Briefing on the Water Quality Elements for the Mid-System Alternative from the Evaluation of Physical Separation Alternatives in the CAWS Technical Report

A Briefing to the *Restoring the Natural Divide* Advisory Committee

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For the Great Lakes Commission and the Great Lakes and Saint Lawrence Seaway Cities Initiative

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Objective

This memorandum was prepared as a summary reference document in advance of the water quality panel discussion taking place as part of the October 30, 2013, Advisory Committee meeting for the *Restoring the Natural Divide* project. Previous efforts as part of this project involved evaluating physical separation alternatives in the Chicago Area Waterway System (CAWS), and this document provides a summary of the baseline conditions, assumptions, and potential water quality project elements associated with the Mid-System Alternative. Additional technical and reference/source information is provided in Appendix A of the Technical Report prepared for the *Restoring the Natural Divide* project

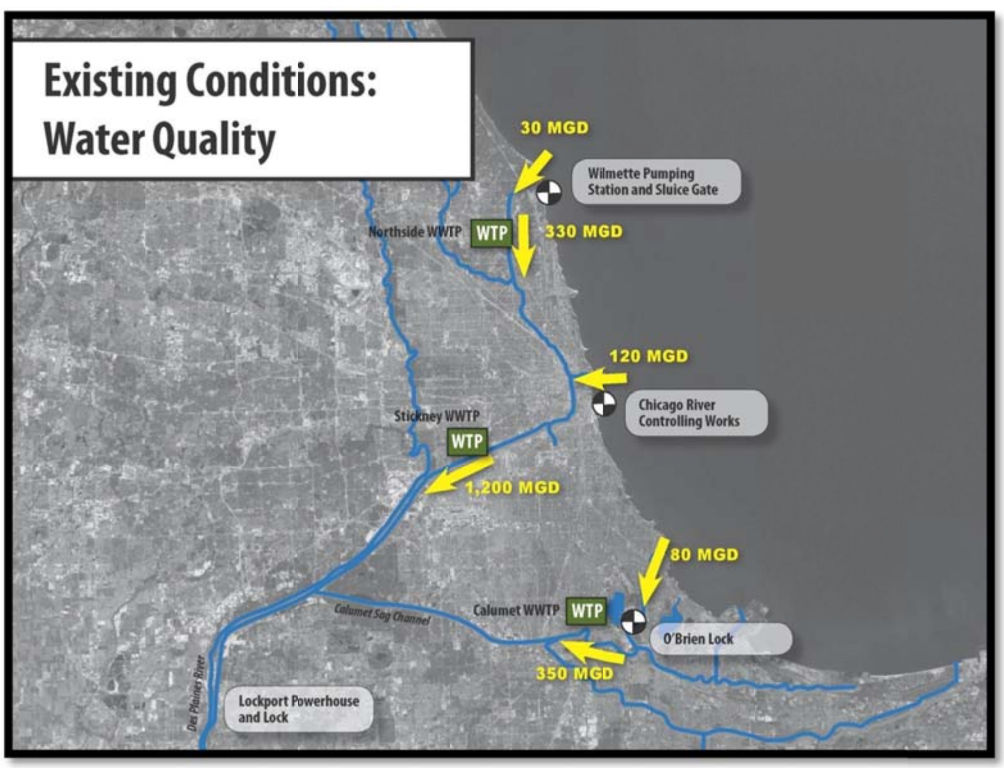
Background Information

While other factors affect the overall water quality of the CAWS and result in degraded water quality, the effluent of three major MWRDGC wastewater treatment plants (WWTPs) – the North Side, Calumet, and Stickney plants – constitutes the majority of dry-weather flow within the CAWS. Characteristics of each of these plants are identified in Table 1 below. These three facilities are well run, produce excellent-quality effluent, and have met their permit requirements for many years. Figure 1 shows the CAWS and the major WWTP locations discussed above.

Table 1. Background Information on Three MWRDGC WWTPs

Parameter	North Side WWTP	Calumet WWTP	Stickney WWTP
Design Average Flow (MGD)	330	350	1,200
Daily Maximum Flow (MGD)	450	430	1,440

Figure 1. Location of Major WWTPs within the CAWS



It is noted that three smaller WWTPs located in Indiana (Hammond/Indiana, East Chicago, and Gary) discharge to the Grand Calumet River. Discharges from the East Chicago and Gary WWTPs primarily discharge to Lake Michigan via the Grand Calumet River. While the Hammond/Indiana WWTP routinely dischargest to the CAWS via the Grand Calumet River, it also discharges to Lake Michigan under certain conditions including recent sediment remediation projects and when flood elevations on the Grand Calumet River dictate. Consequently, it is understood that under current conditions all three of these IN WWTPs have the associated treatment processes and National Pollutant Discharge Elimination System (NPDES) permits to meet Great Lakes Initiative (GLI) standards which allows them to discharge to Lake Michigan . Given that Lake Michigan water quality standards are generally more stringent than those for the CAWS, physical separation scenarios are not anticipated to significantly impact the current treatment operations of these three IN WWTPs, and they can continously discharge to Lake Michigan without substantial upgrades.

Baseline Conditions

In order to represent the uncertainty in future conditions, baseline conditions are categorized as (1) current and planned, (2) anticipated, or (3) emerging. Baseline conditions without a separation project (that is, "without project conditions") is established in order to determine and compare the impacts, improvements, required investments, and benefits associated with a separation project. *Current and planned conditions* represent activities that are either in place, programmed, or authorized for completion. *Anticipated conditions* represent activities that are most likely to occur within the planning horizon of the separation project (through 2059). Formal approval or authorization and the actual timeframe and specific details of these anticipated activities remain unknown. *Emerging conditions* represent trends beyond the current limits of planning, technology, or regulation that could be projected in the future. A brief summary of CAWS baseline conditions is provided below and summarized in Table 2 and more detailed technical information is provided in Appendix A of the Technical Report prepared for the *Restoring the Natural Divide* project.

