MEMORANDUM

Evaluation and Incorporation of USACE HEC-RAS Model of Chicago Waterway System into the Development of the North Branch DWP

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PURPOSE

This memorandum summarizes the procedures and data that were used to incorporate the United States Army Corps of Engineers' (USACE) Chicago Area Waterway System (CAWS) HEC-RAS model as a downstream boundary condition for the North Branch Chicago River (NBCR) Detailed Watershed Plan (DWP) model.

BACKGROUND

Previously, FluidClarity worked with HDR to produce an unsteady HEC-RAS model for the North Shore Channel (NSC) along with the lower reaches of the NBCR downstream of the North Branch dam. Please refer to the Figure 1 for a watershed overview. The original FluidClarity model was developed from the USACE's UNET model and was updated with new information, including georeferenced cross-sections and channels. Flow data analysis was improved and boundary conditions were updated. This model was developed for the 2-, 5-, 10-, 20-, 50- and 100-yr storm events. A stage hydrograph for the confluence of the NBCR and the NSC was created for use as a downstream boundary condition for the model developed for the NBCR DWP.

A parallel study was being conducted by the USACE, which updated the entire CAWS model, including NSC and NBCR from its confluence with the NSC, to its confluence with the Chicago River. The District determined that this USACE model should be used in lieu of the FluidClarity-developed model, in part because the USACE model uses updated information and can be considered the best available data for the waterway system. HDR and FluidClarity performed additional work to extract the information required from the new USACE model for use in the NBCR DWP, as described below.

METHODOLOGY

FluidClarity performed the following steps to incorporate the USACE model into the NBCR DWP:

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(1) Verified and ran the new USACE model.

Once the new USACE HEC-RAS model was acquired by HDR and FluidClarity, the model was reviewed to become familiar with the updated geometry, boundary conditions, and input hydrology .dss files. The geometry of the North Branch Dam, which has been included in the USACE model but was not included in the original USACE UNET model, was reviewed to determine whether the updated geometry of the dam was modeled appropriately, including the presence of a mid-flow weir. The model was revised to include the updated geometry at this location, as necessary. The model was run for the 20-, 50-, 100- and 500-year storm events. Results were compared to the results in the *Downtown Chicago Flooding Study, Draft Final Report,* by AECOM, September 2009, as a QA/QC measure. The model was compared to the original FluidClarity HEC-RAS model to determine the level of discrepancies between the two.

(2) Revised the new USACE model for incorporation into DWP.

The new USACE model was revised to replace the inflow hydrographs located upstream of the North Branch Dam with flows produced by the model from HDR created for the District's DWP. Inflow hydrographs along the NBCR which needed to be removed and replaced within the USACE model were identified. The .dss file was adjusted to include the hydrographs from the 20-, 50-, 100- and 500-year storm events from the District's NBCR model which were then incorporated into the USACE model.

Since the District's NBCR model produced a 25-year hydrograph and not a 20-year hydrograph that correlates with the USACE model, a probability analysis was run and a 25-year hydrograph was interpolated between the 20-year and 50-year USACE results. This was then run and verified versus the relationships demonstrated by the FluidClarity model. A sensitivity analysis at UNBCR cross-section 333.11 demonstrated that the flows and stages for the 20-yr to 25-yr were successful.

The USACE's hydrographs from July 10 to 12th (3 day), were adjusted to enable incorporation into HDR's timespan from July 11 to 15 (5 day). Results were compared and verified.

Through an iterative process, the results from the District's HEC-RAS model were input into the USACE model, and USACE results back into the District model, until there was acceptable agreement between the results of the two models.

The 2-, 5- and 10-year storm events were not included as part of the newly revised USACE model. To determine the downstream boundary condition to be used in the District's NBCR model, the results of the USACE model's 20-year stage hydrograph immediately downstream of the dam was evaluated.

A stage hydrograph was produced by extrapolating down the results of the peak stage of the 20-, 50-, 100- and 500-year storm events generated from the previous

runs. The shape of the 20-year stage hydrograph was retained for 2-through 10-year storm events, and the stages were reduced by a percentage equivalent to the percentage by which the peak flow was reduced for each duration, as a result of the statistical analysis. The original FluidClarity model was used as a guide for determining the amplitude shifting of the lower storm events; since this was an actual model of the study area, it was determined to provide better results and a simple regression analysis.

(3) QA/QC

QA/QC was performed on the model by comparing the unaltered USACE model results to the newly updated USACE results to verify that similar results were produced. Similarly, comparisons were done with the original FluidClarity model results to ensure that riverine characteristics remained intact, with emphasis on the events extrapolated beyond the unaltered USACE model.

