EXHIBIT A

DETAILED STUDY PLAN FOR §316(a) DEMONSTRATION TO SUPPORT APPLICATION FOR ALTERNATIVE THERMAL LIMITS AT THE WILL COUNTY GENERATING STATION

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ALU	Aquatic Life Use
ANOVA	Analysis of Variance
ANS	Aquatic Nuisance Species
AS	Adjusted Standard, thermal
ATL	Alternative Thermal Limit
BIC	Balanced, Indigenous Community
C	Celsius
CAWS	Chicago Area Waterway System
CPE	Catch-per-unit-effort
CSO	Combined Sewer Overflow
CSSC	Chicago Sanitary and Ship Canal
CTD	Conductivity, Temperature, and Depth
DELT	Deformities+Erosion+Lesions+Tumors
DGPS	Differential Global Positioning System
EA	EA Engineering, Science, and Technology, Inc., PBC
F	Fahrenheit
ft	foot (feet)
g	gram (grams)
GIS	Geographic Information System
GLMRIS	Great Lakes and Mississippi River Interbasin Study
GPS	Global Positioning System
IEPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
IWB	Index of Well-Being
IWBmod	modified Index of Well-Being
LDIP	Lower Dresden Island Pool
LLC	Limited Liability Company
m	meter (meters)
Midwest Generation	Midwest Generation, LLC
mm	millimeter (millimeters)
MRWG	Monitoring and Response Work Group
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago

NAD83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NPDES	National Pollutant Discharge Elimination System
p.	page
pp.	pages
PAH	Polycyclic Aromatic Hydrocarbons
PBC	Public Benefit Corporation
Plan	Detailed Study Plan
QHEI	Qualitative Habitat Evaluation Index
RAS	Representative Aquatic Species
RIS	Representative Important Species
RM	River Mile
RTK	Real Time Kinematic
Station	Will County Generating Station
UIW	Upper Illinois Waterway
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
Will County Station	Will County Generating Station

1. INTRODUCTION

Pursuant to Section 106.1120 of the Illinois Subpart K thermal variance regulations, 35 Illinois Administrative Code §106.1100 et seq. (the "Subpart K Regulations"), this document presents the Detailed Study Plan (the "Plan") for the Will County Generating Station ("Will County Station" or "the Station"). The Will County Station is located on the lower Lockport Pool of the Chicago Sanitary and Ship Canal ("CSSC"). The water quality standards, including water temperature limits for portions of the Upper Illinois Waterway ("UIW"), have recently been reviewed and modified by the Illinois Pollution Control Board ("IPCB") (IPCB Docket No. 2008-09, Subdocket D). The new thermal standards, which were adopted by the IPCB on 16 June 2015 and codified on 10 July 2015, will be applicable on 1 July 2018.

Midwest Generation, LLC ("Midwest Generation") intends to petition the IPCB for Alternative Thermal Limits ("ATLs") for the Station. This Plan is designed to provide necessary data for the preparation of a Clean Water Act §316(a) Demonstration under the Subpart K Regulations to support an application for ATLs in National Pollutant Discharge Elimination System ("NPDES") Permit No. IL0002208. Because of the timing of the modification to the Station operations and the duration of studies to be conducted to support the application for ATLs, Midwest Generation will require additional time beyond the 1 July 2018 applicability date of the new thermal standards to complete the process of obtaining ATLs. Therefore, on 21 July 2015, Midwest Generation filed a variance petition with the IPCB, Docket No. 16-19, seeking a 2-year variance from the new thermal standards for the period from the 1 July 2018 applicability date through 30 June 2020 for its Will County, Joliet #9, and Joliet #29 Generating Stations.

As specified in §106.1115(b) of the Subpart K Regulations, Midwest Generation met with the Illinois Environmental Protection Agency ("IEPA") on 4 November 2015 to discuss the elements of the Conceptual Study Plan that had been submitted to IEPA on 7 October 2015. Input from those discussions with IEPA is incorporated into this Plan. This Plan provides specific sampling locations, methods, frequency, and schedule, as well as data management and quality assurance/quality control procedures. Consistent with the discussion with IEPA during the 4 November 2015 meeting regarding habitat, sampling constraints, and safety issues in the CSSC, the ongoing fish sampling program in Lower Lockport Pool will be used to support the Will County Station §316(a) Demonstration, but no additional biota sampling will be required. The additional hydrothermal field surveys will be conducted during the summer of 2016 and winter of 2016-early 2017.

The receiving waterbody for the thermal discharge from the Will County Station is part of the UIW, which has been extensively studied by various dischargers, agencies, and other stakeholders over the last four decades. Site-specific studies have been conducted for the Will County Station by the power plant owners and/or operators over this time. More recently, state and federal partners have conducted a variety of studies to support efforts to limit the range expansion of non-native nuisance species, including several species of Asian carp, between the Mississippi River and Great Lakes drainage basins. Midwest Generation will coordinate the sampling program with the ongoing sampling efforts by these other entities.

