To: Mr. John Urbanic, U.S. Army Corps of Engineers
From: Aditi Bhaskar, Ph.D.
Date: October 4, 2018
Re: Comments on the Final Environmental Impact Statement for the Northern Integrated Supply Project

I am an Assistant Professor in the Department of Civil and Environmental Engineering at Colorado State University in Fort Collins, Colorado. My research focus for the last 10 years has been on urban water resources. The following comments are focused on the water need projections in the FEIS and supporting documents.

General Comments:

The projections of future water need by the NISP participants form the basis of Chapter 1 in the FEIS, establishing the need for this project. Water use projections have been commonly found to over-predict future demands. This has occurred on a national scale, as is shown in Table 1 of Brown *et al.* (2013), where national-scale U.S. water withdrawal projections made decades ago are now seen to be inaccurate over-projections. This may be obvious for long time frames, such as projections made over a 40-year time span. However, the projections made even between the SDEIS and the FEIS are found to be over-projections of observed water use. Harvey Economics (2015, Table IV-1) projected the 2015 water requirements to be 63,300 acre-ft whereas Harvey Economics (2017, Table II-1) reported that the actual potable and non-potable water deliveries by NISP participants was 43,618 acre-ft (14,213 MG) in 2015. A 30% drop over a short time span in the comparison of the projected water requirements and the actual water deliveries should raise questions about the soundness of the projections. Because of this established difficulty in making long-term or even short-term water demand projections, special care should be given to the methodology by which projections are made. However, the FEIS report, section 1.3.4.3, page 1-15 states, "The updated demand projections developed by Northern Water and the Participants essentially incorporate the same methodology as the previous projections."

The methodology used to produce demand projections makes an unreasonable assumption that the only passive conservation gains that will be made in the future are those that are outlined in the Municipal Water Use Efficiency Plans (MWUEPs). Furthermore, many areas of uncertainty in the projection are acknowledged, but no effort is made to either quantify the uncertainty or produce a range of conservation scenarios for 2060 water requirements; rather a singular final number is presented.

Specific Comments:

1. Effects of weather variations on water use should be quantified separately from conservation

The FEIS report, section 1.3.4.3, pages 1-9 to 1-10 states, "The most recent year for which complete water use data are available for all of the NISP Participants is 2015. Participant water deliveries in 2015 are presented in Table 1-3. While 2015 data provide the most recent available information on water use by the NISP Participants, 2015 was a relatively wet year, with reduced demand for landscape irrigation. Net evapotranspiration for grass during the 2015 April through October irrigation season at the Greeley West weather station was 19% below the 2006 through 2015 average. NISP deliveries per capita in 2015 were about 28% lower than in 2000, though 2000 was a particularly hot and dry year during the irrigation season (Table 1-4). This difference likely reflects both the relative cool and wet conditions during the 2015 irrigation season and the ongoing effects of active and passive conservation."

Comment: The report text notes the 28% drop in per capita water use by NISP participants between 2000 and 2015, and attributes these differences to a combination of two factors: weather and conservation, with greater emphasis on the drop being due to weather differences between the two specific years in question. With further analysis, these two factors could be quantified separately. With annual water use data, and annual or seasonal data on evapotranspiration, temperature, and precipitation, a multiple linear regression could be formed to predict how water use depends on these variables. This multiple linear regression could be applied an earlier period and used to predict use in the later period. If the water use projections based on weather variations are under-predicted by the regression model, the effects of conservation can be directly quantified. This type of analysis is a standard water demand forecasting technique to account for expected variation in seasonal or outdoor use due to weather (Billings and Jones, 2008). It is important to separately quantify the effect of weather variations and existing conservation to inform future projections of water use based on conservation that has already taken place (see comment 2).

2. The only conservation included in projections is that of the MWUEPs

BBC (2017) uses a 5-year moving average that started before the starting time of each MWUEP, which is more reasonable than the assumptions used by Harvey Economics (2017). Harvey Economics (2017) uses the average 2000-2015 GPCD as the average present GPCD, and because 2000-2015 has a downward trend, this results in a projection for the present (as a starting point for future projections) well above the GPCD that is actually observed.

