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MEMORANDUM

To: Swinomish Indian Tribal Community
11404 Moorage Way
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From: Joel Massmann, Ph.D., P.E.

Date: April 17, 2014

Subject: Ground Water Recharge Suitability Assessment, Fisher Creek Basin
Technical Report – Preliminary Draft
Skagit River Basin Ground Water Mitigation Recharge Program
Skagit County, Washington
Prepared for Upper Skagit Indian Tribe
Prepared by Associated Earth Sciences, March 12, 2014

A. Overview and Summary

This memorandum provides a review of the Associated Earth Sciences (AESI) Technical Report dated March 12, 2014, as referenced above. The AESI Preliminary Draft Report presents the results of their evaluation of "*ground water recharge suitability for the purposes of enhancing instream flow in Fisher Creek and mitigation for rural residential water use in the Fisher Creek basin*" (page 1, paragraph 1).

The study described in the report is one part of demonstration project that will include two components. These two components are 1*) development of a managed ground water recharge project to enhance current instream flows in the Fisher Creek basin and to offset flow-related impacts from new ground water uses, and 2) creation of mitigation credit program to recover the costs of the ground water recharge project* (page 1, paragraph 2).

Comments and recommendations regarding the report are provided below.

B. Overall project concept and constraints

The overall project concept as described in the report is somewhat ambiguous. It is not clear, based on the draft report, if this is meant to be a groundwater recharge project or a stream-flow augmentation project. The first section of the report indicates that the purpose is "*to evaluate the potential to develop a ground water recharge project that would capture runoff in the project area during high-flow periods and release the water into an infiltration facility to recharge ground water"* (page 1, paragraph 3). The last section of the report discusses releasing flows directly into the creek or to wetlands adjacent to the creek.

Is the intent of this project to consider discharges directly to the creek or to wetlands? Would these be considered viable and accepted approaches for mitigating impacts from groundwater withdrawals? If so, then it would seem a larger suite of potential sites could be identified. Furthermore, a significantly different set of evaluations and data needs would also be warranted if these direct discharges are acceptable. If these approaches involving direct discharge are not viable or accepted, then why are they discussed in the report?

The report should clarify objectives and explicitly address whether projects or sites with direct discharge to the creek or wetlands are to be considered.

C. <u>Connection between the groundwater recharge and mitigation credits</u>

The goal of the project described in this report is to demonstrate if a managed ground water recharge can provide enhanced streamflow which will effectively mitigate for ground water development (page 2, paragraph 2)

The draft report does not describe or discuss the information that may be needed to connect groundwater recharge efforts with potential mitigation credits. Whether or not mitigation is intended to be "water-for-water," in place, and in time, should be considered in evaluating the feasibility of the overall approach and in identifying potential demonstration sites. The data requirements for demonstrating in-place and in-time mitigation are significant and should be factors in identifying potential sites.

The report should clarify if mitigation is intended to be "water-for-water," in place, and in time. If so, then the report should identify the data requirements for demonstrating when and where the managed groundwater recharge would enter the stream and be available for mitigation. These data needs would be as important as basic information needed to evaluate recharge potential. If mitigation is not intended to be "water-for-water," in place, and in time, then this should be clearly stated and reflected in the approach used to identify potential groundwater recharge locations.

D. <u>Hydraulic continuity within the Fisher Creek watershed</u>

The draft report repeatedly asserts that there is "hydraulic separation" or "limited hydraulic continuity" between permeable units at various depths within the Fisher Creek watershed. The implications of these assertions include 1) pumping from deeper depths will not affect flow in Fisher Creek, and 2) recharge into shallow aquifers will not leak into deeper depths. Examples of the statements from the draft report related to these issues are provided below.

- *The glacial till confining unit (Qgtv) creates significant hydraulic separation between the advance outwash aquifer and the surficial outwash aquifer for a vast majority of the project area. This hydraulic separation means that ground water withdrawals from the advance outwash aquifer likely have limited impact on the surface water bodies, including Fisher Creek and its tributaries, in hydraulic continuity with the surficial outwash aquifer* (page 12, last paragraph).

- *Significant hydraulic separation between the interglacial alluvial aquifer and the surficial outwash aquifer is present throughout the project area by one or more confining units* (page 13, paragraph 3).

- *There is no significant hydraulic connection between this aquifer and the surficial outwash aquifer present in the upland area, and there may be very limited interaction between the aquifer and the alluvial sediments in the Skagit River valley* (page 13, paragraph 5).