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2. COMPONENTS FOR A COMPLETE DEMONSTRATION TO SUPPORT APPLICATION FOR ALTERNATIVE THERMAL LIMITS

In cooperation with the Atomic Energy Commission (predecessor to the Nuclear Regulatory Commission), the United States Environmental Protection Agency ("USEPA") developed the *Draft Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements* (1977) ("Technical Guidance Manual"). Although the Technical Guidance Manual has not been finalized, it remains the primary guidance for preparation of §316(a) Demonstrations to support a request for a variance from thermal standards in NPDES permits for electric generating stations. The Technical Guidance Manual presents several approaches for developing a complete §316(a) Demonstration: Retrospective, Predictive, and a "combined" approach.

2.1 RETROSPECTIVE APPROACH

For power plants similar to the Will County Station that have been in operation for a long period and have assembled an extensive database related to the aquatic community, the retrospective analysis uses these historical data to demonstrate that the thermal discharge has not resulted in *prior appreciable harm to the balanced, indigenous population* (community). In the case of the Will County Station, historical operation in compliance with Secondary Contact and AS 96-10 thermal standards has not caused appreciable harm to the aquatic community in the CSSC. A retrospective analysis looks at the historical effects of the thermal discharge on several community biotic categories that may, depending on site-specific conditions, include phytoplankton, zooplankton, benthic macroinvertebrates, habitat formers, and fish. This analysis may look at the abundance, distribution, diversity, long-term trends, and other indicators of the health of these biotic categories relative to areas affected by the thermal discharge and areas beyond the influence of the discharge. Based on the rationale presented in the Conceptual Study Plan and input from IEPA, the §316(b) Demonstration for the Will County Station will focus on the available aquatic habitat and the fish community in the vicinity of the Station.

2.2 PREDICTIVE APPROACH

The predictive analysis uses various metrics for measuring the physiological and behavioral responses of resident aquatic organisms to water temperature derived from laboratory studies and, in some cases, field observations. Such measures may include: mortality under acute and chronic exposure to high or low temperatures, temperature avoidance and preference, and temperature effects on spawning, development, and growth. A hydrothermal model of the receiving water will be developed to predict the rate of heat dissipation, dilution, and configuration of the thermal plume under various ambient canal flows and temperatures, meteorological conditions, and Station operating conditions. The laboratory predicted range of response temperatures of organisms can then be compared to the model predicted distribution of temperatures within the thermal discharge plume to assess the potential for mortality, blockage of migration, avoidance/exclusion from critical habitat or excessively large areas, and potential effects on spawning success, development, and growth.

2.3 APPROACH FOR THE §316(a) DEMONSTRATION FOR THE WILL COUNTY GENERATING STATION

Several recent §316(a) Demonstrations in support of ATLs that follow the USEPA's (1977) Technical Guidance Manual have been filed with IEPA, including one for the Dresden Generating Station located on the Lower Dresden Island Pool ("LDIP") of the Illinois River at the confluence of the lower Des Plaines River and the Kankakee River. These recent Demonstrations have integrated the retrospective and predictive approaches. Given the long operating history and extensive historical fish community data available for the Will County Station, EA Engineering, Science, and Technology, Inc., PBC ("EA") will use a similar approach, integrating retrospective and predictive methods to prepare the §316(a) Demonstration for the Station.

Specifically, the extensive historical database (Section 3) and ongoing fish studies will be used to develop a rationale demonstrating that the thermal discharge from the Station under the Secondary Contact and AS 96-10 standards has resulted in no "prior appreciable harm" to the balanced, indigenous community ("BIC") in the CSSC. Statistical evaluation of the data will be used to compare conditions upstream, within, and downstream of the thermal discharge and to evaluate long-term trends in community metrics. Laboratory-generated biothermal response data for Representative Important Species ("RIS") (Section 2.4) will be used in conjunction with predictive hydrothermal modeling in the vicinity of the Station to estimate the potential effects of the reduced thermal discharge (Section 4) on the BIC under selected operating and environmental conditions.

2.4 LIST OF REPRESENTATIVE IMPORTANT SPECIES

Acknowledging that it is not possible, feasible, or necessary to evaluate every species in a receiving water body, USEPA (1977) provides guidance for selection of RIS to be used for evaluating the effects of thermal discharges on the BIC. The selected species are representative of specific components of the aquatic community including:

- Target species of commercial or recreational fisheries
- Nuisance species
- State or federally listed threatened or endangered species
- Species important to the trophic structure/food chain
- Forage species
- Top level predatory species
- Thermally sensitive species.

In a report prepared for USEPA Region 5 and IEPA, Midwest Biodiversity Institute (Yoder and Rankin 2005) identified a master list of potential Representative Aquatic Species ("RAS") for evaluation of use categories and thermal standards; use of RAS in the evaluation of ATLs is equivalent to USEPA's (1977) RIS rationale process. The RIS list for the Will County Station has been drawn from these RAS lists for the Chicago Area Waterway System ("CAWS")

Aquatic Life Use ("ALU") B classification, which applies to the receiving water for the Will County Station discharge.

