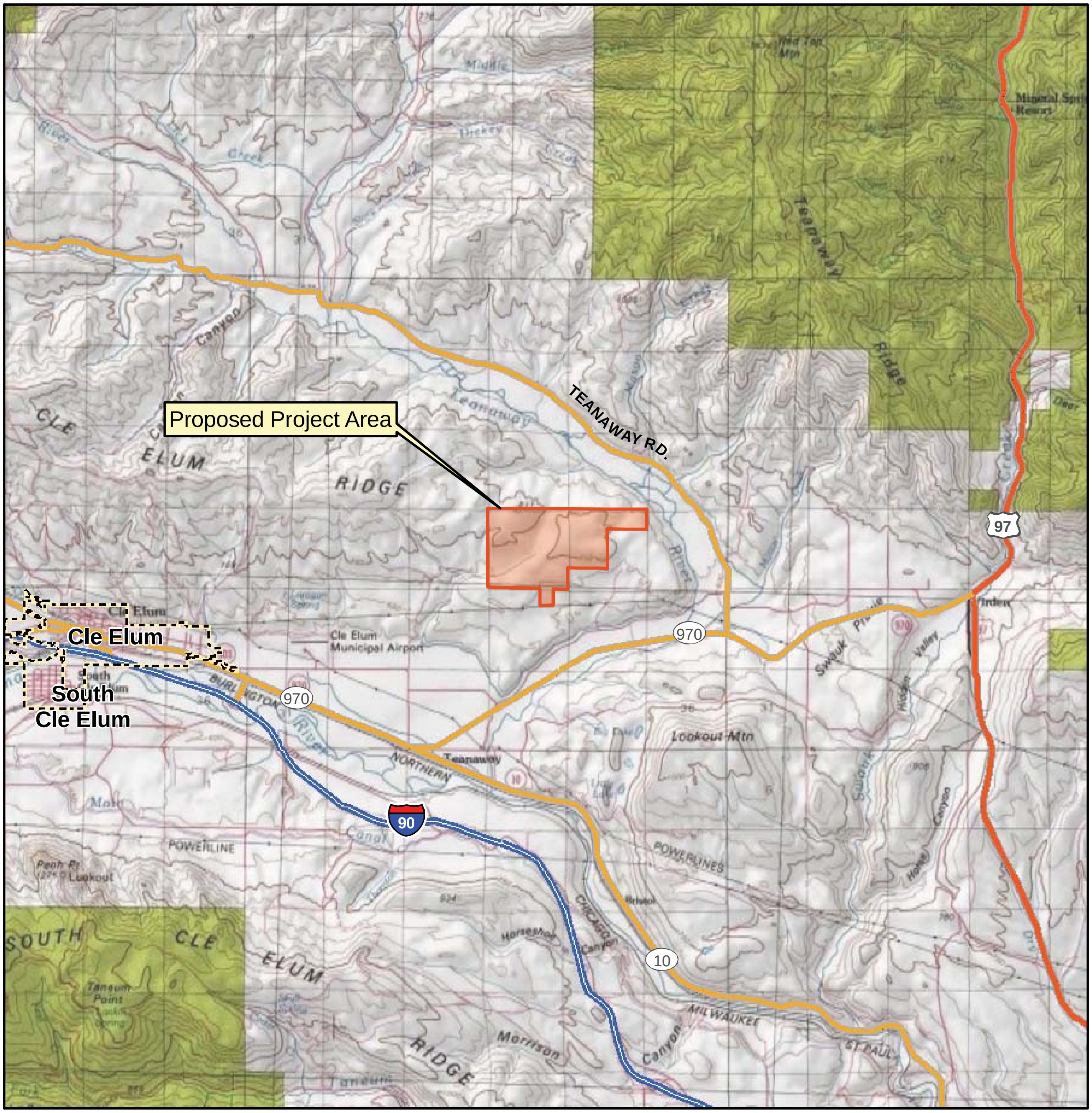
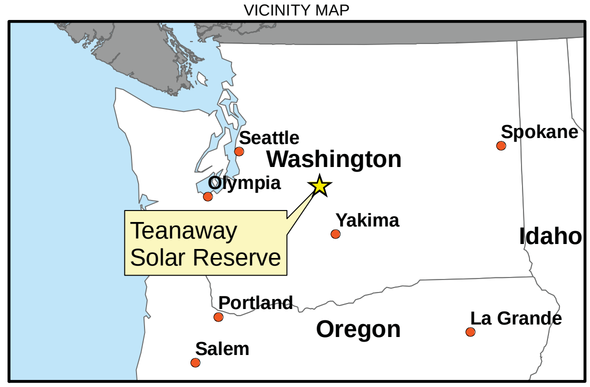
APPENDIX A
Figures



LEGEND

- Proposed Project Area
- City Boundary
- Interstate
- Highway
- Major Road

VICINITY MAP



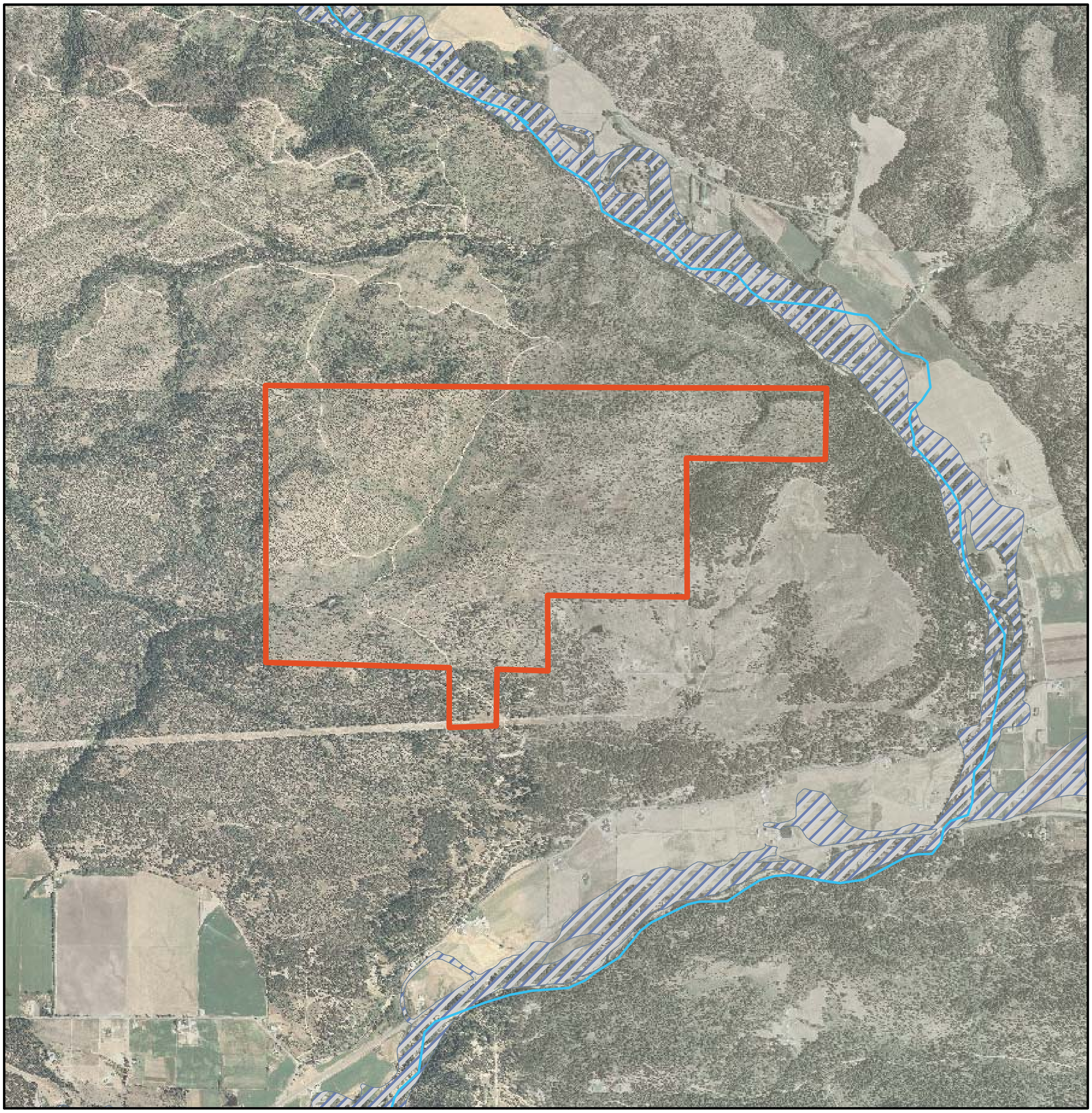
Note:
1. USGS 100K Quadrangle: Wenatchee.