Table 2. Summary of Baseline Water Quality Conditions

Current and Planned	Anticipated	Emerging
• Disinfection at North Side and Calumet WWTPs • TARP Completed[1]	• Disinfection at Stickney WWTP • Some level of nutrient removal at North Side, Calumet, and Stickney WWTPs (minimum level of assumed moderate Mississippi River standards, see Table 3) • Improved local/regional conveyance to TARP[1]	• Constituents not currently regulated for WWTPs • Remediation of contaminated sediments

[1] Part of Flood Management area baseline conditions in Technical Report. Included here based on relation of combined sewer overflows (CSOs) and TARP to water quality.

Current and Planned Water Quality Conditions

Water Quality Classifications and Requirements

Illinois' current water quality standards and associated wastewater discharge requirements include three basic resource classifications or "use classes." Most of the state waters fall within a General Use class, a classification intended to protect ecological and recreational uses. The CAWS does not fall within this use class; rather, it has a separate classification, Secondary Contact and Aquatic Life, which has associated standards intended to recognize the unique character and limitations of the system. This classification has lower ecological expectations with less stringent water quality standards and limited recreational use. As stated above, through improvements made during the Clean Water Act era, both the actual conditions in, and public opinion of, the CAWS as an environmental resource have improved greatly. Consequently, standards for the system are currently being revised to upgrade both the use classification and the associated water quality standards.

The third (and highest) use class in Illinois' regulations applies to Lake Michigan and its tributaries. Historically, Illinois has viewed Lake Michigan as its highest-quality and most-valued water resource. The standards adopted to protect Lake Michigan are significantly more protective than the General Use classification and, of course, the Secondary Contact and Aquatic Life classification that applies to the CAWS. This three-tiered classification system was used as the basis for comparing the water quality effects of the separation options presented below. Some results of the current reclassification mentioned above, such as the requirement to disinfect treated wastewater at the MWRDGC's North Side and Calumet WWTPs, have been factored into this assessment, while other results of the reclassification are more speculative.

In general, all three major WWTPs discharging to the CAWS operate efficiently and produce high-quality effluent that is in compliance with, and at times well below, current effluent discharge permit limits. Effluent quality from wastewater treatment refers to the efficiency and extent that oxygen demand pollutants in the sewage are broken down or removed. Note that, while the three major WWTPs produce high-quality effluent at this time, and this high-quality effluent constitutes the majority of dry-weather flow within the CAWS, other factors such as inherently low-flow/low-velocity, limited-habitat, legacy sediments and CSOs affect the overall water quality of the CAWS and result in degraded water quality. Consequently, water quality and overall environmental conditions in the CAWS are not dominated by wastewater effluent. The current permit limits for the three major MWRDGC treatment plants and their 2010 average effluent quality are presented in Appendix A of the Technical Report.

Wastewater effluents that discharge to the CAWS are not currently disinfected. However, the Illinois Pollution Control Board (Illinois PCB) has established new regulatory requirements that the North Side and Calumet WWTPs add a disinfection process as part of revising the CAWS standards. The effective compliance date to have the disinfection equipment installed and operational is March 1, 2016. Therefore, disinfection at these facilities is included in the baseline conditions for this study. Additional discussion about wastewater treatment standards and requirements anticipated in the future is provided below.

Combined Sewer Overflows

The occurrence and frequency of combined sewer overflows (CSOs) is a flood management issue as it is driven by water volumes; however, the discharge of untreated sewage to the CAWS and Lake Michigan is obviously an issue of water quality as well. Consequently, description of CSO baseline conditions is included in this water quality summary.

A flood water and sewage overflow, or combined sewer overflow (CSO), is a storm-induced discharge of untreated wastewater combined with flood water to waterways during precipitation events. Half of the CAWS drainage area (375 square miles) is served by combined sewers with 263 gravity-combined sewers capable of discharging to the CAWS (MWRDGC Website, 2011). Combined sewers convey raw sewage and flood water from minor storms to WWTPs. During larger storms, the capacity of these sewers is exceeded, and the combined flood water and sewage is allowed to discharge into waterways to reduce sanitary sewers back-ups in the Chicago area. During major storms, it is necessary to release combined flood water and sewage into Lake Michigan. The discharge of combined flood water and sewage degrades water quality and aesthetics in the CAWS and causes basement and overbank flooding. Several programs are in place to continue to reduce the volume and frequency of CSO discharges to the CAWS. In 1975, MWRDGC began construction of the Tunnel and Reservoir Plan (TARP) for flood management and water quality improvements. TARP is designed to capture discharges from combined sewers and convey the untreated wastewater to aerated reservoirs rather than let them overflow to area waterways. After being stored in the reservoirs, the untreated water is pumped to WWTPs for treatment. To date, 109 miles of tunnels are fully operational, providing 2.3 billion gallons of storage, and since TARP became operational in 1985, more than 975 billion gallons of CSOs have been captured and conveyed to WWTPs for treatment.

Two large open-surface-storage reservoirs, Thornton and McCook, are scheduled to be operational by 2015 and 2029, respectively, and will complete the TARP system. These are designed to hold 4.8 billion and 10.0 billion gallons, respectively. Consequently, a completed TARP system is included as part of the current and planned baseline conditions for this study.