In its June 16, 2015 Final Opinion and Order (Docket No. 2008-09, Subdocket D), the IPCB decided that General Use Temperature Standards would apply to the CAWS ALU B classification. Selection of the RIS is based on review of 15 years of fish sampling data collected between 1994 and 2014 from the CSSC (between Romeo Road and the Lockport Lock and Dam); these data are summarized by EA (2015) in the 2014 annual fisheries report[1] (Table 1). These data were used to identify species representative of the fish community in this reach of the CSSC, e.g., numerically dominant species, various trophic levels, targets for recreational or commercial fisheries, potential nuisance species, thermally sensitive species, and state-listed threatened and endangered species; no federally-listed species occur in the CSSC. During the 15 sampling years, a total of 50 fish species has been collected (Table 1). The number of species collected per year ranged from 12 in 1994 to 28 in 2002. Five species were collected in all 15 sampling years and another nine in at least 10 of the study years. The 15 most abundant species accounted for 98 percent of the fish collected in this reach over the past 15 study years and include forage species, top predators, and commercial and recreational species. Six of these most abundant species have been selected as RIS: Bluntnose Minnow, Gizzard Shad, Green Sunfish, Largemouth Bass, Common Carp, and Channel Catfish. Other species among the 15 most abundant are forage and/or recreational species that are adequately represented by the selected species. Banded Killifish, a state-listed RIS species, has only been collected during the three most recent sampling years reported (2012-2014) (Table 1), was collected in greatest abundance in 2014. Thermally sensitive species such as White Sucker and redhorse species prefer riffle and run habitat with clean coarse substrate, particularly for spawning, and therefore, would not be expected to occur in this reach of the CSSC given the significant habitat constraints (Section 5); these species are not included as RIS, which is consistent with the Secondary Contact list developed by Yoder and Rankin (2005).

The retrospective portion of the §316(a) Demonstration will assess the distribution and condition of the BIC as a whole, as well as the distribution of the RIS, comparing the aquatic community within and outside of the influence of the Will County Station's thermal plume. For the predictive portion of the §316(a) Demonstration, thermal effects data are limited for some RIS, in which case data for closely related congeneric species will be evaluated. For example, thermal effects data would be pooled for various species of *Fundulus* spp. as a surrogate for Banded Killifish; this species was not collected in the CSSC prior to 2012.

[1] The 2014 annual fisheries report was submitted to IEPA in September 2015.

The following species are the selected RIS for evaluation of ATLs for the Will County Station in this reach of the CSSC:

Species	Abundant	Commercial[(a)]	Recreational[(b)]	Nuisance	Threated and Endangered	Forage	Predator
Gizzard Shad	X					X	
Bluntnose Minnow	X					X	
Banded Killifish					X		
Common Carp	X			X			
Channel Catfish			X				
Green Sunfish	X		X				X
Largemouth Bass	X		X				X

a. No commercial fishing currently takes place in this waterway.

b. Recreational fishing is minimal due to limited access, heavy commercial barge traffic, the presence of legacy contaminants, and long-standing consumption advisories.

3. DATA GAP ANALYSIS – REVIEW OF EXISTING DATA SOURCES

Commonwealth Edison and Midwest Generation have conducted a variety of studies since 1984 to monitor and document the condition and composition of the aquatic community, and the physicochemical conditions in the vicinity of the Will County Station. The longest running sampling programs have targeted the fish community. In addition to the work by Commonwealth Edison and Midwest Generation, the Asian Carp Regional Coordinating Committee's Monitoring and Response Work Group (MRWG) has conducted annual monitoring of various aquatic trophic groups in the CAWS since 2010, including some portions of the UIW near the Will County Station. The table below briefly summarizes the years of studies conducted or ongoing:

Data Category	Midwest Generation	MRWG
Fish	1984-1995, 2000-2002, and 2005-2015	2010-2015
Aquatic Macrophytes	1992-1995	
Phytoplankton	1991 and 1993 (MWRDGC)	2010-2015[(a)]
Zooplankton	(MWRDGC)	2010-2015[(a)]
Macroinvertebrates	1993 and 1994 (MWRDGC)	
Ichthyoplankton	2005 and 2016[(b)] (entrainment)	2010-2015[(a)]
Sediment	1994-1995	
Habitat Characterization	1993-1995	
Thermal Plume Studies	2002 and 2011	
Mixing Zone	2002 and 2011	
Intake Temperature Monitoring	Continuously for most recent 5-year period (Station collected data)	
Discharge Temperature Monitoring	Continuously for most recent 5-year period (Station collected data)	
Thermal Modeling	2011	

a. Just downstream of Lockport Lock and Dam in Brandon Pool.
b. Midwest Generation is currently planning to conduct this §316(b)-related study in 2016 at Will County Station.
Note: MWRDGC = Metropolitan Water Reclamation District of Greater Chicago.

The information presented in the table has been used to identify existing data gaps that would need to be addressed in order to meet the criteria (USEPA 1977) for a §316(a) Demonstration in support of the application for an appropriate ATL for the Station.

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4. CURRENT STATION OPERATING SCENARIO

In April 2015, Midwest Generation mothballed Unit 3 at the Will County Station, resulting in a significant reduction in the volume of cooling water discharged to the CSSC. Will County will continue to operate a single unit (Unit 4) for the foreseeable future. Although existing Station operation data may be adequate for analysis of alternative temperature limits, 2 years (~~2016~~2015-~~2017~~2016) of studies will be conducted to document the response of the aquatic community to changes in the temporal and geographical extent of the thermal plume under one-unit operation.