0 1 2
Miles

N

FIGURE 1
Vicinity Map
Hydrologic Analysis
Teanaway Solar Reserve
Kittitas County, Washington

CH2MHILL



LEGEND

Shoreline Management Act Stream (450 feet from proposed project area)

FEMA 100-year Flood Zone

Proposed Project Area

Notes:
1. Flood Data: Federal Emergency Management Agency Flood Insurance Rate Map.
2. Stream Data: Washington Department of Ecology.
3. Aerial Imagery: 2006 1m NAIP.

0 1,500 3,000
Feet

N

VICINITY MAP

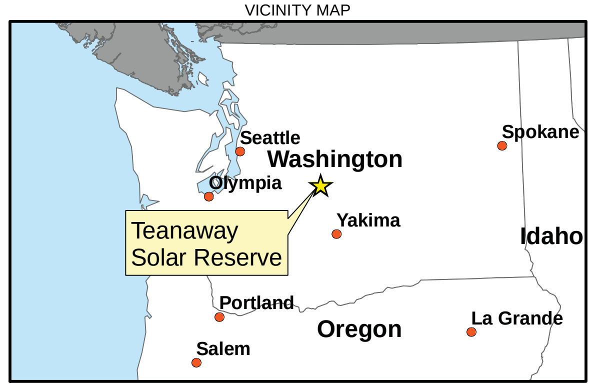
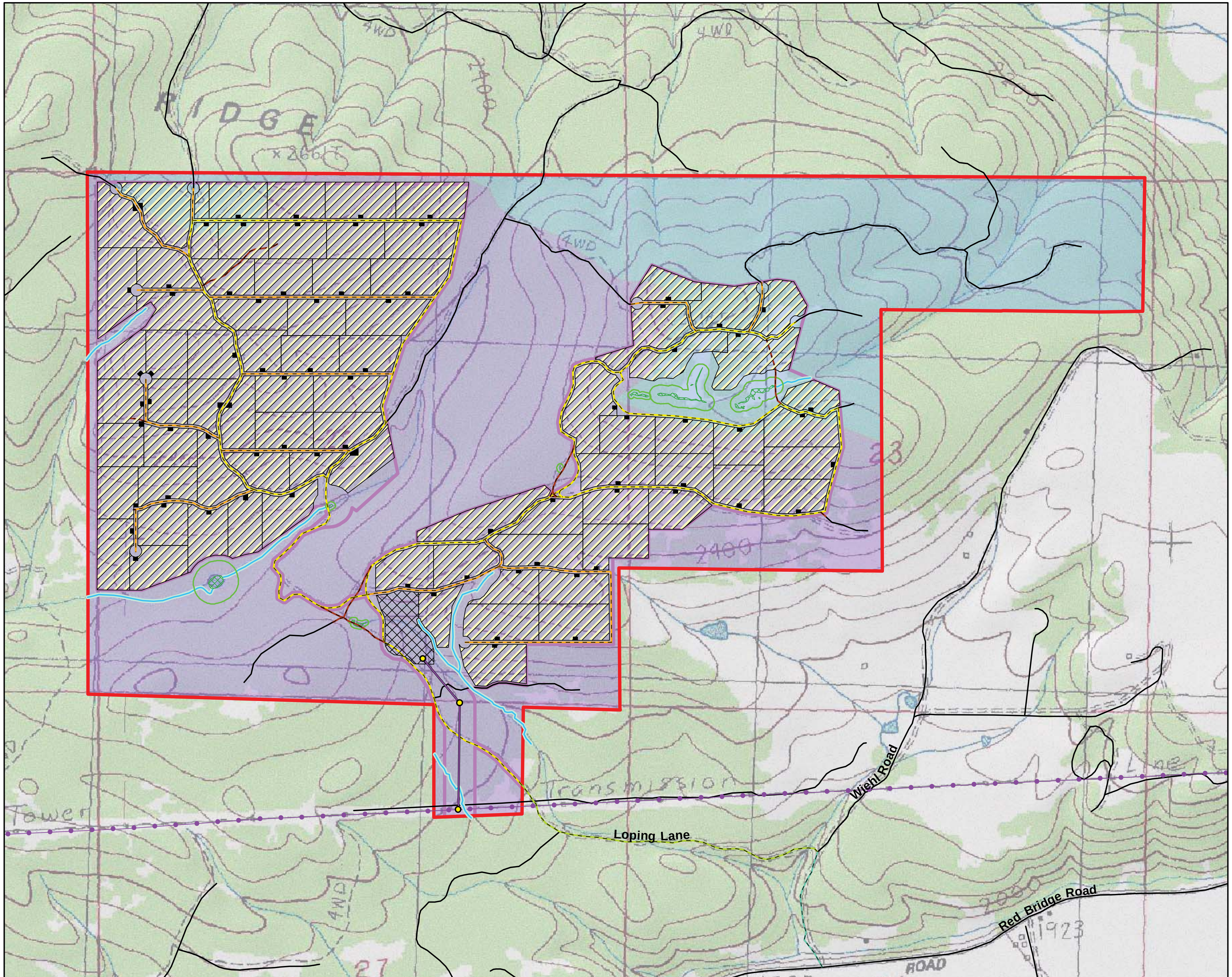


FIGURE 2
100-year Floodplain Map
Hydrologic Analysis
Teanaway Solar Reserve
Kittitas County, Washington



VICINITY MAP

LEGEND

Proposed Project Features

- Proposed Project Area (982 Acres)
- Proposed Project Site (477 acres)
- Proposed PV Array Block
- Proposed Field Inverter and Field Transformer
- Proposed Substation/O&M Facility
- Proposed Transmission Line
- Proposed Transmission Structure
- Primary Access Road
- Secondary Access Road
- Proposed Improved Existing County Access Road
- Proposed Improved Existing Private Access Road
- Existing Maintenance Road (Planned Decommissioning)

Existing Features

- Existing BPA Transmission Line and ROW
- Existing Road
- Stream
- Stream Buffer
- Wetland
- Wetland Buffer
- South Drainage Basin
- North Drainage Basin

N

0 1,000

Feet

1 inch = 1,000 feet

FIGURE 3
Proposed Site Layout with Drainage Basins

Hydrologic Analysis
Teanaway Solar Reserve
Kittitas County, Washington

\\ROSA\PROJ\AFLC\391226\GIS\MAPFILES\DRAFT\SEPA_SUPPLEMENT\HYDROANALYSIS\HA_PROPOSEDSITELAYOUT.MXD PGRONLI 5/28/2010 11:55:34

CH2MHILL

APPENDIX B

GeoEngineers Letter (October 2009)

October 5, 2009

Teanaway Solar Reserve, LLC
218 E. First Street, Suite B
Cle Elum, WA 98922

Attention: Mr. Howard Trott

Subject: Hydrologic Evaluation
(CU-09-00005)
Hydrologic Services
Teanaway Solar Reserve
Kittitas County
File No. 17700-001-01

INTRODUCTION

Teanaway Solar Reserve, LLC (TSR) proposes to construct and operate the project on approximately 982 acres of private land within the Forest and Range (F&R) zoning district in an unincorporated area of Kittitas County, Washington (see Figure 1). TSR submitted a Conditional Use Permit (CUP) and State Environmental Policy Act (SEPA) Checklist for the proposed project to Kittitas County on August 18, 2009. The application was deemed complete by the County on September 3, 2009. The public comment period on the CUP/SEPA ended on October 5, 2009. Comments were received from various state agencies and interested local parties.