Anticipated and Emerging Water Quality Conditions

Effluent limitations for discharges both to the Great Lakes and the CAWS/Mississippi River Systems are likely to become more stringent over time. Predicting the standards and their timing is a challenging undertaking that was beyond the scope of this study. The effluent limits for treated wastewater discharged to the Great Lakes System are anticipated to be more stringent than that currently expected for treated effluent discharged to the CAWS/Mississippi River System, and therefore the cost of treating wastewater to be discharged to the Great Lakes System is expected to be higher. However, costs for upgraded treatment to meet potential future effluent limitations without separation must be compared to potential costs for upgraded treatment with any of the proposed barriers and, subsequently, more stringent effluent requirements. This allows for the determination of costs that can be attributed to separation. Three future wastewater treatment requirements that fall into the anticipated and emerging category are discussed below. It was assumed that there is sufficient social and political will to allow new discharges to the Great Lakes and that the anti-degradation process would influence, but would not prevent, issuance of a permit.

Disinfection

Disinfection at Stickney WWTP is anticipated in the future but has not been mandated at this time. Since disinfection is planned and has been authorized by MWRDGC for the Calumet and North Side WWTPs, it is anticipated that disinfection will be required at the Stickney WWTP at some future time within the study period for the separation project.

Nutrients

Due to the national attention on nutrient loadings to the Gulf of Mexico and state/local Chicago area initiatives to improve water quality in the Chicago River, it is anticipated that, within the study period of the separation project, nutrient reduction will be required at some level, whether wastewater effluent is discharged to the Mississippi River System or Lake Michigan. It is anticipated that discharges to Lake Michigan would likely require more stringent phosphorus removal.

Emerging Contaminants

Although potentially dependent on discharge location (Mississippi River versus Lake Michigan), regulatory requirements for constituents not currently regulated are expected to emerge within the study period for the separation project at some level and would apply with or without the barrier separation project. While these emerging contaminants are a concern to all Great Lakes dischargers, affordable treatment technology is not currently available, and this level of treatment is generally not required at other wastewater plants that discharge to the Great Lakes. Most municipalities are addressing these concerns through source control and aggressive industrial pretreatment enforcement. Given the uncertainty of these potential regulations and the limits of current treatment technology, these emerging regulations were considered part of the baseline condition.

Potential Regulatory Requirements

Based on available information, the potential permit limit scenarios shown in Table 3 were assumed. In addition to nutrients, Table 3 lists other constituents, such as mercury, that could receive lower standards in the future, with a range of possible regulatory requirements. These estimates were developed based on items noted in the table. Potential future regulatory requirements for nitrogen and phosphorus could be met with currently practiced wastewater treatment technologies, which are described in Appendix A of the Technical Report.

Based on the best available information at the time of this study regarding potential wastewater effluent limits standards and regulatory requirements for nutrient removal and the anti-degradation process, the “Moderate” Mississippi River System and “Stringent” Great Lakes System potential regulatory requirements listed in Table 3 were assumed as the most likely scenario for the purposes of this study.

Contaminated Sediments

As described previously in the Current and Planned Conditions section, contaminated sediments have been reported in sediment samples from many of the CAWS waterways. However, the full extent, depth, and characterization of these contaminated sediments are largely unknown and would require extensive investigation and analysis to determine these specifics. While some targeted, localized sediment remediation efforts have occurred in the CAWS, no strategy currently exists for removing contaminated sediments in the broader system.

Although dependent on discharge location (Mississippi River versus Lake Michigan), regulatory requirements for remediation of contaminated sediments are expected to emerge within the study period for the separation project at some level and would apply with or without the barrier separation project. Given the uncertainty of these potential regulations, the limits of current treatment technologies, and the uncertainty of the extent of contaminated sediments in the CAWS, sediment remediation is considered a baseline condition.

Table 3. Potential Ranges of Future Regulatory Requirements

Parameter	Great Lakes System		Mississippi River System		
	Stringent	Moderate	Stringent	Moderate	Current
CBOD (mg/L)	4 [a]	4 [a]	10	10	10
TSS (mg/L)	5 [a]	5 [a]	12	12	12
Ammonia N (mg/L) Apr–Oct Nov–Mar	 0.2 [b] 0.8 [b]	 1.5 [c] 4 [c]	 0.2 [b] 0.8 [b]	 1.5 [c] 4 [c]	 2.5 4
Total – P (mg/L)	0.1 [d]	0.1 to 1 [e]	0.5 to 1 [e]	1 [e]	—
Total – N (mg/L)	3 [d]	6 [f]	3 [d]	6 [e]	—
Bacteria (ct/100 mL)	126 [g]	126 [g]	200 [h]	400 [i]	—
Mercury (ng/L)	1.3 [j]	12 [k]	12 [k]	—	500 [l]
Other BCC [m] and Emerging Contaminants	Advanced Treatment/ Monitoring/ Coincidental Treatment / Source Control	Monitoring/ Coincidental Treatment / Source Control	Monitoring/ Coincidental Treatment / Source Control	Monitoring	—

Notes:

[a] Current Lake Michigan basin effluent standards.

[b] Assuming toxicity to freshwater mollusks is the basis for revised federal ammonia criteria (about 20% of moderate values).

[c] Effluent limits based on current Lake Michigan basin tributary water quality standard for un-ionized ammonia.

[d] Current practical limit of technology. Treatment includes nitrification/denitrification and biological phosphorus removal via activated sludge, chemical addition, enhanced settling and fermentation, and anaerobic digestion; water quality-based requirements based on targets and ecoregional criteria.

[e] Treatment-based requirement; treatment includes advanced biological phosphorus removal via activated sludge and anaerobic digestion; water quality-based requirements based on targets and ecoregional criteria.

