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M E M O R A N D U M

To: Ron Hansen, Spicer Group, Inc.

From: Karen Ridgway, Applied Science, Inc.
Jason Matteo, Applied Science, Inc.

Project: NBECD Flood Control Study

Subject: Proposed NBECD Tunnel Discharge to the Rouge River

Date: Revised October 9, 2007

Introduction

A storm water diversion tunnel that would carry peak wet weather flows from the North Branch of the Ecorse Creek Drain (NBECD) to the Main Branch of the Rouge River was considered as a flood mitigation alternative as part of the NBECD Flood Control Study.

The tunnel was proposed to divert flow from the NBECD and discharge flood flows to the Rouge River near the I-94 Freeway crossing. Two tunnel alternatives were considered for the NBECD. One included a tunnel from the NBECD at the Southfield Freeway to the Rouge River. The second alternative included a tunnel extension under Van Born Road from Gulley Road to the Southfield Freeway to the Rouge River at the I-94 Freeway.

This technical memorandum presents an analysis of the tunnel capacity and steady-state HEC-RAS modeling results for the Rouge River under existing and proposed conditions to identify impacts of the tunnel discharge.

Background

An unsteady-state HEC-RAS model of the NBECD was developed as outlined in the Task 2 report of the Flood Control Study. In addition, a constructability review of the tunnel construction was completed as outlined in the Task 4 report.

A maximum soft ground tunnel diameter of 16 feet was determined to be feasible under Task 4. The capacity of the 16-foot diameter tunnel was determined to be about 1,957 cfs, or about equivalent to the predicted peak diversion flow rate for the 100 year design storm. The tunnel capacity was estimated for an available driving head of about 8.7 feet from the NBECD to the Rouge River, which was calculated by taking the difference between the 100 year flood levels along the NBECD at the Southfield Freeway

(Elevation 594.4 feet) and the Rouge River near the I-94 Freeway crossing (Elevation 585.7 feet).

Figure 1 presents a conceptual layout of the proposed tunnel from the NBECD to the Rouge River. The worst-case peak flood flow rate of 1,957 cfs was therefore added to the Rouge River model near the I-94 Freeway to assess impacts to the Rouge River.

HEC-RAS Model Development

The water surface profiles for existing and proposed conditions were computed using the U.S. Army Corps of Engineers' (USACE) HEC-RAS (Hydrologic Engineering Center River Analysis System) computer program, Version 3.1.3. This version of HEC-RAS supports one-dimensional, unsteady- and steady-state, water surface profile calculations. The FEMA currently considers HEC-RAS an acceptable (and preferred) computer program for use in floodplain analyses.