This letter has been prepared on behalf of Teanaway Solar Reserve, LLC (TSR) in response to the September 16, 2009 comment letter prepared by Mark Teske of the Washington Department of Fish and Wildlife (WDFW) regarding the Teanaway Solar Reserve located in Klickitat County, Washington. The letter raised questions regarding the solar reserve's impact, if any, on flooding and erosional hazards in the vicinity of tributary streams to the Teanaway River. To address issues raised in the WDFW letter, a professional hydrologist from GeoEngineers visited the site of the proposed solar reserve, the surrounding watershed, and the drainages that emanate from the project area. The information presented in this letter is based on a review of Solar Reserve design information, a review of area topographic maps, a field reconnaissance and interviews with local residents familiar with the history of flooding issues along Red Bridge Road. This response is organized according to the topics outlined in the September 16th WDFW letter.

PROJECT DESCRIPTION

Teanaway Solar Reserve, LLC (TSR) proposes to construct and operate the project on approximately 982 acres of private land within the Forest and Range (F&R) zoning district in an unincorporated area of Kittitas County, Washington (see Figure 1). The project will generate up to 75 direct current megawatts (MWdc) of photovoltaic (PV) solar energy utilizing approximately 477 acres of land within the proposed project area. The project location was chosen for its south-facing slopes of moderate steepness, which are required for the effectiveness of the solar facilities.

Several module mounting types will be considered to best address the slope of land and soil stability at the project site. For example, large land areas with a slope toward the south are excellent for single-axis tracking systems. Land areas that are sloped to the east, southeast, west, or southwest will not as easily accommodate single-axis tracking systems, and are better suited to a fixed-tilt mounting structure.

The foundations securing the solar modules will be designed to withstand high winds and snow loads. The site may have multiple foundation types to match the ground conditions and type of mounting structures used. The mounting-system support structures could consist of embedded posts, poles, or structural steel angle. The embedment could be completed via a vibratory drill or similar installation method to depths of approximately 8 feet. Pending final design, the solar module foundations will require site work and potential boring.

The posts will not be anchored unless a patch of bedrock is encountered during installation. The embedment could be completed via a vibratory drill or similar installation method to depths of approximately 8 feet. After the posts are installed, they are held in place by friction from the surrounding soil, without the use of concrete. Driven piles develop their strength by utilizing a definable skin friction between the pile and the soil. As the pile is forced into the ground, the displaced material compresses and that, in turn, creates the friction at the pile/soil interface. Piles are typically driven to a depth that prevents seasonal and temporary changes from affecting their strength. A geotechnical engineer will determine the parameters to be used in the structural design. No concrete will be used when installing the foundations for the modules.

METHOLODOLGY

A professional hydrologist from GeoEngineers visited the site of the proposed solar reserve, the surrounding watershed, and the drainages that emanate from the project area. The information presented in this technical memorandum is based on a review of Conceptual Site Layout as presented in the CUP/SEPA application materials, topographic maps, a field reconnaissance, and interviews with local residents familiar with the history of flooding issues along Red Bridge Road.

RESULTS

A summary of the potential impacts related to the development of the solar reserve is presented below. The public comment letter from the Washington Department of Fish and Wildlife (WDFW) outlined the following concerns: impervious surfaces, January 2009 flooding, and the 303(d) listing of the Teanaway River

IMPERVIOUS SURFACES

Concern was raised by the public comments that impervious surfaces from the proposed project will intercept rain and snow.

Permanent impacts resulting from installation of the solar reserve may result from the removal of ponderosa pine trees, road construction, and placement of the panels. In terms of modification of the hydrology of the watershed, the impacts are less than a typical development consisting of structures and supporting facilities. The roads will be maintained as dirt or gravel, and no large-scale clearing or grading beyond tree removal is required for the reserve. After construction, native grasses will be restored to the disturbed areas.

Although the solar reserve panels are impervious, due to their angled orientation above the ground surface, they will not function as an impervious surface such as a roadway or flat surface at ground level. Therefore, rainwater or snow intercepted by the panels will run off the elevated surface and flow to the native soil and grasses, which will continue to serve the same drainage function that approximates the current condition. The primary effect of runoff from the solar panels will be to concentrate the natural rainfall that would naturally have fallen over a 17.5-square-foot area (individual panel dimensions are 3.5 feet by 5 feet) into a linear corridor with a length that may vary from 3.5 feet to 8.5 feet, depending on the orientation and angle of the panel at the time of a storm event. The likely impact that may result from construction of the individual solar panels would be a minor concentration of runoff at the base of each panel that could result in rilling or small-scale gully formation in extreme rainfall cases.

JANUARY 2009 FLOODING

The January 2009 flooding that occurred adjacent to the proposed project area, specifically along Red Bridge and Wiehl Roads was the result of a significant rain-on-snow event and was possibly the flood of record for the small drainages that emanate from the project area. These drainages can be characterized as ephemeral, vegetated swales. A field visit to the project area shows that the drainages that drain the project area (west and east drainage tracts shown in Figure 1) are in stable condition. No excessive erosion, lateral shifting or incision was evident in the drainages around the project site. The vegetation in the drainages acts to reduce velocity and erosional forces of water as it runs off hillslopes into concentrated areas.

The proposed project area is situated within two basins, one of which (east tract) drains to the Red Bridge Road via Wiehl Road. The condition of the channel that drains Wiehl Road shows that the channel was not significantly altered as a result of the extreme flood events in January 2009. Drainage from the west tract is routed through a stock pond, which effectively removes any peak flow from major flood events, and runs southwest into a drainage that is captured for irrigation along Masterson Road. Observations of the channel upstream and downstream of the stock pond show that the extreme flooding in January 2009 did not significantly impact the channel stability.

One of the major sources of flooding and the main source of debris onto Red Bridge Road during the January 2009 event was a small drainage that does not emanate from the project area and will not be affected by the proposed solar reserve. The unnamed drainage (shown in green on the accompanying Figure 1) is not located within the proposed project area and is hydrologically and topographically disconnected from the project area. The drainage receives flow from the hillside above and directs the runoff down a short, steep section that runs into an irrigation ditch parallel to Red Bridge Road.

