Memo Purpose and Overview

The intent of this memo is to document the various evaluations the Third-Party Contractor (3PC) conducted immediately following the 2015 update of the City water demand projection and the re-evaluation of the need for the Halligan project. The central question which is answered here is whether the updated water demand projection and new net water need of the Applicant (City of Fort Collins, or City) will require a revised analysis of previously completed elements of this EIS. If the results of the update were substantially different from the previous calculations, the Corps of Engineers (Corps) would be required to revisit the screening process for alternatives and re-run the hydrology modeling for the proposed action and each alternative. The level of effort and the delay would be considerable; therefore the Corps directed the 3PC to evaluate the difference in the numbers and consider the need or benefit for re-running the hydrology models. This memo documents the process the Corps and the 3PC followed and the final decision by the Corps that the updated water demand and need projections are not sufficiently different from the original water demand and need projections to warrant rescreening the alternatives and re-running the hydrology modeling.

Need for Updating the P & N Component of the EIS

In 2005, the Corps initiated the NEPA process for an EIS to evaluate the proposed enlargement of the Halligan Reservoir and the Milton Seaman Reservoir by Fort Collins and Greeley, respectively. In 2006, evaluations of the future water demands, current supplies, net needs and a P&N Statement were initiated. In mid-2008, the evaluation of future water demands was revised to incorporate several additional years of historical data. The data sets used to perform these calculations were current at the time the P&N was determined and the Purpose and Need Report was drafted.

The NEPA process has been significantly delayed because of several hurdles including the complexity of the hydrology models to be used for the NEPA analyses; the decision to utilize a Common Technical Platform approach, with the Northern Integrated Supply Project (NISP); the withdrawal, at separate times, of the Tri-Districts and the North Poudre Irrigation Company as

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Subject: HWSP EIS – This memorandum describes and documents the results of the update of the Purpose and Need (P & N) component of the Halligan Water Supply Project Environmental Impact Statement (EIS) and its implications for the remainder of the EIS.
participants in the Halligan Project; and the recent separation of Greeley from the process. Because of the delays, the Corps and the 3PC determined that an update to the demand and need calculations would be required due to changes in economic activity and water use patterns over the past eight years. Harvey Economics (HE), who conducted the first evaluation of the future demand and water need embarked on the update to its original work in February of 2015.

**Role of the 3PC**

Different members of the 3PC Team played a role in the P & N update and the evaluation of its implications to this EIS, all of which was provided to the Corps.

**Western EcoSystems Technology, Inc. (WEST)**—As the lead contractor of the 3PC, WEST is accountable for the quality of the analyses conducted and the overall NEPA process. Therefore, WEST was involved in the development of the procedure to update the demand and need calculations and participated in discussions regarding the analysis and results. Additionally, given its statistical expertise, WEST performed certain analyses to test the statistical difference between the original water demand projections and the updated version.

**Harvey Economics (HE)**—Performing its role as the resource economists in this EIS, HE was tasked with updating the demographic projections, future water use patterns, and projections of total City water needs. Comparing those to estimates of current supply, HE identified the unmet water needs for the City that must be fulfilled through a future action. HE also contributed to the statistical studies and the evaluation of the implications of the updated need projections to the remainder of the EIS.

**DiNatale Water Consultant (DWC)**—DWC simulated the impacts of the updated demands in the Fort Collins system model and evaluated the significance of the difference in those new simulations compared with the simulated effects from the original water demand projections. DWC generated the monthly demand time series used in the Fort Collins system model for this comparison. DWC also evaluated the potential increases in demand due to climate change projections based on a technical report on climate change developed for the CTP.