Similarly, approximately 2 years (~~2016~~2015-~~2017~~2016) of flow and temperature monitoring data from the Station's cooling water intake and discharge will be collected to reasonably document and characterize the thermal loading patterns and capacity factors associated with one-unit operation. Barring unusual meteorological conditions and/or atypical Station operation during the ~~2016~~2015-~~2017~~ 2016 study period, this two-year study period will provide adequate data for the development of the Danish Hydraulic Institute's MIKE 3 model (Section 6.8) that will be used for the predictive assessment of potential thermal effects to RIS under the new current operating scenario for the Will County Station. In the event meteorological or station operating conditions during the ~~2016~~2015-~~2017~~ 2016 study period do not provide adequate data for the model's predictive assessment, the study period will be extended as necessary to collect the additional data required.

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5. HABITAT AND SAMPLING CONSTRAINTS IN THE CSSC

The Will County Station is located at River Mile ("RM") 295.5, approximately 4.5 miles upstream of the Lockport Lock and Dam. The CSSC is a man-made watercourse completed in 1900 to help convey treated sewage and storm water flow away from Chicago and the city's drinking water source, Lake Michigan, to the Illinois River and eventually the Mississippi River and the Gulf of Mexico. Flow in the CSSC is completely regulated by a system of locks and dams. In much of the reach in the vicinity of the Will County Station, the CSSC was excavated into limestone with vertical side walls and a relatively deep, flat bottom to facilitate commercial navigation. As a consequence, the CSSC is an extensively modified, manipulated, and impacted waterway that has significant habitat limitations for many aquatic species. Certain of these conditions also present severe challenges for the collection of representative samples of the aquatic community. Examples of these conditions include:

1. Commercial navigation—With material barges tied up along the canal walls and frequent tugboat/barge traffic, much of the width of the canal (Figure 1) can be unsafe for sampling, and fixed, moored monitoring sensors and samplers are frequently damaged or destroyed by this traffic.
2. Substrate disturbance—Frequent movement of tugboat/barges continually disturb the bottom substrate and re-suspend fine sediments, which has an adverse effect on the benthic macroinvertebrate community.
3. Flood control management—In anticipation of significant storm events, the United States Army Corp of Engineers ("USACE") will drawdown the water level in the CSSC (Figure 2) to increase capacity to carry anticipated stormwater runoff and to control flooding. Depending on the quantity of precipitation actually received during a predicted storm event, low water levels can persist for extended periods of time. These conditions affect fish distribution, potentially strand fish in isolated pools, disrupt spawning activity, and result in desiccation of aquatic species, particularly early life stages of fish, benthic macroinvertebrates, and aquatic vegetation.
4. Combined sewer overflow ("CSO") events—CSO events associated with precipitation runoff reduce dissolved oxygen in portions of the CSSC, which can result in periodic fish kills (Figure 3).
5. USACE electric fish barrier—To impede the dispersion of exotic Asian carp from the Mississippi drainage into the Great Lakes, the USACE operates an electric fish barrier approximately 0.75 miles upstream of the Will County Station (Figure 4). While this barrier may prevent the movement of Asian carp, it also prevents the normal upstream and downstream movement of native fish. The barrier also limits the area available to sample biota upstream of the Station and can result in an accumulation of upstream migrating fish immediately downstream of the barrier.
6. Chemical management measure to control invasive fish species— In early December 2009, rotenone was applied into the water column of the CSSC from RM 296.7 to RM 291 and then detoxified with potassium permanganate. The Will County Station is within this area at RM 295.5. It was estimated that approximately 55,000 pounds of fish were removed (Wisconsin Sea Grant 2010, ANS Barrier Panel notes). At least one Bighead Carp and thousands of other fish, mainly Common Carp, were recovered in the three days

following the rotenone application (Asian Carp News Archive.htm). If such chemical management were to recur during the study period, it may affect the ability to collect representative samples of the fish community for a period of time thereafter until the fish community recovers.

7. Littoral habitat—Shallow littoral habitat, important to many aquatic species, is virtually non-existent in the vicinity of the Will County Station (Figure 5). The closest littoral habitat is more than two miles downstream of the Will County Station's discharge, near the Lockport Controlling Works.
8. Sediment quality—Persistent sediment contamination has resulted in longstanding advisories against consumption of fish.

In order for the December 2009 rotenone application to occur, the USACE prepared an Environmental Assessment. The assessment stated that "*The fish assemblage identified in the proposed eradication reach are for the most part nonnative, tolerant species that are able to withstand very poor water quality and inadequate habitat and fluvial function that is necessary to support a healthy riverine ecosystem. The portion of the Chicago Sanitary and Ship Canal to be treated is completely a man-made system and never was intended to support riverine fishes or riverine macroinvertebrates. The native fishes and macroinvertebrates that will be eradicated in consequence to removing Asian carps would quickly recolonize from both down and upstream reaches.*" (USACE 2009, p. 36).

The USACE also prepared an Environmental Assessment for a proposed upgrade of the Aquatic Nuisance Species Dispersal Barriers Project in the CSSC. This assessment stated that "*The CSSC is a created structure built to transport sewage through a heavily industrialized and urbanized area with poor water quality generally limiting the aquatic resources of the canal. For this reason, fisheries populations in the CSSC and the upper Illinois River declined over many years to a point where they were virtually nonexistent except for the most pollutant-tolerant of species. As a completely channelized structure, the CSSC only provides main channel and main channel order habitat with virtually no spawning habitat, and it significantly reduces the quality and quantity of habitat available for fish and wildlife resources.*" It also stated that "*The present day Lockport Pool of the CSSC supported no aquatic life prior to its construction. Fish species that colonized the new canal came from nearby waters including the Des Plaines River, Lake Michigan and several small streams that flowed into the CSSC.*" (USACE 2013, pp. EA 9-10).