According to Jesse Geiger, the homeowner across the street from the unnamed drainage, the flooding and debris flow from this drainage were a result of recent disturbance to the stream channel caused by another local valley resident. Mr. Geiger told us that another area resident had used excavating equipment to trench into and disturb the streambed of the unnamed small drainage in an effort to reroute flows into irrigation pipes and ultimately into an existing delivery system. According to Mr. Geiger, the channel was never armored or revegetated after the soil disturbance and channel realignment. As a result, high flows in January 2009 destabilized the unprotected channel and breached the weak soil dam that had been erected adjacent to Red Bridge Road. The condition of the channel upstream of the disturbed area was not subject to erosion or damage; rather, only the disturbed reach was destabilized, causing a debris torrent to spill into the road and the subsequent flooding and damage to the road. Field observations of the drainage correlate with the description of events recounted by area residents, as evidenced by comparing the condition of this drainage to the drainage adjacent to Wiehl Road.

TEANAWAY RIVER

The WDFW letter identifies that the Teanaway River is an impaired waterbody due to temperature and flow limitations as defined by the Washington State Department of Ecology (Ecology) Total Maximum Daily Load (TMDL) detailed implementation plan (DIP). According to the DIP, the sources of temperature and flow impairment in the Teanaway River are:

- Lack of streamside shade
- Increased channel width:depth ratio
- Instability of streambanks
- Lower instream flows during the summer

The proposed solar reserve will have negligible influence on any of the processes listed above. WDFW suggests that the proposed development will result in a flashier hydrograph in the drainage channels that emanate from the planned solar reserve project area and that this conversion will further impair conditions in the Teanaway River. We address issues raised by WDFW below:

TIMING OF RUNOFF

Historically, and in an undisturbed state, the ephemeral drainages emanating from the project area flow are naturally "flashy," typically resulting from short, intense rainfall or rain-on-snow events. These events are likely to occur in autumn and early winter, when flows in the Teanaway River are naturally elevated and temperatures low.

It is also important to note that, the drainages flowing from the project area either are intercepted by irrigation ditches or cross over Red Bridge Road and spread out over the fields between Red Bridge Road and Highway 970. As such, there is no direct surface water connection to the Teanaway River from these drainages.

SEDIMENT TRANSPORT

WDFW suggests that the proposed solar reserve project is expected to increase sediment load and impact salmonid egg incubation in the Teanaway River. Sediment transport from the project area to the Teanaway River is not expected to increase as a result of the detention facilities that will be put in place to offset any predicted increases in post-development sediment load. Additionally, irrigation diversions and the lack of a surface water connection limit any sediment movement to the Teanaway River except during periods of extreme flows and sediment concentrations, when the entire valley is flooding and overtopping Highway 970. Furthermore, field observations indicate that the channels routing water from the project area are in stable condition, while the major source of flooding and debris is from a drainage unaffected by the proposed project.

HYPORHEIC ZONE

Hyporheic exchange between the Teanaway River and its floodplain can be an important source of cool water during periods of low flow. However, the historically ephemeral and flashy flow from the project area stream channels likely supplied little of the total water volume in the hyporheic zone. Most of the water that emanates from the project area and adjacent basins is captured for irrigation and therefore is regulated by the irrigation schedule and ultimately enters the Teanaway River as return flows. Flows that exceed the capacity of the irrigation system or that are routed past irrigation diversions have no open channel to pass water quickly to the Teanaway River; rather, the flows spread across the fields and infiltrate into the floodplain, slowly working their way towards the river as hyporheic flows. The processes that currently supply the hyporheic zone from the project area streams will not be altered, nor will the floodplain processes of the Teanaway River be modified as a result of the proposed project.

PROPOSED MITIGATION MEASURES

While field observations indicate that native grasses are sufficiently dense to attenuate runoff, reduce rilling and gully formation, and moderate the runoff generated from intense storm events mitigation measures will still be implemented to further reduce the potential impacts. To mitigate for the potential rilling that may be associated with the solar panels, level spreaders could be applied beneath each panel to take concentrated flow and distribute it evenly back to the native ground surface beneath each panel.

CONCLUSIONS

During final design of the project, and as part of the building permit application, more detailed hydrologic analyses will be completed to design stormwater management features. The applicant proposes to have no effect on the existing hydrology leaving the project site. Any calculated increase in runoff will be managed through the use of level spreaders, infiltrating basins or detention. Runoff from the project area routes through two drainages, (labeled as the west and east tract drainages on Figure 1), one of which currently has a stock pond that can be easily modified to collect and release runoff in a manner such that the post-development runoff matches the existing hydrology. When additional analyses are completed, the applicant will utilize a continuous hydrologic model such as MGS Flood or the Western Washington Hydrology Model to accurately model the effects of the development on basin hydrology.

There is no field evidence that the landslides/debris torrents referenced in the public comment letter received from the WDFW emanated from the proposed project area. Flooding of the drainages is a natural process that occurs during extreme events such as the rain-on-snow event that occurred in January 2009. The volume and timing of surface water runoff from the project area will not increase beyond the existing condition as a result of careful planning and application of stormwater management measures where necessary. The proposed solar reserve development will not result in hundreds of acres of impervious area, as suggested by the WDFW letter. The primary cause of landslides/debris torrents seen in the January 2009 event that impacted Red Bridge Road resulted from land disturbance in drainage that is neither within, nor affected by, the proposed project.

LIMITATIONS

GeoEngineers has prepared this letter report for the exclusive use of the Teanaway Solar Reserve, LLC and their authorized agents for Hydrologic Services for the Teanaway Solar Reserve located in Klickitat County, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with the generally accepted hydrologic science practices in this area at the time this report was prepared. The conclusions and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, expressed or implied, should be understood.

APPENDIX C

Time of Concentration Calculations

Time of Concentration Worksheet

PROJECT:	Teanaway Solar Reserve Project				
BASIN	North Drainage Basin				
LOCATION:	Kittitas County, Washington				
Parameters		**Units**			**Comments**
Total length of Flow	4895	ft			
Sheet Flow Segment					
Length	100	ft			
Slope of hydraulic Grid Line - S_o	0.11	ft/ft			
n_s - Sheet flow Manning' Effective roughness coeff.	0.4				*[HEC-HMS Technical Reference Manual]*
Travel time (sheet Flow Segment) $T_1 = 0.42\,(n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	12.3	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Shallow Concentrated Flow Segment					
Length	300	ft			
S_o	0.050	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Velocity V = 16.1345(S_o)^0.5	3.61	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*
T_2 = L/(60*V)	1.4	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Pipe Flow Segment					
Length	4495	ft			Assume sheet flows empty into inlets connected to pipes.
T_3 = L/(60*V)	25.0	min			Assume pipe flow velocity of 3fps
T_c	38.7	min			

Time of Concentration Worksheet

PROJECT: Teanaway Solar Reserve Project
BASIN South Drainage Basin
LOCATION: Kittitas County, Washington

Parameters		**Units**			**Comments**
Total length of Flow	7738	ft			
Sheet Flow Segment					
Length	100	ft			
Slope of hydraulic Grid Line - S_o	0.11	ft/ft			
n_s - Sheet flow Manning' Effective roughness coeff.	0.25				*[City of Portland Stormwater Management Manual 2004 page 2-74]*
Travel time (sheet Flow Segment) $T_1 = 0.42\ (n_s L)^{0.8}/((1.58^*(S_o)^{0.4})$	8.4	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Shallow Concentrated Flow Segment					
Length	300	ft			
S_o	0.070	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Velocity $V = 16.1345(S_o)$^0.5	4.27	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*
$T_2 = L/(60^*V)$	1.2	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Pipe Flow Segment					
Length	7338	ft			Assume sheet flows empty into inlets connected to pipes.
$T_3 = L/(60^*V)$	40.8	min			Assume pipe flow velocity of 3fps
T_c	50.4	min			

Crivella, Ellen/PDX

From: Garton, Brittany/PDX
Sent: Wednesday, June 16, 2010 1:32 PM
To: Creech, Jane T. (ECY); Howie, Douglas (ECY); McKinney, Charlie (ECY)
Cc: Seidell, Nichole/PDX
Subject: Teanaway Solar Reserve: Updated Hydrology Report
Attachments: AttF_HydroAnalysis_06022010_Rev2.pdf

Jane, Charlie, and Doug-

I wanted to make sure all of you received the updated version of the Hydrology report that we submitted to the County earlier this month. Thanks for all of your help and support throughout this process. It's been a pleasure working with all of you to ensure that I completed my analysis accurately, and to the standards set out in the Eastern Washington Stormwater Management Manual. I hope you all are enjoying your summer!