[f] Current reasonable technology limit. Treatment includes advanced nitrification/denitrification via activated sludge and anaerobic digestion; water quality-based requirements based on targets and ecoregional criteria.

[g] *E. coli* (ambient Lake Michigan water quality standard).

[h] Fecal – Current ambient water quality standard for General Use Water.

[i] Current Illinois effluent standard.

[j] Current Lake Michigan ambient water quality standard.

[k] Current water quality standard for General Use Water.

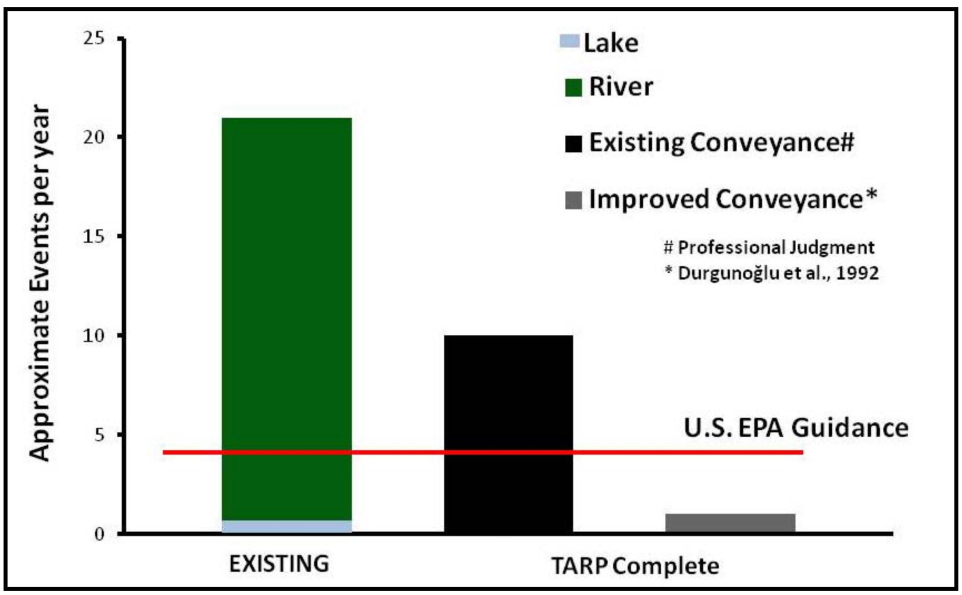
[l] Current Chicago Waterway System ambient water quality standard.

[m] Bioaccumulative chemicals of concern.

Combined Sewer Overflows and TARP

At the scheduled completion of two large storage reservoirs for TARP in 2015 and 2029, about 14.8 billion gallons of reservoir storage will be added to the combined flood water and sewage system. The former MWRDGC director has estimated that, with the completion of these TARP reservoirs, up to 10 overflow events per year could still occur from numerous existing overflow discharge locations into the CAWS (one overflow event can consist of anywhere between one and all 263 combined sewer outfalls discharging to the CAWS) (Lanyon, 2011). Additional research suggests that overflow events could be reduced to as few as one or fewer per year if the full TARP reservoir capacity is used (Durgunoglu et al., 1992). The limiting factor in reducing overflow events with TARP completed will likely be the ability to convey flows through local sewers and regional interceptor sewers/tunnels to the TARP reservoirs. In other words, enough flow conveyance capacity must be provided to make full use of reservoir storage. Figure 2 compares the potential CSO frequency under existing conditions and with TARP reservoirs completed (with existing conveyance and improved conveyance). Included is the U.S. EPA guidance that targets a goal of no more than four overflow events each year.

Figure 2. CAWS CSO Frequency

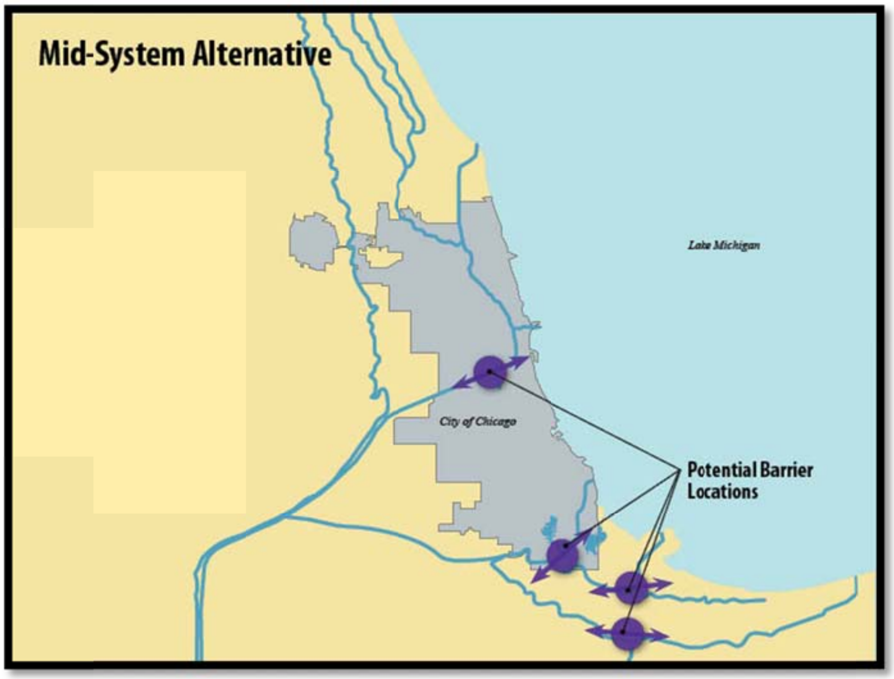


Improved conveyance to allow TARP reservoirs to be fully operational is not part of the programmed and authorized TARP project for current/future conditions. However, it is anticipated that improved conveyance for local sewers and regional interceptor sewers/tunnels will be addressed by area municipalities and agencies regardless of a separation project. Therefore, for the purposes of this study, the improved conveyance required to fully use TARP is defined as an anticipated condition included with the baseline condition.