A description of the CSSC is provided in the Great Lakes and Mississippi River Interbasin Study ("GLMRIS") Report prepared by the USACE. The GLMRIS Report presents the results of a multi-year study regarding the range of options and technologies available to prevent aquatic nuisance species movement between the Great Lakes and Mississippi River basins through aquatic connections. Concerning the CSSC, the GLMRIS Report states: "*The CSSC is a man-made channel that was constructed in 1900 to supplement and ultimately replace the Illinois and Michigan Canal as a conduit to the Mississippi River system. Its construction facilitated the reversal of the Chicago River. Industrial and commercial land use dominates the riparian zone along most of the CSSC. There is little to no canopy cover and instream habitat for aquatic life is limited. Areas of scouring, as well as pockets of deep silty sediments also occur near*

Lockport, although habitat improves slightly near the sunken barges on the west bank. Aquatic vegetation and snags are present in this shallow area with deep sand and silt deposits (MWRDGC 2008). Water and sediment quality is impaired throughout. Sediment samples collected near Lockport in 2006 contained elevated levels of cyanide and phenols. Ten-day Chironomus tentans toxicity testing on sediments collected at Lockport indicated poor habitat quality for benthic organisms (MWRDGC 2006)." (USACE 2014, Appendix B, p. B-12).

The waterway will continue to be subjected to these types of Asian carp monitoring and control activities in the future. Along with the minimal habitat provided by the CSSC environment, these activities will serve to limit any potential improvements in the aquatic community in the vicinity of Will County Station.

Given these conditions, the constraints on sampling methods and equipment, safety during sampling of this reach of the CSSC, and the relatively permanent and irreversible degradation of physical aquatic habitat, it was agreed at the 4 November 2015 meeting with IEPA that the collection of fish data as part of the ongoing sampling program in the UIW will be adequate to characterize aquatic community conditions in the vicinity of the Will County Station. It was further agreed that additional sampling of fish or other biotic categories will be impractical and is not expected to yield representative information. For these reasons, such additional sampling will not be required to support the §316(a) Demonstration for the Will County Station.

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6. STUDY PLAN FOR DEMONSTRATION TO SUPPORT ALTERNATIVE THERMAL LIMITS

6.1 PHYTOPLANKTON

Except in a few unusual circumstances, phytoplankton have generally been viewed as a biotic category with low potential for impact associated with thermal discharges to rivers. The 1977 Technical Guidance Manual supports this assumption. High reproductive capacity and short generation times of most phytoplankton species allow rapid recovery and limit potential effects to a small spatial and temporal extent. Thermal sensitivity testing has demonstrated that phytoplankton typically have relatively high thermal tolerance levels. Relatively high nutrient availability in the UIW further promotes rapid reproduction and growth.

Annual monitoring of phytoplankton productivity (chlorophyll *a*) since 2010 by the MRWG just downstream of the Lockport Lock and Dam in the upper portion of Brandon Pool provides data that could be used to assess the current status of the phytoplankton community in the vicinity of the Will County Station. Also, the MWRDGC has had weekly chlorophyll *a* data from a site in the lower Lockport Pool since at least 2003. Phytoplankton studies conducted as part of the UIW studies in 1991 and 1993 included the lower Lockport Pool and provide an historical context for changes in the phytoplankton community in response to other water quality changes over the last two decades. Given that phytoplankton are typically a low impact biotic category, the available existing information is considered adequate to characterize this component of the aquatic community and therefore, no additional studies of phytoplankton are proposed to support development of a §316(a) Demonstration.

Existing historical data for the CSSC and thermal tolerance data from scientific literature will be reviewed in the §316(a) Demonstration for the Will County Station to support the finding that phytoplankton is a low potential impact biotic category at this site.

6.2 SUBMERGED AQUATIC VEGETATION

Aquatic vegetation can provide cover and spawning habitat for some species/life stages of fish and invertebrates. Large, dense stands of macrophytes can, however, adversely affect the concentration of dissolved oxygen concentrations, particularly during the nighttime respiratory phase. During recent fisheries surveys, EA (2015) has documented significant increases in distribution and areal extent of macrophytes downstream of Lockport Lock and Dam and occasional low dissolved oxygen associated with dense mats of duckweed/algae, which impair habitat for some fish species.

The CSSC in the vicinity of the Will County Station does not provide conditions conducive to development of beds of submerged aquatic vegetation. Although water levels can fluctuate widely as a result of canal and flood control operations, typical water depth in this reach is uniformly greater than 21 ft to facilitate shipping. Both shores are lined by steep vertical limestone walls, providing no shallow littoral zone habitat and substrate is fine material that is routinely re-suspended by frequent commercial barge traffic. Limited littoral habitat is available downstream of the Lockport Controlling Works, approximately 2.5 miles downstream from the Will County discharge. No survey of submerged aquatic vegetation is proposed for the CSSC in the vicinity of the Will County Station.