Thanks again,
Brittany

Brittany Garton
Staff Engineer

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2020 South West 4th Avenue
Suite 300
Portland, OR 97201
Direct 503.736.4108
Fax 503.736.2000
www.ch2mhill.com

Crivella, Ellen/PDX

From: Seidell, Nichole/PDX
Sent: Friday, June 18, 2010 11:13 AM
To: Cooke, John T. (JT) (Perkins Coie); Ryan, Patrick W. (Perkins Coie)
Cc: Garton, Brittany/PDX
Subject: FW: TSR

Hi All,

Brittany and I just spoke to Doug Howie. He agreed that we are most conservative in the latest version of the report and indicated that he did not think there was a need to change the report analysis. he is finishing up his review and plans to have any additional comments (he doesn't anticipate any as he said he was comfortable with his level of involvement and he approach Brittany took on the rain-on-snow piece) to Jane early next week. Jane will add in any comments she has and provide us with a summary email. Doug recommended we wait until we receive that email from Jane and respond to any comments all at once. We agree that we can explain our use of the term "regional event" and that it should have read "NRCS 1A" and that regardless or the terms, the analysis is solid.

On another note, we still need to respond back to the Doug at the County on his comments. See below for a proposed response.

Doug's comment

Paragraph 2.1.1 attempts to blame the flooding on man-made activities down-gradient of the site. The quote" October 5, 2009, suggests that the cause of this flood event is most likely the result of anthropogenic activity down gradient from the project site rather than hydrologic issues on the proposed project site itself" falsely identifies anthropogenic or man-made activities to cause flooding. A clarification needs to be made that man exacerbated problems down-gradient resulting from the flooding only. Man's activities down gradient did not make it rain or make the snow melt causing flooding. Otherwise, the report seems complete. I imagine I will be receiving a final design for storm water at a later date.

Proposed TSR Response

While the letter written by GeoEngineers, Inc. on October 5, 2009 suggests that the cause of flooding in January 2009 is most likely a result of anthropogenic causes rather than hydrologic issues on the proposed project site, the exact causes of the flooding have not been determined. One of the major sources of flooding and the main source of debris on Red Bridge Road during the flooding event was a small drainage that does not emanate from the project area and will not be affected by the proposed project, as it is hydrologically and topographically disconnected from the project area. Further, the rain-on-snow analysis shows that the magnitude of runoff from a rain-on-snow event is not expected to significantly increase from construction of the project. Due to limited infiltration capacity during a rain-on-snow event, the site is expected to generate a similar volume of runoff at build-out as would be generated with the current site conditions.

Crivella, Ellen/PDX

From:	Garton, Brittany/PDX
Sent:	Friday, June 18, 2010 2:39 PM
To:	doug.dhondt@co.kittitas.wa.us
Cc:	Seidell, Nichole/PDX
Subject:	TSR- Response to Comment Provided on the Hydrology Report

Doug-

I received your comment regarding the hydrology report and provide the following in response:

While the letter written by GeoEngineers, Inc. on October 5, 2009 suggests that the cause of flooding in January 2009 is most likely a result of anthropogenic causes rather than hydrologic issues on the proposed project site, the exact causes of the flooding have not been determined. According to one study, one of the major sources of flooding and the main source of debris on Red Bridge Road during the flooding event was a small drainage that does not emanate from the project area and will not be affected by the proposed project, as it is hydrologically and topographically disconnected from the project area. Further, the rain-on-snow analysis shows that the magnitude of runoff from a rain-on-snow event is not expected to significantly increase from construction of the project. Due to limited infiltration capacity during a rain-on-snow event, the site is expected to generate a similar volume of runoff at build-out as would be generated with the current site conditions.

Please let me know if you have any other questions or comments.

Thanks,
Brittany

Brittany Garton
Staff Engineer
Water Business Group

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Paragraph 2.1.1 attempts to blame the flooding on man-made activities down-gradient of the site. The quote" October 5, 2009, suggests that the cause of this flood event is most likely the result of anthropogenic activity down gradient from the project site rather than hydrologic issues on the proposed project site itself" falsely identifies anthropogenic or man-made activities to cause flooding. A clarification needs to be made that man exacerbated problems down-gradient resulting from the flooding only. Man's activities down gradient did not make it rain or make the snow melt causing flooding. Otherwise, the report seems complete. I imagine I will be receiving a final design for storm water at a later date.

Douglas P. D'Hondt, P.E., L.E.G.
County Engineer
Kittitas County Public Works Department
411 North Ruby Street, Ste., 1
Ellensburg, WA 98926
Phone 509-962-7690
Fax 509-962-7663

doug.dhondt@co.kittitas.wa.us

Crivella, Ellen/PDX

From: Creech, Jane T. (ECY) [JTON461@ECY.WA.GOV]
Sent: Thursday, July 01, 2010 2:46 PM
To: Seidell, Nichole/PDX
Cc: McKinney, Charlie (ECY); Jamison, Lynda (ECY); Merz, Jonathan (ECY); Howie, Douglas (ECY); Espinoza, Joy (ECY); Garton, Brittany/PDX
Subject: RE: e-Copy: Correspondence sent on behalf of WA State Dept. of Ecology

Hi Nichole,

Thanks for the note. I added answers within your note below.

Please contact me if I can help with anything.

Have a great day,
Jane

Jane Creech
WA Dept of Ecology
Water Quality/Central Region
509-925-2557
jane.creech@ecy.wa.gov

From: Nichole.Seidell@ch2m.com [mailto:Nichole.Seidell@ch2m.com]
Sent: Thursday, July 01, 2010 2:31 PM
To: Espinoza, Joy (ECY); Brittany.Garton@CH2M.com
Cc: Creech, Jane T. (ECY); McKinney, Charlie (ECY); Jamison, Lynda (ECY); Merz, Jonathan (ECY); Howie, Douglas (ECY)
Subject: RE: e-Copy: Correspondence sent on behalf of WA State Dept. of Ecology

Thank you all for taking the time to provide us with this input. For clarification, do you want us to respond to the items detailed in the letter and the 13 items outlined in the attachment? Yes, please.

Can we respond to all items via a brief letter? Sure, as long as (1) you do respond to all comments and (2) the responses fully address the items (especially Doug's questions, where he requests a couple of additional calculations).

Just wanted to be sure expectations are clear and we are getting you what you find most useful.

Thanks!

From: Espinoza, Joy (ECY) [mailto:jesp461@ECY.WA.GOV]
Sent: Thursday, July 01, 2010 1:39 PM
To: Garton, Brittany/PDX; Seidell, Nichole/PDX
Cc: Creech, Jane T. (ECY); McKinney, Charlie (ECY); Jamison, Lynda (ECY); Merz, Jonathan (ECY); Howie, Douglas (ECY)
Subject: e-Copy: Correspondence sent on behalf of WA State Dept. of Ecology

Good afternoon,

Attached please find your electronic copy of correspondence sent on behalf of WA State Department of Ecology, Water Quality Program. Should you have any questions, please feel free to contact either Charles McKinney, Section Manager at 509/457-7107 or Jane Creech, TMDL Coordinator at 509/925-2557.