Based on BBC (2017)'s 5-year moving average window, the GPCD change between 2006 and 2013 was -2.7 GPCD per year. The moving average window is used to remove weather effects on GPCD change. The MWUEPs started between 2005 and 2017, with the average start year of 2011 (Table 1). Therefore, the gains of -2.7 GPCD from 2006 to 2013 were not due to the MWUEPs as few had even started in 2006. Large-scale passive conservation drivers that would explain this observed GPCD decrease are that new homes have water-saving fixtures, as required by Colorado law (SB 14-103 requiring sale of WaterSense labeled products), and these indoor technology advances over time reduced GPCD. In fact, the -2.7 GPCD per year that was observed between 2006 and 2013, without active conservation planning on the municipalities' parts, is generally a greater per year change in GPCD than that planned in the MWUEPs (Table 1). Only Frederick, Lafayette, and MCQWD have planned GPCD changes per year that exceed what was observed between 2006 and 2013.

Table 1. Calculations based on Figure 6 from BBC (2017).

	Start Date of Latest Conservation Plan	End Date of Plan	GPCD at Start of Plan	GPCD at End of Plan	GPCD Change per year (gallons)
CWCWD	2005	2016	478	456	-2.00
Dacono	2011	2020	101	91	-1.11
Eaton	2012	2021	216	199	-1.89
Erie	2014	2020	160	145	-2.50
Evans	2009	2018	156	138	-2.00
Firestone	2015	2024	171	154	-1.89
FCLWD	2014	2023	211	190	-2.33
Fort Lupton	2006	2030	293	273	-0.83
Fort Morgan	2005	2050	417	375	-0.93
Frederick	2012	2021	188	153	-3.89
Lafayette	2010	2016	164	145	-3.17
LHWD	2014	2023	194	175	-2.11
MCQWD	2017	2031	242	204	-2.71
Severance	N/A	N/A	133	133	
Windsor	2015	2024	106	96	-1.11
Wtd. Avg.**			197	182	
Minimum	2005	2016		Minimum	-3.89
Maximum	2017	2050		Maximum	-0.83
Average	2011	2024		Median	-2.00

It is important that the MWUEPs include strong active conservation plans in addition to the passive conservation savings that would be gained simply by the building of new homes with updated technology. However, the projections made by both BBC (2017) and Harvey Economics (2017) only include future conservation savings which are those planned by municipalities in their water savings plans. The savings made by national and state water use drivers of passive conservation savings may be even more significant than the local active savings.

Furthermore, the MWUEPs mostly plan for between 6 and 14 years (except for Fort Lupton and Fort Morgan at 24 and 45 years), the plans will end between 2016 and 2050, well before the forecast window for the NISP FEIS. It appears that no conservation savings are included after the MWUEP time windows. In 2010, the weighted average GPCD was 204 gallons (BBC 2017), and the Harvey Economics (2017) projection for 2060 is 192 GPCD, a decline of -0.24 GPCD/year. The duration of the MWUEPs is the other reason that additional passive conservation savings, separate from the MWUEPs should be incorporated into projections. After these plans are completed, why would we assume that the efficiency gains would cease until 2060?

3. Uncertainty in water demand projections should be dealt with directly by examining conservation scenarios

Harvey Economics (2017) p. 6 states, "For these reasons, long-term projections such as demographic and related water demand projections provided in this report can be counted upon to be inaccurate on either the low or the high side as the year 2060 approaches… This report recognizes these many dimensions of uncertainty. Key assumptions are carefully scrutinized, and assumptions based upon the best available information are adopted where possible. The study team assiduously attempted to bring no bias into the assumptions underlying the projections offered in this report, but the study team recognizes that there is an equal chance that the assumptions could be wrong in either direction. Since no probabilities could be assigned to a different set of assumptions, the study team relied upon only a single set of projections with the presumption of uncertainty described here."

Comment: A reasonable approach to this acknowledgement of multiple sources of uncertainty would be to quantify this uncertainty. The report states that probabilities could not be assigned to a different set of assumptions. Another reasonable approach if probabilities cannot be assigned in any way would be to simply create a range of scenarios for water use intensities and population growth over time to see how these variations would lead to variations in the final water requirements.

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