6.3 ZOOPLANKTON

Similar to phytoplankton (Section 6.1), zooplankton have generally been demonstrated to be a biotic category with low potential for impact associated with thermal discharges (USEPA 1977). High reproductive capacity and short generation times allow rapid recovery and limit potential effects to very small spatial and temporal extents. Thermal testing has demonstrated that zooplankton typically have relatively high thermal tolerance levels.

The annual monitoring of zooplankton since 2010 by the MRWG just downstream of the Lockport Lock and Dam in the upper portion of Brandon Pool provides data that could be used to assess the current status of the zooplankton community in the CSSC near the Will County Station. Given that zooplankton are typically a low impact biotic category, the available existing information is considered adequate to characterize this component of the aquatic community; therefore, no additional studies of zooplankton are proposed to support development of a §316(a) Demonstration.

Existing historical data for the CSSC, if available, and thermal tolerance data from scientific literature will be reviewed in the §316(a) Demonstration for the Will County Station to support the finding that zooplankton is a low potential impact biotic category at this site.

6.4 BENTHIC MACROINVERTEBRATES

The benthic macroinvertebrate community will be analyzed and discussed in the §316(a) Demonstration in a manner similar to that described above for the phytoplankton and zooplankton communities. Benthic macroinvertebrates were sampled during the summers of 1993 and 1994 in the vicinity of the Will County Station as part of the UIW study. Additionally, benthic macroinvertebrates have been sampled by MWRDGC at one or two locations near the Station.

The USACE Environmental Assessment (2009) stated that "*the macroinvertebrate assemblage, as indicated by the MWRDGC, identified in the proposed* [rotenone] *eradication reach is also for the most part made up of very tolerant species that are able to withstand very poor water quality and inadequate habitat and fluvial function that is necessary to support a healthy riverine ecosystem. The predominant species are native bloodworms (Chironomus), and the non-native zebra mussel (Driesenna polymorpha) and rusty crayfish (Orconectes rusticus)*" (USACE 2009, p 36-37).

Frequent tugboat/barge traffic in the CSSC causes frequent disturbance of the bottom habitat and re-suspension and settling of fine sediment throughout this reach. It is likely that this ongoing disturbance of the bottom habitat plays a significant role in the modification and simplification of the benthic macroinvertebrate community described by the USACE (2009). Therefore, this Plan does not propose new sampling for benthic macroinvertebrates. However, existing historical data for the CSSC and thermal tolerance data from scientific literature will be reviewed in the §316(a) Demonstration for the Will County Station to determine whether it supports the finding that the thermal discharge from the Will County Station does not adversely affect the benthic macroinvertebrate community of the CSSC and Lower Lockport Pool.

6.5 FRESHWATER MUSSELS

The Illinois River and its headwaters once provided habitat to a diverse community of freshwater mussels; however, those populations declined dramatically following construction of the CSSC and the navigational lock and dam system.

The Illinois Natural History Survey (Price et al. 2012) conducted a regional survey for freshwater mussels in the Des Plaines River basin and other tributaries to Lake Michigan. Price et al. (2012) identified live specimens of nine freshwater mussel species; shells for another 10 species were identified, but with no live specimens. The authors reported that many species collected historically in the Des Plaines River basin have not been documented in the basin since at least 1920. Only three species (represented by dead specimens or relic shells) were identified from the one sampling location downstream of Lockport Lock and Dam in Brandon Pool. Price et al. (2012) also reported no evidence of successful reproduction (recruitment of individuals less than 30 mm or with three or fewer growth rings). Price et al. (2012) concluded that "*the Des Plaines River basin has undergone significant freshwater mussel species loss, and unless water and sediment quality improve, species loss will likely continue. Urbanization in the region has profoundly impacted the aquatic habitat available for freshwater mussels. The navigable waterways throughout the Des Plaines River basin are highly modified for navigation and waste disposal, and waterways that were formerly rivers exist now as dredged canals with artificial walls.*"

Although Price et al. (2012) did not sample for mussels in the CSSC, sampling in Brandon Pool indicates that mussel populations do not exist in the reach downstream of Lockport Lock and Dam where there is better potential mussel habitat than occurs in lower Lockport Pool. Information on current mussel distribution in the UIW is limited, however, the available evidence indicates that potential freshwater mussel habitat in the CSSC is of poor quality and that living mussel populations are not likely to exist in the vicinity of the Will County Station. Therefore, no mussel surveys are proposed in this Plan. Existing historical data, if available, will be reviewed in the §316(a) Demonstration for the Will County Station to determine whether it supports the finding that freshwater mussels are not expected to occur or be affected by the Will County Station's thermal discharge.

6.6 FISHERIES

The objective of this study will be to determine/compare the composition, distribution, abundance, condition, and incidence of anomalies of fish upstream, within the mixing zone, and downstream of the Will County Station's discharge. The ~~2016~~ 2015 and ~~2017~~ 2016 results from the ongoing monitoring program will be compared with those obtained since 1994 to evaluate spatial and temporal trends within the fish community.

Sampling of the juvenile and adult fish community in the CSSC upstream of the Lockport Lock and Dam has been conducted for more than 25 years (1984-1995, 2000-2002, and 2005-2015) by Commonwealth Edison or Midwest Generation. Sampling has included the use of electrofishing and beach seines in appropriate habitat. Except as noted below, the overall geographic and temporal coverage of these surveys is more than adequate to characterize the fish communities in the vicinity of the Will County Station and any changes that have occurred over time in response to Station operation, upstream discharger operations, and other environmental changes in the aquatic system. Due to the change in electrofishing methods in 1994, any historical comparisons will be confined to data collected since then (Table 1).