Mid-System Alternative Water Quality Elements

The Mid-System Alternative would require four barriers to separate the two basins (Figure 3). A barrier on the South Branch Chicago River upstream of Bubbly Creek would separate the South Branch from the CSSC. The south section of the CAWS would be separated by three barriers: (1) on Little Calumet River near the USACE flood-control project at Hart Ditch, (2) on Grand Calumet River near the historic natural divide, and (3) on Calumet River immediately south of the connection with Lake Calumet (north of the T.J. O'Brien Lock and Dam and the existing railway and vehicle traffic bridge).

Figure 3. Mid-System Alternative



The proposed physical barriers would change the final discharge location for the three MWRDGC WWTPs depending on the barrier location. Table 4 summarizes the final discharge location for the three barrier alternatives.

Table 4. Mid-System Alternative Final Discharge Location for Three MWRDGC WWTPs

WWTP	Mid-System Discharge Location
North Side	Great Lakes System
Calumet	Mississippi River System
Stickney	Mississippi River System

With full implementation of the Mid-System Alternative, the North Side WWTP would require treatment upgrades beyond those identified in Part II, Baseline Conditions, to meet anticipated standards for water quality. The barriers would prevent treated effluent and augmented flows from traveling from Lake Michigan downstream toward Lockport. Therefore, stagnation is likely to occur on either side of the barrier. Flow could be augmented on both sides of the South Branch barrier by rerouting Stickney WWTP effluent and/or by providing Lake Michigan water to supply a headwater on either side of the barrier. Similarly, Calumet WWTP flow could be rerouted riverside of the Lake Calumet barrier to augment flow.

Since water quality standards are more stringent for Lake Michigan than for the CAWS, it is expected that some level of WWTP upgrades would be required for the North Side WWTP, since its effluent would be discharged to the lake with this alternative. Upgrades to the Stickney and Calumet WWTPs are not anticipated as part of the Mid-System Alternative separation, since their effluent would continue to be directed riverside of the barriers (other anticipated baseline improvements would occur without any separation alternative). Under baseline operating requirements, the North Side plant meets permit levels for river discharge. After separation, effluent will be diverted to Lake Michigan, and the discharge standards are expected to become more stringent. At a minimum, nutrient treatment improvements for removing phosphorous and nitrogen will be required. However, anti-degradation issues could emerge from such a large flow of water returning to Lake Michigan in the form of highly treated wastewater effluent. Water quality regulations are based upon an anti-degradation philosophy that even if discharge standards are met or achievable, a reduction in the beneficial use of a water body is not allowed, as described in further detail below.

Pursuant to Clean Water Act requirements and associated U.S. EPA regulations, all states must include an anti-degradation provision in their state water quality standards. While use classification and water quality standards are enacted to protect specific beneficial uses and functions of a water body, the anti-degradation provision is intended to protect high-quality water resources from degrading below their existing high quality. The substance of this provision is that new and expanding pollutant sources are allowable only if they are determined to be necessary to support important social or economic community purposes. If allowable, such new or expanded loading is subject to higher performance standards, not merely compliance with traditional standards. Any diversion option that redirects discharges currently flowing downstream to the Des Plaines and Mississippi Rivers and then to Lake Michigan would constitute a new load to Lake Michigan and therefore would be subject to the Illinois anti-degradation standards. Given the sensitivity of the Lake Michigan ecosystem, anti-degradation requirements will most likely be applied to nutrients as well as to bio-accumulative and toxic pollutants, such as mercury, that are discharged with the treated effluent.