**CDM Smith**—CDM Smith evaluated the potential impacts of the updated demands in the Fort Collins system model in the context of the hydrology simulated via the CTP. CDM Smith reviewed the updated data provided by HE in comparison to the original demand datasets. In addition, CDM Smith worked with DWC to calculate and review the monthly distribution of Fort Collins’ demands in order to determine if there was any significant change within monthly demands based on the updated data. The monthly demand distribution is based upon the projected trends in growth in water use based on the projected water demands of multi-family residential, higher density developments and large contractual water users (industrial water users), all which may have different monthly water demand patterns.
Evaluation Process Leading to Conclusions by Corps

A topic of the 12February 2015 Halligan Water Supply Project EIS status meeting was updating the water demand projection in the Purpose and Need Report. The first estimate of demand for Fort Collins was made in 2006 based on data through 2005. In 2008, the 3PC received an additional two years of data from Fort Collins (2006 and 2007 data) and the demand analysis was revised to include those years. The current draft of the Purpose and Need Report reflected the updated demand analysis that included 2006 and 2007 data. The years following 2007 included substantial changes in water use patterns and a major economic recession. Based on the amount of time that had passed, the Corps determined that the original water demand projections would not be adequate for EIS purposes. However, since the P & N is the foundation for the alternative formulation and hydrology analyses, including the CTP model runs, there was the possibility that this work would need to be redone if updated water demands were substantially different from the original estimate of demands. The Corps directed the 3PC to halt work on technical reports related to alternatives that might change if the demand projection changed.

In April 2015, HE presented the results of updated water need analysis to the Corps, the other 3PC team members, and Fort Collins, and refined those projections based on comments. The Corps requested a statistical test of the differences in the two projections and a comparison of simulated monthly impacts on the City system. The Corps and the 3PC examined and discussed all this information, along with consideration of the myriad uncertainties in forecasting and estimation throughout the EIS process.

Updated Water Demands and Project Need

During February and March of 2015, HE gathered specific recent data on historical and projected population, water use, water losses, and large water users past and future use, along with other inputs to determine the City’s future water demands. HE evaluated and validated the information, including interviews with the City, the North Front Range Metropolitan Planning Organization (MPO), and each of the identified large water users. HE met with the Corps, the 3PC and City staff to discuss HE’s assumptions and methodology for calculating future demands. Upon completion of that work, HE made a comparison of the original demand projections with the updated projections.

Differences between the original and updated demand analyses—A number of changes have taken place in the interim between the original and updated demand analyses for the Halligan Project:

- **Forecasting horizon**: The original P&N work included water demand projections though the year 2050, which, at that time reflected about a 45 year planning horizon. The updated analysis includes a 50 year planning horizon which results in demand projections calculated through the year 2065. The Corps has confirmed that a 50 year planning horizon is appropriate and is consistent with other regional water management EISs.
• **Lower historical average gallons per capita per day (gpcd):** The availability of an additional seven years of population and water use data since the original P & N work allowed HE to calculate an updated historical average gpcd that is more reflective of the current water use patterns of Fort Collins Water Utility (Utility) customers.¹ The inclusion of the more recent data resulted in a decrease of the average gpcd from about 148 gallons per day to about 132 gallons per day.² That average historical gpcd is then applied to the population projections as a portion of total water demand.

• **Projected population growth:** The updated population projections from North Front Range MPO, the City of Fort Collins and the Utility reflect higher annual growth rates throughout the planning horizon than were assumed in the earlier work.

• **Additional large water users:** Since the time of the original P & N work, several commercial customers have emerged as additional large water users for the Utility.

• **Changes in large water user demands:** Several large water user customers have contractual agreements with the Utility for specific amounts of water, and in recent years, those contracts have been adjusted.

• **Location of determination of need:** In the original P & N work, HE estimated the Utility’s water needs and shortages at the point of inflow to the water treatment plant. In the update, that was changed to the point of river diversion for consistency with the point of measuring supply.

**Summary of updated water demands and project need**—The changes above tend to offset one another, rendering the need for the Halligan Project similar to but slightly less than the estimated need in the original work.³ The following exhibit provides the updated water demand projections for the City:

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¹ The methodology used to calculate gpcd did not change between the original work and the update; however, the number of years included in the calculation increased from six (2002 through 2007) to eleven (2004 through 2014).