- *Ground water supplies in the Fisher Creek basin are generally derived from aquifers with limited hydraulic continuity with surface waters in the basin and represent a small percentage of the overall water budget in the basin* (page 14, paragraph 2).

- *As discussed above, there is generally significant hydraulic separation between these deeper aquifers and the surficial outwash aquifer that is in presumed hydraulic continuity with Fisher Creek* (page 14, paragraph 4).

- *Ground water in the advance outwash aquifer likely discharges predominantly into the alluvium in the Skagit River valley as the Vashon advance outwash sediments (Qgav) are truncated at the valley margin (Figure 7A)* (page 12, last paragraph).

These statements are contradicted by results from the recent USGS modeling study.[1] For example, the USGS developed simulations to evaluate effects of extraction wells that are placed in deeper layers. These wells reduce discharge to streams within the sub-basins and they reduce discharge to the Skagit River Valley. The USGS simulations show that increasing residential withdrawals in deeper wells results mostly in reduced discharge to streams (approximately 75% of the increased pumping). The decrease in outflow to the Skagit River Valley (approximately 24% of the increased pumping) is considerably

[1]Johnson, K.H., and Savoca, M.E., 2010, *Numerical Simulation of the Groundwater-Flow System in Tributary Subbasins and Vicinity, Lower Skagit River Basin, Skagit and Snohomish Counties, Washington*, U.S. Geological Survey Scientific Investigations Report 2010-5184, Version 1.1 March 2011.

smaller than the change in discharge to streams (Johnson and Savoca, Table 12, p. 63). These percentages demonstrate hydraulic continuity between shallow and deeper deposits.

The USGS model represents the best available science for quantitatively describing hydraulic continuity within the Fisher Creek watershed. The AES draft report does not provide a better alternative for quantifying hydraulic continuity and does not provide any analysis or data to support their assertions that ground water withdrawals from the advance outwash aquifer and deeper aquifers will have limited impact on streams and other surface water features.

The report should be revised to quantitatively justify the assertion that there is limited hydraulic continuity between shallow and deeper aquifers or the report should be revised to reflect the results from the best available science for describing hydraulic continuity.

E. Low flow within Fisher Creek as compared to other watersheds

The draft report suggests that base flows in Fisher Creek are small relative to streams in other watersheds:

> *Flows are typically very low (approximately 0.5 – 1 cfs) during the dry summer and early fall months. This low baseflow range is indicative of a watershed with relatively little ground water contribution to the stream. Typically, ground water discharge to the stream during the dry season is what maintains streamflow during that period. This observation is consistent with our understanding of the surficial outwash aquifer. Due to its relatively thin and discontinuous nature, the surficial outwash aquifer can only provide limited baseflow in Fisher Creek and its tributaries* (page 16, paragraph 2).

The assertion that the hydrogeology in the Fisher Creek watershed results in flows during the summer and early fall that are uniquely low is not supported by data from other streams in western Washington. The USGS analyzed data from 65 continuous streamflow-gaging stations in western Washington with 7 or more years of daily streamflow records.[1] These data were collected from natural or otherwise unimpaired streams (i.e., streams without anthropogenic alterations such as flow regulation or diversions). The following regression model was developed for estimating the 7Q10 low-flow statistic using basin area (A) and mean annual precipitation (P):

$$7Q10 = 8.48 \times 10^{-4}(A^{1.17}\ P^{1.23})$$

[1] Curran, C.A., Eng, Ken, and Konrad, C.P., 2012, *Analysis of low flows and selected methods for estimating low-flow characteristics at partial-record and ungauged stream sites in western Washington*: U.S. Geological Survey Scientific Investigations Report 2012-5078, 46 p.

The estimated 7Q10 for Fisher Creek at the location of USGS Gauge #12200701 is 0.64 cfs. This is calculated assuming drainage area, A, equal to 6.3 mi^2 and annual precipitation, P, equal to 37.9 in/yr. These values were derived for the gauge location using the USGS StreamStat database and website.[1]

It should be noted that this estimate is for Fisher Creek under natural conditions without any diversions. The observed lowest flow from the 2006-2008 data collected at USGS Gauge #12200701 is approximately 0.4 cfs. If there were no diversions or flow regulation, then the observed low-flow value would be larger than this and would likely be similar to what is observed in other drainage basins with similar areas and precipitation values. This suggests that the aquifers that provide baseflow to Fisher Creek may not be uniquely thin or discontinuous, relative to other watersheds in western Washington.