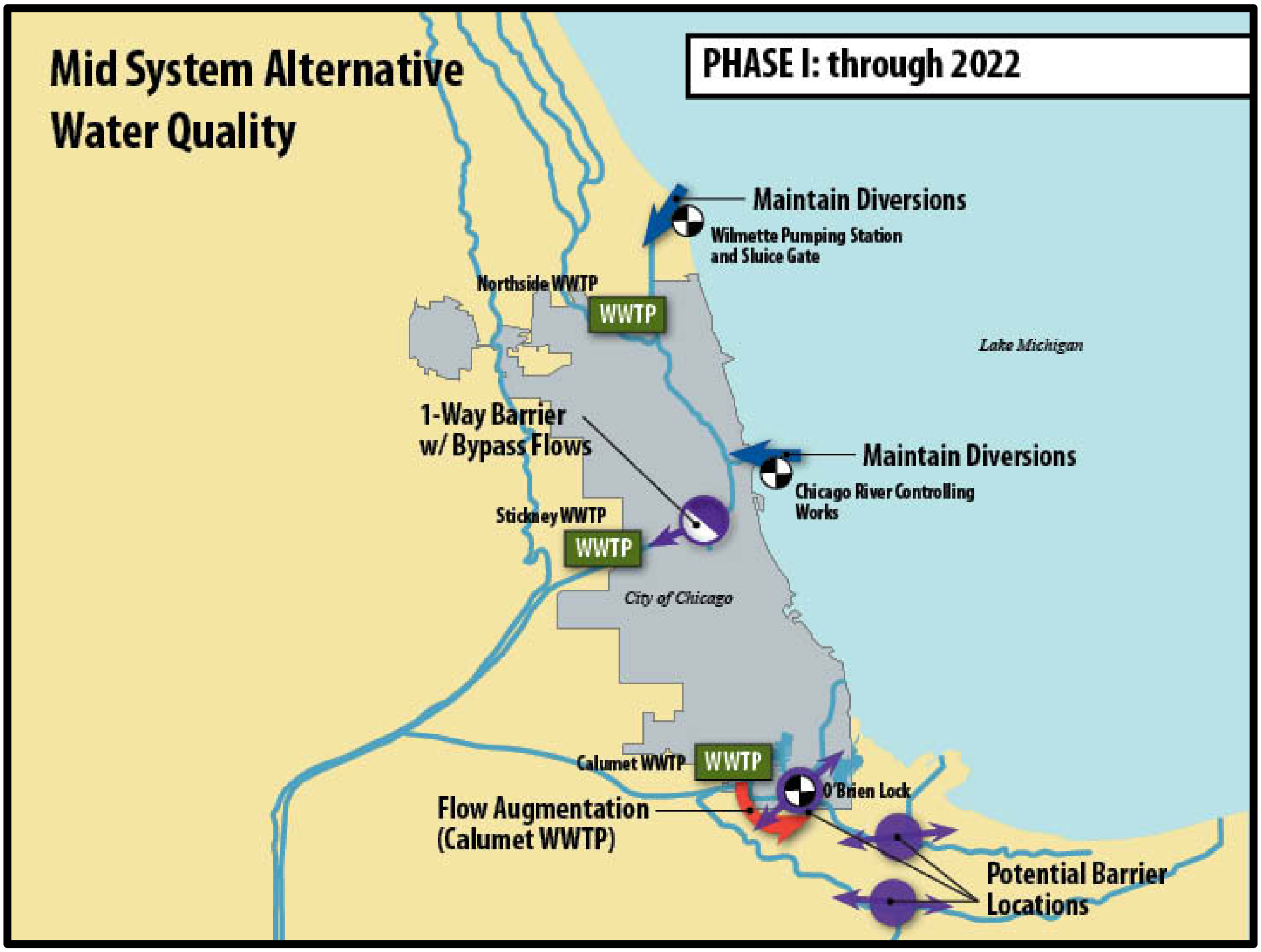
Phase I: Through 2022

The barrier near Bubbly Creek, on the South Branch of the Chicago River, would initially be constructed as a one-way barrier to address flood management and water quality requirements. The barrier would be able to bypass flows from the lakeside to the riverside only. The North Side WWTP discharge would continue to be directed riverside through the barrier (Figure 4) while improvements to the plant are being constructed. Once the improvements to the plant are constructed, green infrastructure is installed, and TARP improvements are completed, the barrier would be completed, and all flows north of the barrier would be directed toward Lake Michigan.

Phase I of this alternative would include a one-way barrier that is anticipated to be operational by 2022, resulting in:

- Water diversion through Wilmette Pump Station and CRCW for flow augmentation, as needed
- Flow augmentation from Calumet WWTP riverside of the barrier as needed