² HE calculates gpcd differently than the City. The differences between the HE and Water Utility methods are discussed in HE’s Water Demands Technical Memo for the Fort Collins Water Utility, 2015.

³ Project need is based on the projected water requirements at the point of diversion compared to calculation of the Utility’s firm annual yield.
Exhibit 1. Projected Potable Water Demands and Water Requirements for the Fort Collins Water Utility, 2015 to 2065

<table>
<thead>
<tr>
<th>Year</th>
<th>Potable Water Demand at the Tap (AF)</th>
<th>Large Water User Demand at the Tap (AF)</th>
<th>Total Potable Demand at the Tap (AF)</th>
<th>Potable Water Requirements (AF)</th>
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<tr>
<td>2015</td>
<td>18,900</td>
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<td>24,300</td>
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<td>20,400</td>
<td>6,400</td>
<td>26,800</td>
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<td>28,200</td>
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<tr>
<td>2030</td>
<td>22,000</td>
<td>7,600</td>
<td>29,600</td>
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<tr>
<td>2065</td>
<td>25,000</td>
<td>9,800</td>
<td>34,800</td>
<td>38,400</td>
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Notes: (1) Projections of potable water demand exclude large water user demand, which is projected separately.
(2) Larger water user demand includes all identified large water users.
(3) Potable water requirements are measured at the point of diversion and include conveyance, treatment and distribution losses.

Water demands and water requirements only reflect water used for potable purposes; non-potable water deliveries and obligations are not included in this exhibit.
Water demands and requirements have been rounded to the nearest hundred acre-feet.

Source: Harvey Economics, 2015.

The comparison of potable water requirements at the end of the updated planning horizon in 2065 compared to the requirements at the end of the previous planning horizon in 2050 shows an overall decrease of less than 200 AF per year. That decrease in water requirements amounts to a change of less than half of one percent. Projections of water demands and water requirements were developed using detailed information and assumptions, resulting in more specific estimates than shown here. The data offered in Exhibit 1 above was rounded to the nearest hundred AF after all other calculations were completed so as not to suggest a higher level of accuracy than appropriate.4

The estimate of firm annual yield of the current Fort Collins system has not changed in the interim between the original work and the update. Hence, the updated unmet need represents a decrease of less than 200 AF. The decrease in unmet need amounts to a change of about two percent.

Test of Statistical Differences
Statistical tests were conducted to assess whether the original 2002-2007 mean gpcd estimate and the updated 2004-2014 mean gpcd estimates are significantly different. The goal of this

4 The differences between the detailed projections and the rounded projections in each year is very small, less than 50 AF.
testing was to provide information to help the Corps determine if previously completed modeling steps should be re-run.

A standard t-test approach was used to assess whether the original 2002-2007 and updated 2004-2014 gpcd averages are significantly different.\(^5\) Because the standard t-test approach assumes that data are independent and identically distributed, following a normal distribution, a nonparametric bootstrap technique to was also used generate a 95% confidence interval for the difference between the original 2002-2007 and updated 2004-2014 gpcd averages. Finally, a paired t-test\(^6\) was used to assess the similarity of the original and updated 2002-2007 mean gpcd estimates.

**Results and implications of gpcd test**—Results of the standard t-test indicate that the original 2002-2007 (147.95 gpcd) and updated 2004-2014 (132.47) averages are significantly different at an alpha level of 0.05. The difference between these means was 15.48 (95% confidence interval: 0.63-30.34 gpcd. The nonparametric bootstrap method also indicated that the original 2002-2007 and updated 2004-2014 gpcd averages are significantly different (95% confidence interval: 4.34-28.17 gpcd). Both the t-test and nonparametric bootstrap results indicate that the original 2002-2007 gpcd average is significantly higher than the updated 2004-2014 gpcd average.