Thank you,

Joy Espinoza
Secretary for the Water Quality Program
Department of Ecology - Central
509-454-7888

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
15 W Yakima Ave, Ste 200 • Yakima, WA 98902-3452 • (509) 575-2490

July 1, 2010

Brittany Garton and Nichole Seidell
CH2M Hill
2020 Southwest 4th Avenue, 3rd Floor
Portland, OR 97201-4958

Dear Brittany and Nichole,

Thank you for giving the Washington State Department of Ecology (Ecology) the opportunity to review and comment on the Additional Information Submittal materials, which are added to the application for a Conditional Use Permit for the Teanaway Solar Reserve (TSR).

Doug Howie, Ecology stormwater engineer, prepared comments on the hydrologic analysis portion of the submittal, with accompanying spreadsheets (see attachments).

As you know, the *Teanaway Temperature TMDL* protects hyporheic recharge to the river in order to ensure adequate flows during the late summer/early fall low-flow period. We note that you intend to design and install best management practices (BMPs) that will "collect runoff from a developed area and release it at a slower rate than it would typically run off the site." What does "typically" mean here? Please be more specific in your description of BMPs to ensure that post-construction site hydrology will remain virtually unchanged from pre-construction site hydrology, which includes appropriate absorption of water into hillside soils during the wet times of the year.

Additionally, the October 5, 2009 letter from GeoEngineers states that the flows from the project site likely provided little of the water in the hyporheic zone, and that most of the water in the hyporheic zone comes from runoff captured from the proposed project site and used for agricultural purposes. We do not completely agree with this analysis, especially regarding the north basin. Saturated soils on hillslopes also have a substantial influence on hyporheic recharge.

Please respond to these comments through a letter addressing each comment, rather than producing another hydrologic analysis. Because a new report will be needed during the project design phase, it is not necessary to develop a new report at this time.

Feel free to contact me with any questions at 509-457-7107 or cmck461@ecy.wa.gov, or you can contact Jane Creech at 509-925-2557 or jton461@ecy.wa.gov.

Sincerely,

Charles McKinney

Charles McKinney
Section Manager
Water Quality Program

Attachments

cc: Dan Valoff, Kittitas County Community Development Services
Doug D'Hondt, Kittitas County Public Works
Jon Merz, WA Dept of Ecology
Lynda Jamison, WA Dept of Ecology
Doug Howie, WA Dept of Ecology
Jane Creech, WA Dept of Ecology

ATTACHMENT #1

Comments from Doug Howie (WA Dept of Ecology) on Teanaway Solar Reserve Hydrologic Analysis Kittitas County, Washington, June 2010, prepared by CH2M-Hill.

1. The proper name for the Department of Ecology (Ecology) stormwater manual is "Stormwater Management Manual for Eastern Washington (SWMMEW)" not "Eastern Washington Stormwater Management Manual". Please reference the correct name.
2. Please show the two basin boundaries on the Figure that shows the project boundary. It is difficult to see what part of drainage basin is the project site and what part is outside the project site.
3. I had difficulty confirming the developed CN from the tables you provided. Please show how the CNs of 73 and 76 were calculated.
4. The 3-hour storm should not use the "NRCS storm distribution Type IA" as stated in the second paragraph of section 5.0. Ecology developed and presented the 3-hour storm hyetograph in the SWMMEW. I ran the simulations using the correct 3-hour storm hyetograph and obtained higher peak flows than those shown in the report (see Attachment #2, *3-hour storm.pdf).* The peak flows for the 3-hour storm are lower than those obtained in the longer rainfall simulations. Please use the correct hyetograph during the design process.
5. There is confusion with the 24-hour storm. The report references the NRCS Type IA storm and the "Regional Storm" as if they are the same thing. The NRCS Type IA storm is a 24-hour storm that has been developed for the western portion of Washington and Oregon. Rainfall amounts used in simulations of the Type IA storm are selected directly from precipitation maps. The "Regional Storm" for the Cle Elum area is a 36-hour storm and the hyetograph for the storm is shown in Table 4.2.5 of the SWMMEW. To use this storm you need to multiply the 24-hour rainfall by 1.16 to get the 36-hour rainfall.
6. As a result of the confusion, a simulation with the Type IA storm was run with a rainfall that is 16% higher than required. Thus, there appears to be a composite simulation of the rainfall for the 36-hour "Regional Storm" and the hyetograph for the NRCS Type IA storm. I ran an analysis with the Type IA storm with the increased rainfall and matched the numbers in the report (see Attachment #3, *Type IA CH_Ecol mult.pdf*).
7. If you run the analysis with either the Type IA storm and the correct 24-hour rainfall (see Attachment #4, *Type 1A CH mult_Ecol act.pdf*) or the Region 1 storm with the increased rainfall (see Attachment #5, *CH Type IA mult_Ecol regional mult.pdf*), the resulting peak flow rates are lower than the values in the report. Therefore, it appears the numbers in the report, while not strictly accurate, are conservative and indicate a larger impact than would be seen with either of the Type IA or Region 1 storm using the correct rainfall amount. Rainfall volumes are based on the amount of rainfall, and by using the increased rainfall for the analysis in the report shows a higher volume than would be seen when using the correct rainfall.

8. In various locations, text in the report shows the return event information (i.e. 10-year) for a storm but doesn't identify the length of the rainfall. Please use the full identification of the storm i.e. 10-year, 24-hour storm.
9. When the analysis is run during the design phase of the project, please use the NRCS Type IA storm with the correct rainfall amount.
10. In section 5.1, a reference is made to development of the "Stormwater Pollution Prevention Plan". In accordance with the SWMMEW, you are required to develop a "Stormwater Site Plan (SSP)" which includes analysis of both Construction and Permanent BMPs for the site. The SSP lists eight Core Elements that must be addressed and submitted to the local jurisdiction.
11. Please identify the units for the variables in the rain on snow equation on page 12.
12. In the Summary section the statement "stormwater BMPs will be implemented if necessary" appears. Stormwater BMPs of some type must be implemented on this project to provide water quality treatment and control runoff.
13. I did not find any problem with the analysis done by CH2M-Hill for rain on snow.