As part of the QA/QC, a sensitivity analysis for varying starting water surface elevations of Lake Michigan was performed for 3.8 CCD and 0.8 CCD. The critical points chosen were cross-sections located at the start of NBCR, the confluence with NSC, and downstream of the Wilmette Pumping Station. The locations were chosen because they encompassed the area affected. Regarding the 3ft drop in WSEL of the Lake caused by changing from the medium height to the low level WSEL scenario, there was no change at the upstream portion of NBCR cross-section located downstream of the dam. There was a 0.2 - 0.5 ft drop at the confluence of NBCR & NSC, and there was a 0.1 - 0.25 ft drop at the 1st cross section south of the Wilmette Pumping Station.

FIGURE 1: CHICAGO WATERWAY SYSTEM

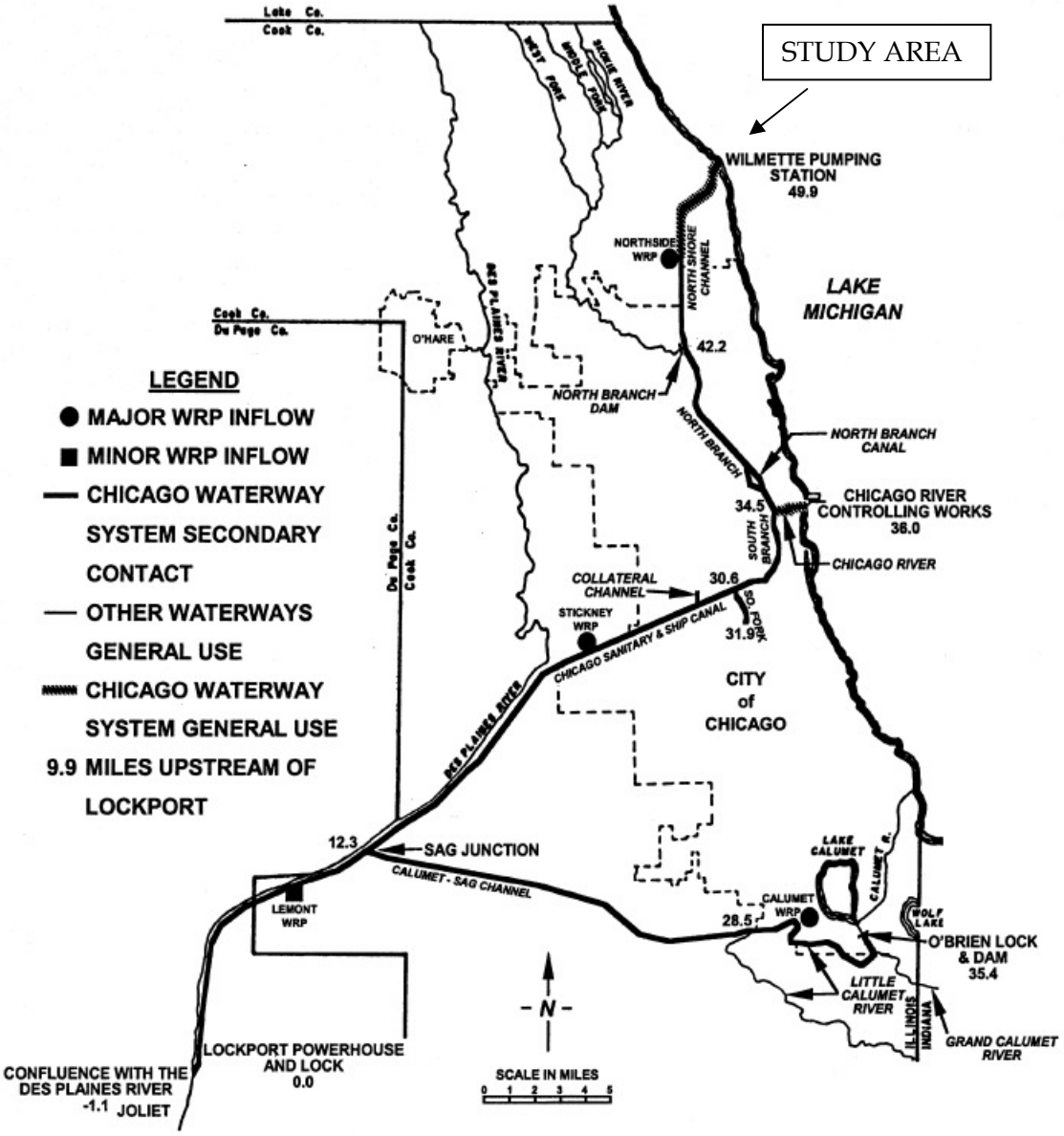

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FIGURE 2: HEC-RAS MODEL LAYOUT