Comparison of original 2002-2007 and updated 2002-2007 gpcd averages indicated they are also significantly different (95% confidence interval: 2.67-4.92).

Because both of these tests assessed a difference in gpcd averages using the variation in gpcd rather than the variation across all the inputs into gpcd, these confidence intervals are biased low. The implication is that the confidence intervals are narrower than they likely would be if the variation across all of the inputs into gpcd were considered.

We were able to statistically compare the gpcd estimates because they were averages of empirical data from several years. Ideally, we would have liked to conduct similar tests on the other major components of demand: projected population and water use by large water users. We could not statistically test the projected population growth and large contractual water users because they were projections with no variability rather than averages of data sets with variability. The projections may be based on data sets with measurable variability but we did not have the underlying data or the measure of their variability.

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For similar reasons, statistical comparison of the original 2050 demand estimate and the updated 2065 demand estimate was also not possible. Although the new and old gpcd are significantly different, that does not by itself indicate that the demand projections are statistically different because the demand projections are determined from a combination of the gpcd, population growth, and large water user demand.

**Hydrologic Modeling Test**

The hydrological tests relate to the impacts of water demand projections to the alternatives and modeling. Fort Collins system modeling subdivides the overall demand into two broad categories: 1) municipal (e.g. commercial and residential) demand and 2) large industrial water user demand. The municipal demand is based on the projected population times the per-capita water use rate. The large industrial users were individually projected by HE. These tests focus on the impacts to this change of demand to change in monthly demands for modeling and changes in diversions.

**Change in monthly demands**—The Fort Collins system model inputs add a demand variation factor to the average annual demands projected by HE. This factor is based on a regression of historical per-capita use to historical river flows, increasing demand in dry years, and decreasing demand in wet years. The factor increases or decreases the average annual HE demand by about +/- 3%, but up to 10% in some years. The same demand variation factor was applied to the 2050 demands and the 2065 updated demands.

On a monthly basis, the increase in the municipal demand and decrease in the large industrial demand has the combined effect of reducing winter demand by about 40 AF per month, and increasing summer demand by 20 to 35 AF per month, with shoulder months about the same (May, Sept, Oct). The differences in demand on a monthly basis are all less than a 2% change from the 2050 modeled amounts.

Some of the future growth in Fort Collins will be in-fill development and redevelopment to higher density housing. This type of development shifts the monthly demand distribution, with winter demands increasing and summer demands decreasing due to the increase in the relative proportion of water used indoors vs. outdoors. This shift would reduce the differences in monthly demands described in the previous paragraph.

**Impact on diversions**—The change in demand does not directly correlate to an equal change in diversions from the Poudre River by Fort Collins. Fort Collins’ senior water rights are limited legally to certain flow rates that are less than the total Fort Collins demand in any month, so diversions under the Fort Collins senior direct flow rights will likely not change due to the demand changes. Fort Collins uses water stored in Horsetooth Reservoir and its changed water rights (also known as its South Side Ditch rights or “SSD”). The change in demand may result in somewhat higher use of the SSD rights in the summer. However, the SSD rights are limited by water court decree to the amount that can be used in any single month. These volumetric limits may prohibit the additional use, and Fort Collins would then rely on its water in storage in
Horsetooth Reservoir. Releases from Horsetooth to the Fort Collins water treatment plant do not affect streamflows at the point of diversion.

Based on this information, it is reasonable to assume that in most months, the change in streamflow would be less than the change in demand described in the previous section. Due to the inter-related nature of all water rights in the Poudre Basin, small changes to Fort Collins diversions can precipitate changes to other water rights in the basin and could result in rare instances of changes from the previous modeling that are larger than the change in demand.

Due to the minimal change in demands and the likely smaller impact on streamflows, an updated model run with the updated demands would provide no additional refinement in the simulation of future impacts of the proposed action or alternatives, even though the simulated flows would be slightly different from the existing model runs.