6.6.1 Field Fisheries Study

The ongoing fish sampling program consists of one location upstream of the Will County Station's discharge (Location 301), a location within and downstream of the discharge canal (Location 302), and two locations downstream of the edge of the mixing zone near the Lockport Controlling Works (Locations 302A and 302B, upstream and downstream of the Route 7 Bridge in Lockport) (Figure 6). The ongoing fish sampling program fulfills the requirements of Special Condition 17 of the Joliet Station #9 NPDES Permit (Permit Number IL0002216) and Special Condition 18 of the Joliet Station #29 NPDES Permit (Permit Number IL0064254).

Electrofishing will be conducted at all four lower Lockport Pool locations using a boat-mounted electrofishing system energized by a 230-volt, 5,000-watt three-phase AC generator. Each electrofishing zone is 500 m long. Electrofishing will be conducted in a downstream direction at all locations. Electrofishing will begin no earlier than 0.5 hours after sunrise and will finish no later than 0.5 hours before sunset. The sampling crew will consist of a driver and a netter. Both crew members will have long-handled dip nets for catching stunned fish.

Seining will be conducted at Location 302A using a 25-ft long x 6-ft deep straight seine with 3/16-inch Ace mesh. The sampling distance will depend on the area available at each location and, to the extent possible, will be kept constant during each sampling period. If electrofishing and seining are to be conducted in the same area on the same day, seining will be conducted first and at least one hour elapsed before electrofishing is conducted.

Ongoing sampling is conducted once in mid-May, once in June, and twice monthly in July, August, and September, for a total of eight sampling events. These sampling events will continue to be coordinated with MRWG to minimize cross-program interference.

6.6.2 Physicochemical Measurements

Water temperature, dissolved oxygen concentration, percent oxygen saturation, specific conductance, and Secchi disk depth will be measured at each electrofishing location during each trip. Sampling techniques and calibration procedures/frequencies will be the same as those used historically during the UIW studies (EA 2015).

6.6.3 Sample Processing

All fish will be held in source water immediately after collection and until processing. All fish will be counted and identified to the lowest practical taxonomic level, usually species. For each location and gear, a maximum of 30 specimens of each species collected will be measured for total length (mm) and weight (g). If over 30 individuals of a species are collected at any location, then 30 representative individuals will be measured and weighed. The remaining individuals of that species will be counted and a group (batch) weight recorded. Minnows (excluding all carp species, Goldfish, and their hybrids) and other small species such as darters and topminnows will be identified, counted, and batch weighed. After processing, all live fish will be returned to the river. All fish not processed in the field will be preserved in formalin, labeled, and returned to the laboratory for processing. In the laboratory, fish will be processed in the same manner as in the field.

A voucher collection of unusual or taxonomically difficult species will be compiled. All observed threatened or endangered species will be photo documented and returned live, if possible, and will not be routinely included in the voucher collection.

All fish encountered will be examined for external anomalies. External anomalies will be classified as DELT anomalies (Deformities, Erosions, Lesions, and Tumors), parasites, or "other" abnormalities. The following is a review of DELT anomalies and their causes in freshwater fishes:

1) Deformities - These anomalies can affect the head, spine, fins, and have a variety of causes including toxic chemicals, viruses, bacteria (e.g., *Mycobacterium* sp.), and protozoan parasites (e.g., *Myxosoma cerebalis*).

2) Eroded fins - These are the result of chronic disease principally caused by flexibacteria invading the fins causing a necrosis of the tissue. Necrosis of the fins may also be caused by gryodactylids, a small trematode parasite. For this study, fin erosion will be separated into three categories: slight erosion <1/3 of fin eroded; moderate erosion 1/3 to 2/3 of fin eroded, and severe erosion >2/3 of fin eroded.

3) Lesions and Ulcers - These appear as open sores or exposed tissue and can be caused by viral (e.g., *Lymphocystis* sp.) or bacterial (e.g., *Flexibacter columnaris*, *Aeromonas* spp., *Vibrio* sp.) infections.

4) Tumors - Tumors result from the loss of carefully regulated cellular proliferative growth in tissue and are generally referred to as neoplasia. In wild fish populations, tumors can be the result of exposure to toxic chemicals such as polycyclic aromatic hydrocarbons (PAHs). Viral infections (e.g., *Lymphocystis*) can also cause tumors. Parasites (e.g., *Glugea anomala* and *Ceratomyxa shasta*) may cause tumor-like masses, but are not considered tumors. Parasite masses can be squeezed and broken between the thumb and forefinger whereas true tumors are firm and not easily broken.

An external anomaly will be defined as the presence of externally visible skin or subcutaneous disorders, and is expressed as percent of affected fish among all fish processed. Only those anomalies visible to the naked eye will be recorded. The exact counts of anomalies present (e.g., the number of tumors or lesions per fish) will not be recorded.

6.6.4 Data Analysis and Interpretation

Data from electrofishing and seining will be reported as number, catch-per-unit-effort ("CPE", No./km for electrofishing and No./haul for seining), and percent abundance for each species. Index of Well-Being ("IWB") and modified IWB ("IWBmod") scores will be calculated for the electrofishing data and species richness will be calculated for both gears.