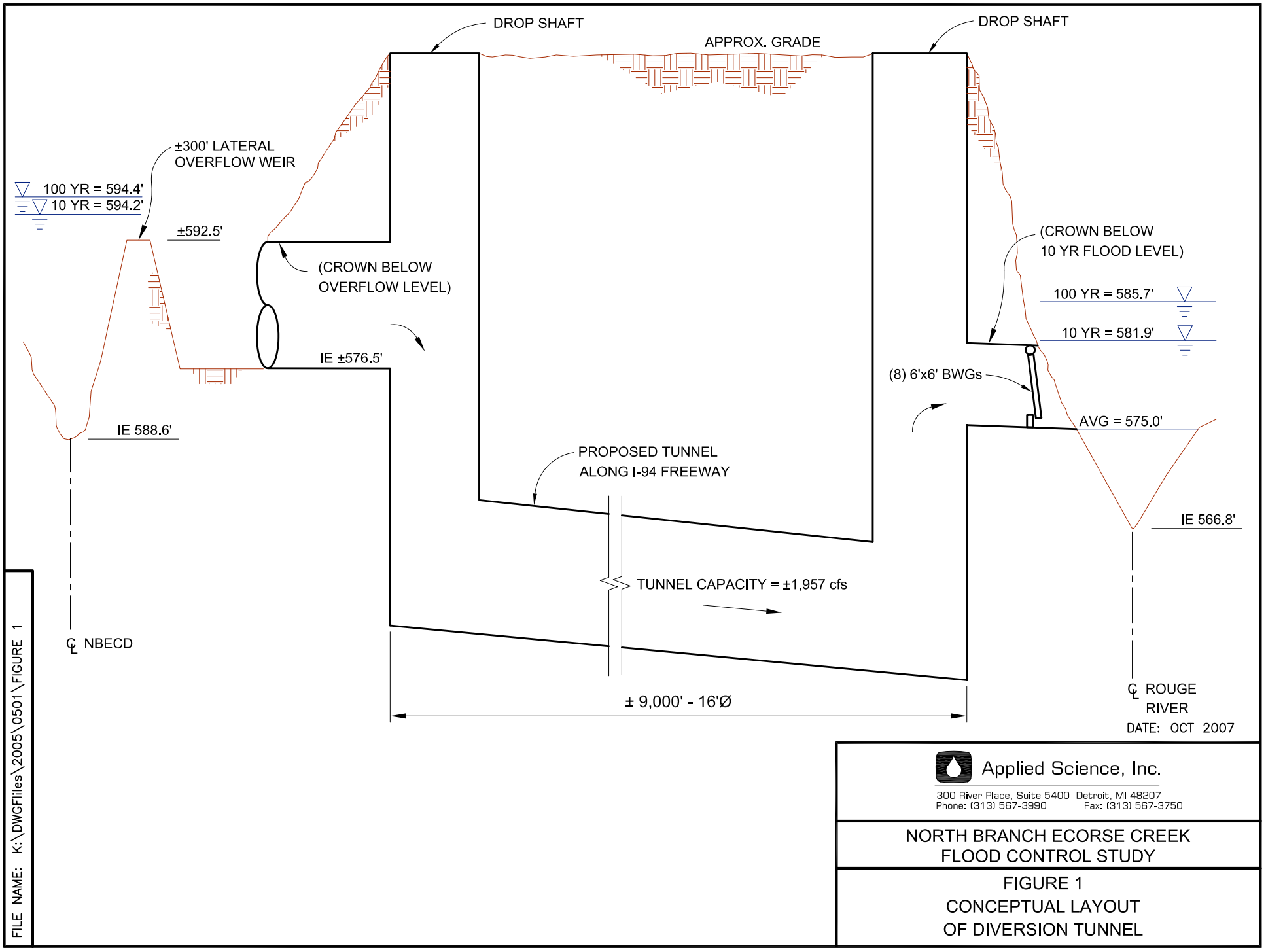
The existing HEC-RAS river model extends along the Main Branch of the Rouge River from Ford Road near Evergreen to the turning basin at the Ford Motor Company Rouge Plant (RS 3.15) and along the Lower Branch of the Rouge River from Gulley Road to the confluence with the Main Branch. This model is currently being used by the USACE to model the proposed concrete lining removal project.

For this analysis, the steady-state mode of the HEC-RAS model was utilized to predict the increase in 100 year flood levels along the Rouge River and to determine the cross-sectional modifications required to mitigate the increase in flood levels. The proposed diversion flow rate of 1,957 cfs from the NBECD was added to the river flood flow rate of 20,339 cfs in the Rouge River in the HEC-RAS model near the I-94 Freeway on the Main Branch of the Rouge River.

Model Assumptions

The flood flows along the Rouge River used in the HEC-RAS model were obtained from a previous hydrologic analysis conducted by Applied Science, Inc. (ASI) presented in a technical report entitled, "Final Flood Analysis Report of the Rouge River in Dearborn, Michigan", dated December 11, 2001. This report has been provided to the MDEQ and the U.S. Army Corps of Engineers (USACE) for review and use in other projects, such as the proposed removal of portions of the concrete lining along the Main Branch of the Rouge River. Discharge estimates were generated for return periods that ranged from the 1 year to the 500 year frequencies.

The flood flow rates presented in the Final Flood Analysis Report dated December 11, 2001 were generated using a rigorous statistical analysis of the available stream gage data, and were slightly higher than the flood flow rates presented in the FIS report dated May 6, 1996 for the City of Dearborn. The FIS report presented the estimated 100 year flood flow rate of 16,020 cfs on the Main Rouge River at the confluence with the Lower Rouge River. The 100 year flood flow rate presented in the Final Flood Analysis Report



FILE NAME: K:\DWGFiles\2005\0501\FIGURE 1

Applied Science, Inc.
300 River Place, Suite 5400 Detroit, MI 48207
Phone: (313) 567-3990 Fax: (313) 567-3750

NORTH BRANCH ECORSE CREEK
FLOOD CONTROL STUDY

FIGURE 1
CONCEPTUAL LAYOUT
OF DIVERSION TUNNEL

was 18,919 cfs at the same approximate location. The higher flood flow rates presented in the Final Flood Analysis Report were conservatively used for this analysis. Table 1 presents the flood flow rates by reach along the Lower and Main Branches of the Rouge River.

For proposed conditions, the diversion tunnel flow rate of 1,957 cfs was added to the HEC-RAS model along the river reach bounded by Rotunda (RS 5.65) and about 1,700 river feet upstream of the Turning Basin (RS 3.28).