ATTACHMENT #2

3-hour storm.pdf

Peak Discharge calculated by Ecology (DCH) using HEC-HMS

Basin	2yr-3hr			10yr-3hr			100yr-3hr		
	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ
Existing									
North	-	-	#DIV/0!	2.04	0.72	183.3%	33.60	24.71	36.0%
South	-	-	#DIV/0!	4.48	1.92	133.3%	82.41	58.90	39.9%
Proposed									
North	0.02	0.05	-60.0%	3.40	1.01	236.6%	37.44	29.40	27.3%
South	0.22	0.53	-58.5%	21.08	10.36	103.5%	125.33	109.23	14.7%
Increase									
North	0.02	0.05	-60.0%	1.36	0.29	369.0%	3.84	4.69	-18.1%
South	0.22	0.53	-58.5%	16.60	8.44	96.7%	42.92	50.33	-14.7%
Percent Increase									
North	#DIV/0!	#DIV/0!	#DIV/0!	66.7%	40.3%	65.5%	11.4%	19.0%	-39.8%
South	#DIV/0!	#DIV/0!	#DIV/0!	370.5%	439.6%	-15.7%	52.1%	85.4%	-39.1%

% Difference is based on (Ecology-CH2M-Hill)/CH2M-Hill

ATTACHMENT #3

Type IA CH_Ecol mult.pdf

Peak Discharge calculated by Ecology (DCH) using HEC-HMS
Ecology Uses Type IA storm with Regional Rainfall (1.16 multiplier)

Basin	10 yr Storm			25 yr Storm			100 yr Storm		
	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ
Existing									
North	21.77	21.77	0.0%	39.85	39.85	0.0%	71.52	71.54	0.0%
South	55.98	55.96	0.0%	102.02	102.01	0.0%	183.87	183.89	0.0%
Proposed									
North	24.77	24.78	0.0%	43.75	43.77	0.0%	76.49	76.53	-0.1%
South	89.52	89.52	0.0%	144.33	144.34	0.0%	237.34	237.38	0.0%

% Difference is based on (Ecology-CH2M-Hill)/CH2M-Hill

CH2M-Hill used 1.16 times 24-hour storm rainfall and the Type 1A storm
Ecology used 1.16 times 24-hour storm rainfall and the Type 1A storm

ATTACHMENT #4

Type 1A CH mult_Ecol act.pdf

Peak Discharge calculated by Ecology (DCH) using HEC-HMS
Ecology Uses Type IA Storm

Basin	10 yr Storm			25 yr Storm			100 yr Storm		
	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ
Existing									
North	11.62	21.77	-46.6%	24.58	39.85	-38.3%	49.19	71.54	-31.2%
South	30.43	55.96	-45.6%	63.16	102.01	-38.1%	125.76	183.89	-31.6%
Proposed									
North	13.89	24.78	-43.9%	27.85	43.77	-36.4%	53.41	76.53	-30.2%
South	56.43	89.52	-37.0%	98.36	144.34	-31.9%	170.07	237.38	-28.4%

% Difference is based on (Ecology-CH2M-Hill)/CH2M-Hill

CH2M-Hill used 1.16 times 24-hour storm rainfall with the Type 1A storm
Ecology used actual 24-hour rainfall (CH2M value/1.16)

ATTACHMENT #5

CH Type IA mult_Ecol regional mult.pdf

Peak Discharge calculated by Ecology (DCH) using HEC-HMS
Ecology Uses 36-hr Regional Storm

Basin	10 yr Storm			25 yr Storm			100 yr Storm		
	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ	Ecology Regional	CH2M	% Differ
Existing									
North	15.27	21.77	-29.9%	25.19	39.85	-36.8%	41.96	71.54	-41.3%
South	40.32	55.96	-27.9%	66.66	102.01	-34.7%	111.50	183.89	-39.4%
Proposed									
North	16.84	24.78	-32.0%	27.09	43.77	-38.1%	44.29	76.53	-42.1%
South	57.86	89.52	-35.4%	87.84	144.34	-39.1%	137.11	237.38	-42.2%

% Difference is based on (Ecology-CH2M-Hill)/CH2M-Hill

CH2M-Hill used 1.16 times 24-hour storm rainfall with the Type 1A storm
Ecology used CH2M rainfall value and the Regional Storm hyetograph

July 26, 2010

Charles McKinney
15 W Yakima Ave, Ste 200
Yakima, WA 98902-3452

Subject: Response to Department of Ecology Comments Provided on the Additional Submittal Materials Teanaway Solar Project Hydrologic Analysis

Dear Charlie,

Thank you for giving CH2M HILL the opportunity to respond to the comments the Department of Ecology (Ecology) provided on July 1, 2010 regarding the Additional Information Submittal materials, which supplemented the application for a Conditional Use Permit for the Teanaway Solar Reserve (TSR) (Attachment 1). As requested, responses are provided below to each individual comment that was provided by Ecology. Comments are numbered, with responses written in italics following each comment.

1. The proper name for the Department of Ecology (Ecology) stormwater manual is "Stormwater Management Manual for Eastern Washington (SWMMEW)" not "Eastern Washington Stormwater Management Manual." Please reference the correct name.

All references made to the "Eastern Washington Stormwater Management Manual" in the Teanaway Solar Reserve Hydrologic Analysis from June 2010 are meant to reference the Stormwater Management Manual for Eastern Washington. In future reports and analyses, the proper name for the document will be used.

2. Please show the two basin boundaries on the Figure that shows the project boundary. It is difficult to see what part of drainage basin is the project site and what part is outside the project site.

The proposed project site is defined at 477 acres, and the project area is 982 acres. The North drainage basin encompasses 259 acres, of the project area and the South drainage basin encompasses the remaining 723 acres. The basins within the project area are illustrated in purple and blue on Figure 3 (see attached).

3. I had difficulty confirming the developed CN from the tables you provided. Please show how the CNs of 73 and 76 were calculated.

The CNs developed for the project were based on hydrologic soil group and vegetative cover type from Technical Release 55: Urban Hydrology for Small Watersheds (NRCS,1986). All soils within the project area are in hydrologic soil group C. The woods-grass combination was used to determine the *existing curve number for the site. The existing site's CN of 72 was computed for an area with 50 percent woods and 50 percent grass (pasture) cover in good condition. Tables 1 and 2 tables included below show the numbers used as a basis for calculating the composite CN for existing and proposed conditions.*

Table 1: Curve Number Calculations for Existing Conditions

Drainage Basin	Vegetated Cover Classification	Area (ac)	Curve Number Used
North Drainage Basin			
	Herbaceous Wetlands	0.59	100
	Open Water	0.03	100
	Ponderosa Pine Forest and Woodlands	258.39	72
	Composite Curve Number		**72**
South Drainage Basin			
	Herbaceous Wetlands	0.07	100
	Open Water	0.78	100
	Ponderosa Pine Forest and Woodlands	707.72	72
	Riparian	13.00	74
	Upland Aspen	1.42	41
	Composite Curve Number		**72**

Table 2: Curve Number Calculations for Proposed Conditions

Drainage Basin	Vegetated Cover Classification	Area (ac)	Curve Number Used
North Drainage Basin			
	Natural Site Conditions (50% woods, 50% grass)	212.16	72
	Roads (Gravel)	2.55	89
	Impervious Area	0.06	98
	Grassland in Fair Condition (Array Field)	44.23	79
	Composite Curve Number		**73**
South Drainage Basin			
	Natural Site Conditions (50% woods, 50% grass)	347.88	72
	Roads and Substation Area (Gravel)	19.54	89
	Impervious Area	0.81	98
	Grassland in Fair Condition (Array Field)	354.77	79
	Composite Curve Number		**76**

4. The 3-hour storm should not use the "NRCS storm distribution Type IA" as stated in the second paragraph of section 5.0. Ecology developed and presented the 3-hour storm hyetograph in the SWMMEW. I ran the simulations using the correct 3-hour storm

hyetograph and obtained higher peak flows than those shown in the report (see Attachment 2, 3-hour storm.pdf). The peak flows for the 3-hour storm are lower than those obtained in the longer rainfall simulations. Please use the correct hyetograph during the design process.

CH2M HILL received guidance on the 3-hour storm calculations from Ecology during the period between the first submittal of the Hydrologic Report (February 2010) and the updated submittal of the Hydrologic Report (June 2010). The Hydrologic Report (June 2010) misstates the storm distribution used. The design storm distribution that was used was the 3-hour short duration storm distribution as shown in the Stormwater Management Manual for Eastern Washington. The correct hyetograph, as referenced in the SWMMEW, will be applied during the design process.