**Identification of Uncertainties**

The final consideration for determining the need to revise the alternative formulation and modeling pertains to recognition of the uncertainties inherent in this, and similar, EIS processes. By its nature, an EIS is built upon uncertainties associated with assumptions, projections, simulations and estimates.

A water project EIS follows a sequence in which each component builds upon another. Following scoping, the EIS begins with an establishment of the need for that project. This element is based on assumptions about the future which by definition, are uncertain. The following uncertainties regarding the estimation of supply and demand:

- Fort Collins’ need is a combination of projected demands combined with a safety factor intended to reduce the negative impacts of uncertainty associated with these projections. The safety factor addresses dimensions of risk outside of the reliability criteria during emergency situations (i.e. pipeline failure) and droughts that exceed the planning level (greater than 1-in-50 year drought). Fort Collins currently uses a 20% safety factor of annual demand in storage through the design drought. This is equivalent to three months of average winter demand and just over one month of average July demand. However, the size of the safety factor requires judgement and, based on similar analyses in this region, the USACE adopts a 15% safety factor for this EIS.

- The alternative formulation and screening component is based upon the established need. In that formulation process uncertainty is present as to the exact yields of the project concepts and project elements within alternatives.

- There are inherent uncertainties in hydrology modeling. The hydrology model is based on simulating future demands and the monthly distribution of those demands, both of which are estimates. In addition, there is uncertainty in the hydrology that drives the model. The hydrology simulated in the Halligan Water Supply Project is based upon historical
hydrology and a statistical drought which are used to simulate the flows that may occur in the future. There is no certainty that these flows will occur with a similar magnitude and variability in the future.

d. The impact analyses of each of the alternatives require assumptions and estimates of effects upon each environmental resource. Hence, these impact assessments carry an element of uncertainty.

The 3PC professionals base their work on the best available data using methods and assumptions appropriate to their respective tasks. Even so, an unavoidable level of uncertainty exists throughout the EIS process.

**Elements of uncertainty beyond the EIS process**—Outside the Halligan EIS process, there are other sources of uncertainty which will affect the eventual outcome and effects of the alternative ultimately selected by the Corps. Climate change, technological change, and institutional change are among the primary sources.

Climate change has been considered in the Halligan EIS based upon a 2014 report prepared by DWC and CDM, “Climate Change Hydrologic Impacts Analysis for the Common Technical Platform for the NISP and SWSP Environmental Impact Statements.” The report examines potential temperature changes due to future climate change and its effects on additional lawn watering and evapo-transpiration of reservoirs in Northern Colorado. In sum, the demand for outdoor watering might increase by about 800 to 1,100 AF per year, and evaporation at the enlarged Halligan, Overland Pits and South Gravel Pits might increase approximately 150 AF per year for a total increase in demand between 950 and 1,250 AF per year. In addition, evaporation may reduce the amount of water Fort Collins has access to through it C-BT supplies, but that amount has not been quantified. Clearly, the prospect of climate change contributes to uncertainty about needs, hydrology, project sizing and impacts.

Technological change over a 50-year time horizon is a certainty, but its effects are unpredictable. The motivation of efficiency is often a driver, but the discovery of new “needs” in the form of products or services to be satisfied is another driver. Innovation to lower costs but also to improve quality of life will have an untold effect on water demands, supplies and impacts.

Institutional change can come in many forms over a 50-year time horizon. Water providers in Northern Colorado might consolidate, for example. New laws and regulations might affect water uses, hydrology, and project impacts.

In conclusion, there are many sources of uncertainty facing the Halligan EIS and the ultimate impacts of the project. The level of acceptable precision must reflect this fact. The Corps determined that the updated water demand projected through 2065 is not sufficiently different from the original projection to warrant changing the alternatives, their design, or the CTP model runs. The Purpose and Need Report will be updated with the new demand projections. The Preliminary Draft Alternative Screening Report will be completed and finalized and work on
technical reports and EIS chapters will resume for the Halligan Project and action alternatives as proposed.

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