Model Results

HEC-RAS Backwater Profile

The HEC-RAS model predicted a maximum increase in the 100 year flood levels of about 0.4 feet due to the addition of the proposed NBECD diversion, occurring just upstream of the I-94 Freeway (HEC-RAS RS 4.9293). The predicted increase in the 100 year flooding level of the proposed tunnel outlet near the I-94 Freeway extended upstream to the westbound lane of Michigan Avenue (RS 7.075) and downstream to the Turning Basin (RS 3.15278). The proposed condition HEC-RAS backwater profile is presented on Figure 2.

Proposed Cut Along the Rouge River

To mitigate the predicted increase in 100 year flood levels, the Rouge River was assumed to be modified in the HEC-RAS model by cutting a portion of the concrete-lined section of the Main Rouge River. The USACE is currently planning to remove sections of the concrete-lined portion of the Rouge River above the normal water level from directly downstream of the New York Central RR (RS 6.87749) to just upstream of the I-94 Freeway (RS 4.9293) and installing a bicycle path and restoring the overbank areas within the Rouge River right-of-way to a more natural condition with native vegetation. However, additional cuts would be necessary beyond those proposed by the USACE to mitigate the increase in flood levels due to the proposed diversion tunnel discharge. The predicted 100 year backwater profile with the proposed mitigating cuts in-place is shown on Figure 2. The proposed cuts were an initial estimate and will need further refining if this alternative is chosen. A slight reduction in flooding levels is shown on Figure 2.

Significant cuts to the existing channel would be required for about 9,200 river feet from directly downstream of the I-94 Freeway (RS 4.8114) to the Turning Basin (RS 3.15278) in order for the NBECD diversion to have no adverse impact on flooding levels along the Rouge River. The proposed mitigating cut would extend below the average, normal water level, and would widen the average river top width by about 100 feet. The cross-sectional area would be increased by approximately 1,900 square feet due to the proposed mitigating cuts. The total required mitigating cut volume calculations are shown on Table 2. A comparison of the typical existing concrete-lined cross section and the proposed mitigating cut cross section is shown on Figure 3.

Table 1
NBECD Flood Control Study
Rouge River Flood Flow Rates by Reach

Rouge River Conditions					
Branch	River Reach			100 Year Flood Flow Rate by Return Period (cfs)[1]	
	Upstream Milepost	Downstream Milepost	Description	Existing	Proposed
Main	3.28	3.15	1,700' u/s to 1,000' u/s of Turning Basin	20,677	22,624
	5.65	3.28	Rotunda to 1,700' u/s of Turning Basin	20,339	22,296
	7.49	5.65	Confluence with Lower Branch to Rotunda	18,919	18,919
	7.62	7.49	Henry Ford Estate to Confl. with Lower Branch	14,445	14,445
	9.21	7.62	Ford Rd. to Henry Ford Estate	14,369	14,369
Lower	9.35	7.49	Military Rd. to Confluence with Main Branch	4,644	4,644
	10.61	9.35	Telegraph Rd. to Military Rd.	4,522	4,522
	11.15	10.61	Gulley Rd. to Telegraph Rd.	4,395	4,395

NOTE:

1) Dry weather flows were estimated based on tributary drainage area using USGS stream gage data on the Lower, Middle and Upper Main Branches for Water Year 2004. Flood flow rates by reach were obtained from Table 14 of the "Final Flood Analysis Report for the Rouge River in Dearborn, Michigan".

2) The diverted tunnel flow of 1,957cfs was added to the HEC-RAS model directly downstream of the I-94 Expressway bridge crossing (HEC-RAS RS 4.917).

Figure 2
Main Branch of the Rouge River
Water Surface Elevation Comparison
HEC-RAS Backwater Profile