F. Estimating the required quantity of mitigation water

Chapter 7 in the draft report describes the approach used to estimate the required quantity of mitigation water. The projected annual water demand is presented in Table 7 in the draft report. Comments related to these estimates are provided below.

1. Rates of development

The projected number of new dwellings was estimated assuming future development will occur at a rate similar to what occurred within Skagit and Snohomish Counties between 2001 and 2011 (page 25, paragraph 2). It is not clear how representative this time period is, given that this decade included the "Great Recession" between 2007 and 2009. Other rates of development should be considered.

2. Parcels that fall fully or partially outside of the Fisher Creek basin

Parcels that straddled the Fisher Creek basin but that were located primarily outside the basin boundary were removed from the analysis (page 21, paragraph 3). Parcels that were outside but near the boundary were not considered. Groundwater wells that are located partially or completely outside of the Fisher Creek surface water basin may still impact streamflow within the basin. The USGS model provides an approach for estimating these impacts.

3. Estimates of the number of new dwellings

The water demand estimates are based on the projected number of future new dwellings. The number of new dwellings projected after 50 years is 171. It is not clear how this estimate was calculated, based on the information provided in the draft report.

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[1] U.S. Geological Survey, 2010, *StreamStats: U.S. Geological Survey database*, accessed March 31, 2014, at http://water.usgs.gov/osw/streamstats/Washington.html

The estimated annual number of new dwellings was calculated as percentage of the available potential dwellings in a given year (page 25, paragraph 2). The percentage used for Skagit County was 2% and the percentage used for Snohomish County was 1.5%. The number of potential new dwellings is presented in Table 4 in the draft report and ranges from a low of 395 to a high of 698.

Table 1 below compares the estimated number of new dwellings from AES Table 5 with estimates developed using my understanding of the approach used by AES. Table 2 gives more detailed calculations for the first 10 year increment. It is not clear how AES derived the values include in their Table 5.

An alternative model for estimating the number of new dwellings is to assume that annual growth is based on a percentage of existing dwellings, rather than on a percentage of the available potential new dwellings. This approach is more commonly used by water utilities in estimating future growth. The results from this approach assuming a growth rate of 1.75% per year are included in Table 1 below.

Additional detail regarding the calculations behind the estimates provided in the AES report should be provided. Ranges of values for estimates should be provided, based on uncertainties in relevant input assumptions. These uncertainties include the maximum potential new dwellings and the development rate.

Table 1. Estimated number of new dwellings

	AES Table 5	Lower Estimate[1]	Higher Estimate[2]	Alternative Model[3]
10-year	45	64	113	81
20-year	85	118	208	177
30-year	124	162	287	291
40-year	151	200	354	427
50-year	171	232	409	588

[1]Assumes 395 maximum potential new dwellings with 1.75% development rate
[2]Assumes 696 maximum potential new dwellings with 1.75% development rate
[3]Assumes growth rate of 1.75% per year with initial dwellings equal to 426

Table 2. Details used to develop estimates for the first 10 year increment

Lower Estimate[1]				Upper Estimate[2]		
Available	Developed[3]	Sum[3]	**Year**	Available	Developed[3]	Sum[3]
395			**0**	698		
388	7	7	**1**	686	12	12
381	7	14	**2**	674	12	24
375	7	20	**3**	662	12	36
368	7	27	**4**	650	12	48
362	6	33	**5**	639	11	59
355	6	40	**6**	628	11	70
349	6	46	**7**	617	11	81
343	6	52	**8**	606	11	92
337	6	58	**9**	595	11	103
331	**6**	**64**	**10**	**585**	**10**	**113**

[1]Assumes 395 maximum potential new dwellings with 1.75% development rate
[2]Assumes 696 maximum potential new dwellings with 1.75% development rate
[3]Values are calculated using two significant digits and then rounded

4. Effects of future sewer lines

The annual consumptive water demand was calculated based on a 50% return flow per dwelling (page 26, Table 5). This assumes that septic systems will be used in perpetuity. The potential effects of future sewer lines on mitigation requirements should be considered and discussed.

5. Timing of recharge and mitigation requirements

The required mitigation quantity was calculated by assuming a 164-day mitigation period (page 27, paragraph 2). This assumes that it is possible to exactly mitigate for these 164 days. This approach might be reasonable if mitigation were to occur as direct discharge to the stream from some surface storage facility, but it is not reasonable if mitigation occurs via infiltration and recharge to groundwater. Much more water would be required to insure that water is available to the stream for the 164 days, and to mitigate impacts in the tributaries.