5. There is confusion with the 24-hour storm. The report references the NRCS Type IA storm and the "Regional Storm" as if they are the same thing. The NRCS Type IA storm is a 24-hour storm that has been developed for the western portion of Washington and Oregon. Rainfall amounts used in simulations of the Type IA storm are selected directly from precipitation maps. The "Regional Storm" for the Cle Elum area is a 36-hour storm and the hyetograph for the storm is shown in Table 4.2.5 of the SWMMEW. To use this storm you need to multiply the 24-hour rainfall by 1.16 to get the 36-hour rainfall.

CH2M HILL discussed this issue with Doug Howie at Ecology on June 18th, 2010. What is referred to as the regional storm event in the Hydrologic Analysis (June 2010) is in fact an NRCS Type 1A storm with precipitation depths 16% higher than required. CH2M HILL agrees with Doug that by utilizing the methodology presented in the report, the numbers presented in the report, are more conservative than they would have been if either the NRCS Type 1A or Regional Storm methods were used. CH2M HILL notes that in future analyses and reports, the NRCS Type 1A storm will be used with the required precipitation depths from the isopluvial maps (not increased by 16%), and the correct storm name will be referenced.

6. As a result of the confusion, a simulation with the Type IA storm was run with a rainfall that is 16% higher than required. Thus, there appears to be a composite simulation of the rainfall for the 36-hour "Regional Storm" and the hyetograph for the NRCS Type IA storm. I ran an analysis with the Type IA storm with the increased rainfall and matched the numbers in the report (see Attachment 3, Type IA CH_Ecol mult.pdf).

See response to comment #5.

7. If you run the analysis with either the Type IA storm and the correct 24-hour rainfall (see Attachment 4, Type 1A CH mult_Ecol act.pdf) or the Region 1 storm with the increased rainfall (see Attachment 5, CH Type IA mult_Ecol regional mult.pdf), the resulting peak flow rates are lower than the values in the report. Therefore, it appears the numbers in the report, while not strictly accurate, are conservative and indicate a larger impact than would be seen with either of the Type IA or Region 1 storm using the correct rainfall amount.

Rainfall volumes are based on the amount of rainfall, and by using the increased rainfall for the analysis in the report shows a higher volume than would be seen when using the correct rainfall.

See response to comment #5.

8. In various locations, text in the report shows the return event information (i.e. 10-year) for a storm but doesn't identify the length of the rainfall. Please use the full identification of the storm i.e. 10-year, 24-hour storm.

In future reports and analyses, the full identification of the storm (i.e. 10-year, 24-hour storm) will be used.

9. When the analysis is run during the design phase of the project, please use the NRCS Type IA storm with the correct rainfall amount.

See response to comment #5.

10. In section 5.1, a reference is made to development of the "Stormwater Pollution Prevention Plan". In accordance with the SWMMEW, you are required to develop a "Stormwater Site Plan (SSP)" which includes analysis of both Construction and Permanent BMPs for the site. The SSP lists eight Core Elements that must be addressed and submitted to the local jurisdiction.

CH2M HILL notes that a Stormwater Site Plan will need to be developed and submitted to Ecology for approval prior to development and as a part of the permitting process for the project. The Stormwater Site Plan will be used to demonstrate compliance with the applicable core elements and developed as outlined in the Stormwater Management Manual for Eastern Washington.

11. Please identify the units for the variables in the rain on snow equation on page 12.

The units are as follows:

P = Precipitation (measured in inches)
I= Impervious Fraction
R= Runoff (measured in inches)

12. In the Summary section the statement "stormwater BMPs will be implemented if necessary" appears. Stormwater BMPs of some type must be implemented on this project to provide water quality treatment and control runoff.

BMPs will be implemented on this project to control runoff as stipulated by the local and state regulatory authorities. Specific stormwater BMPs will be chosen based on site-specific conditions during design and on their ability to function with and protect the natural watershed. Specific BMPs will be outlined in the National Pollutant Discharge Elimination System (NPDES) permit and the Stormwater Pollution PreventionSite Plan (SWPPP) also referred to as a Stormwater Site Plan that will be submitted for approval to the Washington State Department of Ecology prior to construction of the project.

13. I did not find any problem with the analysis done by CH2M-Hill for rain on snow.

Noted.

14. As you know, the Teanaway Temperature TMDL protects hyporheic recharge to the river in order to ensure adequate flows during the late summer/early fall low-flow period. We note that you intend to design and install best management practices (BMPs) that will "collect runoff from a developed area and release it at a slower rate than it would typically run off the site". What does "typically" mean here?

The intent of the statement was to establish the preference of infiltration and retention BMPs rather than a "typical" detention-style system that may match pre-project peak release rates but provide limited protection of hyporheic discharge. Infiltration and retention BMPs may also alleviate existing flood risks to downbasin landowners.

15. Please be more specific in your description of BMPs to ensure that post-construction site hydrology will remain virtually unchanged from per-construction site hydrology, which includes appropriate absorption of water into hillside soils during wet times of the year.

See response to comment #12.

16. Additionally, the October 5th, 2009 letter from GeoEngineers states that the flows from the project site likely provided little of the water in the hyporheic zone, and that most of the water in the hyporheic zone comes from runoff captured from the proposed project site and is used for agricultural purposes. We do not completely agree with this analysis, especially regarding the north basin. Saturated soils on hillslopes also have a substantial influence on hyporheic recharge.

Comment noted. Please note that the GeoEngineers letter was referenced only for purposes of interviews conducted regarding the January 2009 flood event. No part of the GeoEngineers letter was used to develop the hydrologic analysis presented in the CH2M HILL June 2, 2010 report.

Feel free to contact me with any questions at 503-872-4803 or nichole.seidell@ch2m.com. Thanks again for the opportunity to provide responses to comment

Sincerely,

CH2M HILL

N Seidell

Nichole Seidell
Project Manager

c: Jane Creech
Douglas Howie

Crivella, Ellen/PDX

From: Howie, Douglas (ECY) [doho461@ECY.WA.GOV]
Sent: Friday, July 30, 2010 7:56 AM
To: Seidell, Nichole/PDX
Cc: Creech, Jane T. (ECY); McKinney, Charlie (ECY)
Subject: RE: Teanaway Solar Reserve- Phone Call on July 29, 2010

Nicole:

I agree with the description of what is needed for the final design for the Teanaway Project stormwater treatment and control facilities that you provide in the text below. Please work with your client to ensure that this requirement is presented to the people who are doing the final design and that the final design must be in compliance with the Stormwater Management Manual of Eastern Washington.

Thank you for making time available to discuss this issue.

Douglas C. Howie, P.E.
Stormwater Engineer
Department of Ecology, Water Quality Section
300 Desmond Dr. SE; PO Box 47600
Olympia, WA 98504-7600
(360) 407-6444 (voice)
douglas.howie@ecy.wa.gov

From: Nichole.Seidell@ch2m.com [mailto:Nichole.Seidell@ch2m.com]
Sent: Thursday, July 29, 2010 4:47 PM
To: Howie, Douglas (ECY)
Cc: Creech, Jane T. (ECY); McKinney, Charlie (ECY)
Subject: Teanaway Solar Reserve- Phone Call on July 29, 2010

Hi Doug,

Thanks for taking the time to talk with us today regarding the Teanaway Project.

Per our discussion today, we concur that design of any facilities to manage water quantity or quality on the site must accommodate all drainage from the contributing basin, including those areas not within the project site, either by appropriately sized facilities onsite or conveyance around the project.

Again, we appreciate you taking the time to provide such a thorough review.

Please give me a call if you have any questions!

Nichole Seidell
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