Figure 4. Water Quality Elements for Mid-System Alternative – Phase I

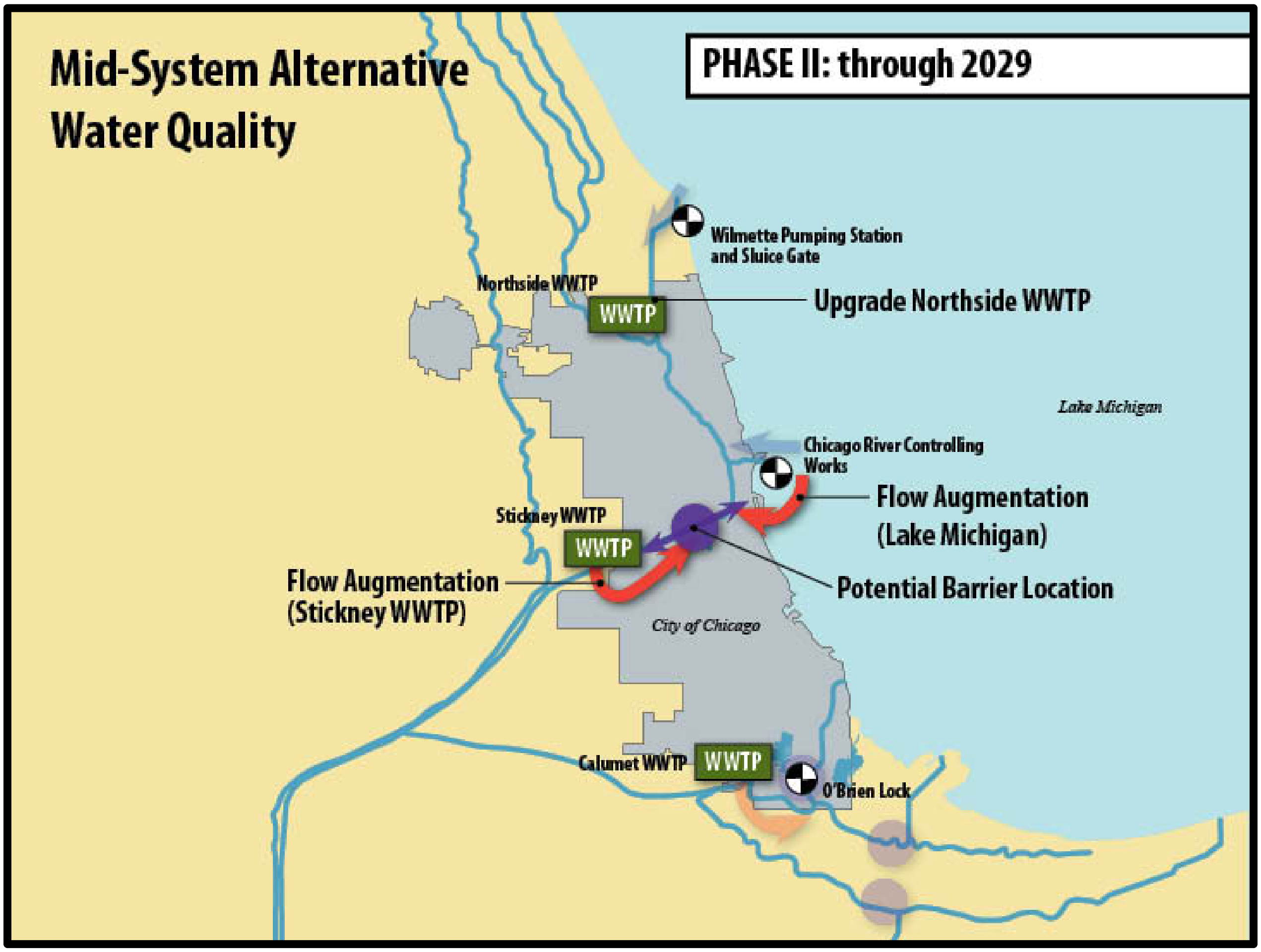


Phase II: Through 2029

Phase II would ultimately eliminate the lakeside to riverside bypass flow through the South Branch barrier, thereby providing a completed barrier and separation (Figure 5). Before ending the flow bypass, the following will be required:

- TARP will be completed for managing CSOs (considered as part of the baseline condition).
- Upgrades to North Side WWTP will be completed to address discharge to Lake Michigan and meet water quality standards.
- Management of contaminated sediments (completed as part of the baseline condition).
- Flow will be augmented riverside and lakeside of the South Branch barrier from the Stickney WWTP and Lake Michigan.

Figure 5. Water Quality Elements for Mid-System Alternative – Phase II



In summary, the overall improvements in water quality with the Mid-System Alternative would be such that water quality, recreational use of the CAWS, and potentially property values along the waterways would be maintained or improved. The proposed improvements would return portions of the water currently diverted from Lake Michigan to the lake, and water quality and flood management would be improved through using green infrastructure, restoring the floodplain, and preserving the capacity of TARP for larger floods. In addition, the improvements in combined sewer overflow management, flow augmentation, and wastewater treatment would protect and improve water quality throughout the CAWS, leading to enhanced water usage opportunities, such as recreation, and potentially increased property values.

Mid-System Alternative Water Quality Costs

While measureable investments will be needed for flow augmentation on either side of the South Branch and Calumet River barriers, the most substantial water quality investment for the Mid-System Alternative is the incremental cost for upgrading treatment at North Side WWTP from baseline conditions to discharging effluent to Lake Michigan.

The baseline costs—those costs that might occur regardless of any barrier—could vary widely based on the proposed range of regulatory requirements including no changes to the current effluent discharge permit limits within the project period ("no change" option). The baseline condition for WWTP effluent is to continue to assume that it discharges into the Mississippi River basin. It is anticipated that, within the study period for the separation project, nutrients will need to be reduced by some level. Two different levels of treatment for removing nutrients from effluent discharged to the CAWS were assumed for the baseline condition: a moderate level of treatment and a more stringent level of treatment.

These two baseline condition assumptions were then used to calculate the incremental costs of additional treatment required when discharging effluent to Lake Michigan due to placing separation barriers. Moderate and stringent levels of effluent treatment were assumed for Lake Michigan to account for uncertainty in water quality permitting for discharges that reach the lake. Therefore, the most expensive option is to modify a WWTP that is currently designed to treat effluent to a moderate river requirement to instead treat effluent to a stringent lake requirement. The least expensive option would be if a plant will be mandated to meet a stringent river requirement and now must upgrade to meet a stringent lake requirement.

Therefore, cost estimates for three different scenarios were examined for WWTPs:

- The first and most likely scenario is the **Moderate River to Stringent Lake Scenario**. This scenario assumes that the effluent quality limits required for discharges to the CAWS/Mississippi River are moderate, while those requirements for discharges to Lake Michigan are stringent. Therefore, the improvements in effluent quality required when a WWTP discharges to the lake instead of the river would be the most costly because the difference in standards would be the greatest. This scenario was assumed to be the most likely based on the best available information at the time of this study regarding potential wastewater quality standards and regulatory requirements for nutrient removal and the anti-degradation process. This scenario would also be the most costly.
- The second scenario, the **Moderate River to Moderate Lake Scenario**, assumes that both bodies of water require moderate effluent quality improvements. The resulting costs are due to the difference between the moderate river requirements and the moderate lake requirements; that is, the moderate lake requirement is higher than the moderate river requirement. This scenario would have costs that fall in between those of the other two scenarios.
- The third scenario, the **Stringent River to Stringent Lake Scenario**, assumes that both bodies of water require a similar stringent level of effluent quality improvement. This scenario would be the least costly.

Preliminary planning-level construction and operations unit cost estimates, illustrated in Table 5, were developed for incrementally adding new treatment processes to the North Side WWTP to meet either moderate or stringent treatment objectives. Nitrogen is the governing parameter for selecting processes for moderate or stringent treatment objectives. Costs related to treatment (source control, monitoring, coincidental treatment, and advanced treatment) for mercury, bioaccumulative toxics, and emerging contaminants of concern (i.e. pharmaceuticals, personal care products) are not included given the uncertainty of these potential regulations and the limits of current treatment technology.