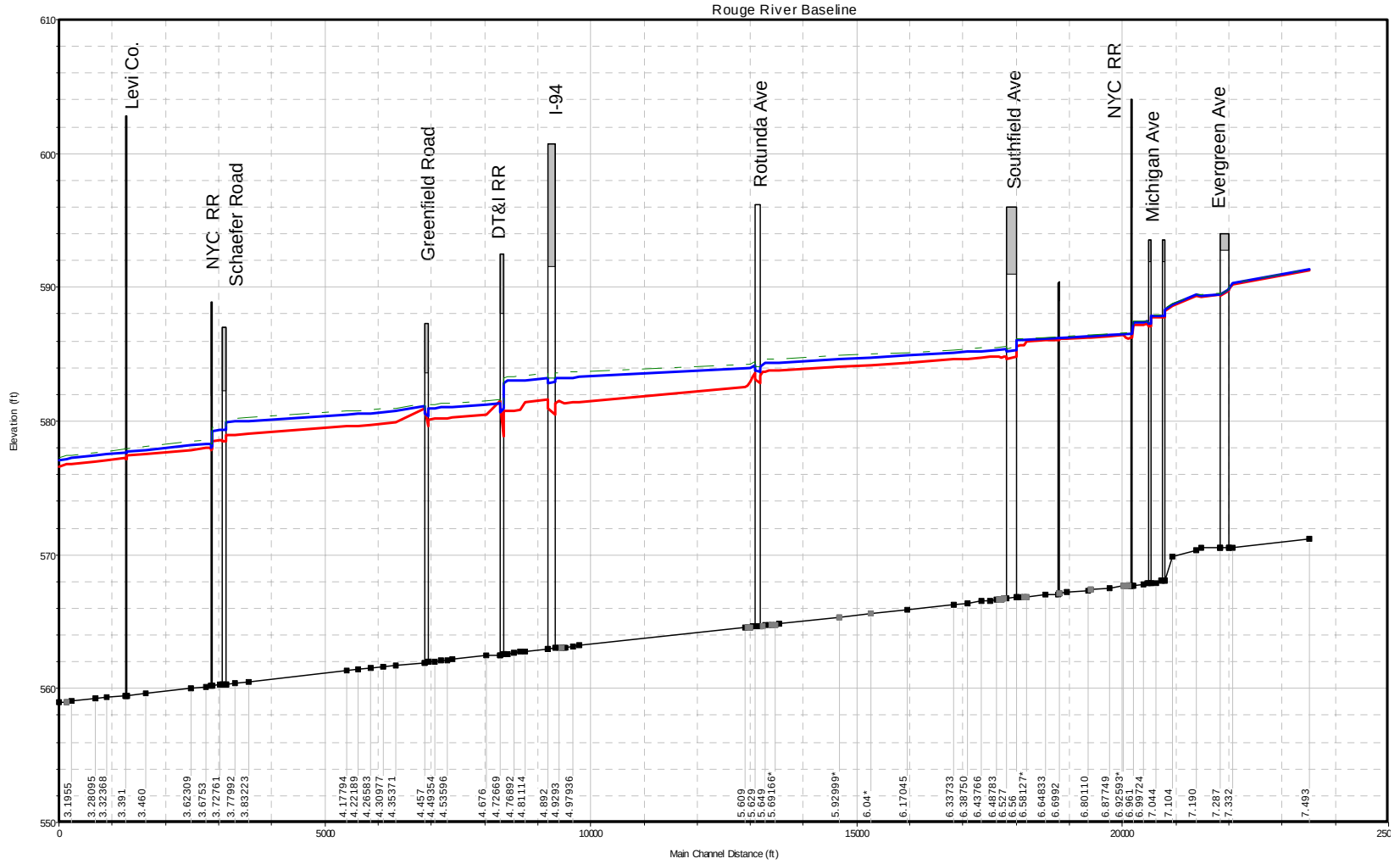


Table 2

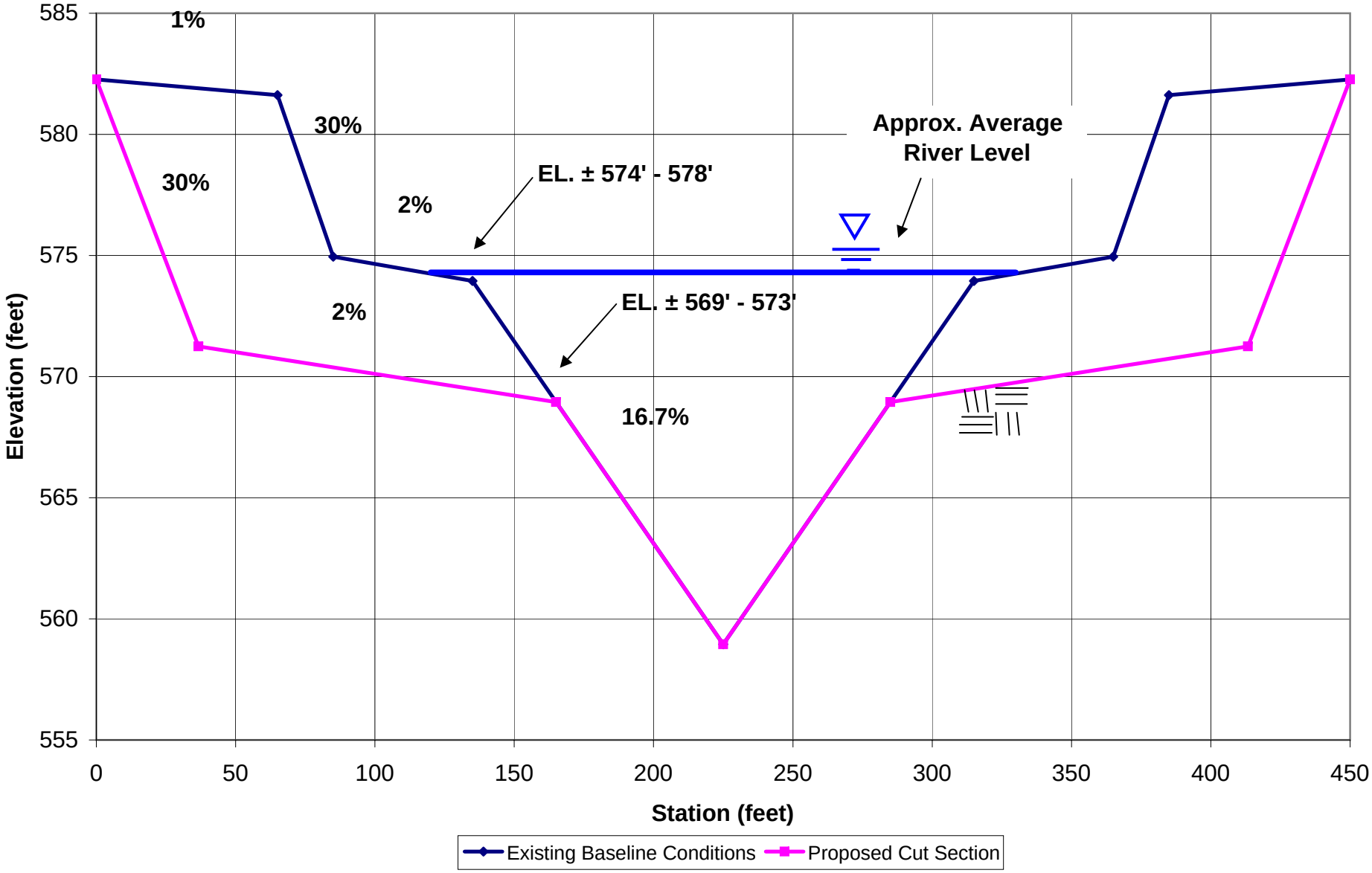
NBECD Flood Control Study

Summary of Cut Volume Calculations

Assuming the Levy, NYC, Schaefer, Greenfield, and DT&I Bridge Abutments will be Removed and Replaced

HEC-RAS River Station (miles)		Distance Between Stations (feet)	Required Cut Volume	
Downstream	Upstream		(ft^3)	(CY)
3.15278	4.81114	9,202	17,432,324	645,642

Figure 3
Main Branch of the Rouge River
Typical Existing Baseline and Proposed Cut Cross Sections



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In addition, five (5) bridge crossings (Levy, NYC RR, Schaefer, Greenfield, and the DT&I RR) would have to be removed and replaced with structures with much larger spans to accommodate the larger, modified cross-sectional channel geometry.

Conclusions

The proposed diversion tunnel discharge of up to 1,957 cfs from the NBECD to the Main Branch of the Rouge River near the I-94 Freeway is predicted to increase the 100 year flood levels by about 0.4 feet. To mitigate this predicted increase, significant cuts would be necessary from the I-94 Freeway (RS 4.81114) to the Turning Basin (RS 3.15278). Five (5) bridge crossings would also have to be removed and replaced. The costs to complete these required cuts and bridge replacements may be substantial, and should be included in the capital costs for construction of the proposed diversion tunnel.

In addition, there are significant permitting issues with the tunnel alternative to the Rouge River that would require time and cost to evaluate. For instance, permits from the MDEQ and the USACE would be required for the proposed tunnel. Inter-basin diversion permits from the MDEQ and USACE may be difficult to obtain. Concerns could be raised regarding the effect on habitat as well as flooding on the Rouge River. An extensive study would likely be required that evaluates the impacts of the tunnel discharge on habitat, fisheries, wetlands, and navigation and determines what, if any, mitigation measures would be required. Mitigation measures that improve habitat/fisheries may also be required.

The MDOT would also require a permit for the tunnel alignment under the I-94 Freeway from the NBECD to the Rouge River. The MDOT has previously stated in a meeting that this permit would be very difficult to obtain.

The Rouge River watershed communities may also object and require retention/detention prior to discharge into the Rouge River or other best management practice (BMP) measures that would add costs to this alternative.