Table 5. Preliminary Planning-Level Estimates of Incremental Additional Construction Costs and Additional Operations Costs Required to Meet Moderate and Stringent Nutrient Treatment Objectives

Scenario	Planning-Level Estimated Construction Costs ($/gpd)	Planning-Level Estimated Operations Costs ($/MG treated)
Moderate River Side Discharges	$1.90	$270
Stringent River Side Discharges	$3.50	$750
Moderate Lake Side Discharges	$2.60	$330
Stringent Lake Side Discharges	$3.50	$750

Source: WERF Sustainability Report (Falk, M.W., Neethling, J.B., Reardon, D.J., 2011, Striking the balance between nutrient removal and sustainability, WERF research project NUTR1R06n)

Notes:

[a] Construction cost estimates do not include allowances for contingencies and for associated costs for engineering, legal, and administrative costs. These would be necessary for total project cost estimates.

[b] Operations costs include energy and chemicals; no labor, maintenance, or equipment replacement costs are included.

[c] $/gpd rounded to nearest $0.05.

[d] $/MG treated rounded to nearest $10.

[e] These costs are planning-level estimates. Costs could range from +100% to -50%.

[f] Breakdown of costs is included in the Attachment Tables A1 and A2 of the Technical Report Appendix A.

The estimated project costs were developed based on the following assumptions:

- The potential range of regulatory requirements forecasted to govern future effluent limits (Table 3)
- The final discharge locations based on the barrier alternative (Table 4)
- The unit wastewater treatment processes and preliminary planning-level estimated capital and operations costs to meet the potential range of regulatory requirements (see Table 5 and Appendix A of Technical Report)

The baseline costs and the projected future scenarios of no change, moderate, and stringent riverside options at each WWTP are summarized in Table 6. The wastewater treatment cost estimates based on barrier alternative locations and unit processes required to meet the potential regulatory ranges are summarized in Table 7.

To calculate the total project-related costs, the net difference between base scenario costs and the treatment costs were calculated depending on barrier location alternatives. The permit levels for the lakeside discharges were assumed to be more stringent than the riverside discharges based on the anti-degradation process that would be driving permit limits lower. The net project costs for the Mid-System barrier locations are included in Table 8.

The estimated project construction and operations costs presented in Tables 6-8 are raw cost numbers based on 2010 dollars and only represent the costs for WWTP upgrades. When including the investments needed for flow augmentation at the barriers and adjusting all capital and O&M costs to present value, the total water quality investments estimated for the Mid-System Alternative range from $0.18 billion (stringent river/stringent lake) to $1.20 billion (moderate river/stringent lake). These investments primarily relate to WWTP upgrades at the North Side WWTP, as the $0.18 billion for the stringent river/stringent lake scenario assumes no WWTP upgrades are necessary and is composed entirely of costs related to flow augmentation at the barrier locations. The total investments for the Mid-System Alternative over the project lifecycle range from $3.26 billion to $4.27 billion, depending on what is assumed for the future effluent standards.

Table 6. Preliminary Baseline Estimates of WWTP Capital and Operations Costs for Riverside Discharge

Base Scenarios	Capital $/gpd	Operation $/MG Treated	**Capital Costs ($)** Northside	Calumet	Stickney	Total	**Operation Costs ($/Year)** Northside	Calumet	Stickney	Total
Design Average Flow (mgd) ->			330	350	1200		330	350	1200	
No permit changes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Moderate riverside discharges	$ 1.90	$ 270	$ 600,000,000	$ 700,000,000	$ 2,300,000,000	$ 3,600,000,000	$33,000,000	$34,000,000	$ 118,000,000	$ 185,000,000
Stringent riverside discharges	$ 3.50	$ 750	$ 1,200,000,000	$ 1,200,000,000	$ 4,200,000,000	$ 6,600,000,000	$90,000,000	$96,000,000	$ 329,000,000	$ 515,000,000

Table 7. Estimated WWTP Capital and Operations Costs for Lakeside Discharge

Mid System	Capital $/gpd	Operation $/MG Treated	**Capital Costs ($)** Northside	Calumet	Stickney	Total	**Operation Costs ($/Year)** Northside	Calumet	Stickney	Total
Design Average Flow (mgd) ->			330	350	1200		330	350	1200	
Moderate lakeside discharges	$ 2.60	$ 330	$ 900,000,000	$ -	$ -	$ 900,000,000	$40,000,000	$ -	$ -	$ 40,000,000
Stringent lakeside discharges	$ 3.50	$ 750	$ 1,200,000,000	$ -	$ -	$ 1,200,000,000	$90,000,000	$ -	$ -	$ 90,000,000

Notes:
Capital Costs Rounded to nearest 100,000,000
Operation Costs Rounded to nearest 10,000,000

Table 8. Estimated Project Related WWTP Upgrade Costs by Discharge Permit Scenario

	Capital Costs ($)				Operation Costs ($/Year)			
	Northside	Calumet	Stickney	Total	Northside	Calumet	Stickney	Total
Design Average Flow (mgd) ->	330	350	1200		330	350	1200	
Project Related Costs Assuming <u>Varying</u> River/Lake Discharge Permit Requirements								
Mid System								
Moderate River Permit / Stringent Lake	$ 600,000,000	$ -	$ -	$ 600,000,000	$ 57,000,000	$ -	$ -	$ 57,000,000
Stringent River Permit / Stringent Lake	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Moderate River Permit / Moderate Lake	$ 300,000,000	$ -	$ -	$ 300,000,000	$ 7,000,000	$ -	$ -	$ 7,000,000

Notes:

Capital Costs Rounded to nearest 100,000,000

Operation Costs Rounded to nearest 10,000,000