Electrofishing and seining data will be segregated by location, segment, and trip. Mean electrofishing and seining community parameters (i.e., CPEs, species richness, and IWBmod scores [electrofishing only]) will be compared on intra-year (segment vs. segment by year) and inter-year (year vs. year by segment) basis. Statistical testing (ANOVA and Tukey's Studentized Range Test) will be conducted on the electrofishing data. Analyses of relative weight and DELT anomaly data will also be on inter-year and intra-year basis. Physicochemical data collected in conjunction with these studies will be compared on a spatial basis (e.g., location vs. location and segment vs. segment).

An entrainment study conducted at the Will County Station in 2005 is a source of ichthyoplankton data in the immediate vicinity of the Station. In addition, ichthyoplankton entrainment data ~~is currently planned to be~~was collected at the Will County Station in 2016 as part of §316(b) requirements. These data will be used to characterize the species and life stages susceptible to the Station's thermal plume. No additional ichthyoplankton studies are proposed to support development of the §316(a) Demonstration.

6.7 AQUATIC HABITAT

During the UIW studies conducted from 1993 through 1995, the habitat at each fish and macroinvertebrate sampling location in lower Lockport Pool was evaluated using the Qualitative Habitat Evaluation Index ("QHEI") developed by Rankin (1989). The habitat results were summarized in *Aquatic Ecological Study of the Upper Illinois Waterway* (Commonwealth Edison 1996). They generally showed that habitat was poor upstream of Brandon Road Lock and Dam, particularly in lower Lockport Pool. Although habitat conditions improved moving downstream of the Brandon Road Lock and Dam, QHEI scores were still typically in the "poor" range of the scale. The predominant habitat in lower Lockport Pool is deep channel; other types of habitat that would contribute to the diversity and quality of overall aquatic habitat are not present or spatially limited. The habitat within each lower Lockport Pool electrofishing location will again be evaluated using the QHEI in 2016~~ and 2017~~.

New bathymetric information for the reaches influenced by the Station's discharge will be collected. These data, combined with the new QHEI survey data, will be used to generate habitat maps for this reach of the CSSC and used in the predictive portion of the §316(a) Demonstration to interpret availability and distribution of preferred habitat for the RIS within and outside of the thermal mixing zone and selected thermal isothermal contours of the Station's thermal plume. Given the extreme physical constraints on and homogeneity of habitat in lower Lockport Pool, no additional habitat mapping is proposed in this reach.

6.8 THERMAL PLUME SURVEYS AND HYDROTHERMAL MODELING

A series of thermal plume surveys were conducted during the summer of 2011 to characterize the distribution of temperatures in the thermal mixing zone at the Will County Station. The surveys included measurement of surface temperatures along a series of transects, plus 3-4 vertical temperature profiles along each transect (Figure 7). The survey area extended from approximately 3,700 ft upstream of the Will County Station's discharge to approximately 7,000 ft downstream of the discharge (Figure 7).

In order to more completely document the downstream distribution and dissipation of thermal plume temperatures and support hydrothermal modeling of the plume for the predictive assessment, the Plan proposes the addition of three transects downstream of the 7,000-ft transect (Figure 8). Because Midwest Generation mothballed Will County Unit 3 in 2015, new thermal surveys will be conducted under winter (during late 2016-early 2017) and summer (during 2016) operations. The survey data collected in 2011, along with new data collected, will be used to calibrate and validate the MIKE 3 thermal model that will be used to predict the configuration of the plume under various canal flow, meteorological, and operating conditions.

6.8.1 Bathymetry Survey

Bathymetric data will be collected along each study transect (Figures 7 and 8). They will be collected along 16 transects oriented perpendicular to flow beginning downstream of the USACE electric fish barrier to immediately upstream of the Lockport Lock and Dam. Labeled headstakes and transect markings will be set on each shore to provide visual cues during the survey. As part of the survey effort, additional data will be obtained along a diagonal line between the end of one transect and the beginning of the next transect for all but the three most downstream transects (Transects 13 to 14, Transects 14 to 15, and Transects 15 to 16) and as a continuous transect along the approximate centerline of the river to serve as cross-lines for each of the 16 survey transects. Cross-line data will be used following processing as part of the quality assurance/quality control procedures. Figures 7 and 8 show the estimated location of the 16 survey transects; the exact locations may be adjusted in the field based on observed flow conditions, location of barges tied along the canal wall, and other safety considerations.

Individual depth soundings will be collected acoustically using a Teledyne Odom Hydrotrac precision survey fathometer interfaced with a 200 kHz, narrow beam (3°) transducer (or equivalent system). The transducer will be set at a fixed depth below the waterline of the survey vessel (draft) and a correction will be applied to the soundings by the fathometer to reflect the actual depth between the water surface and riverbed. The raw depth soundings obtained by the fathometer will be ported directly to HYPACK and saved as a negative elevation value. During the survey operation, HYPACK will merge the raw soundings with time and RTK GPS position information, and store these data in files for post-processing. As HYPACK collects the raw soundings, it will also employ a geoid model to convert the negative elevation values (water depths) to elevation relative to the vertical control of North American Vertical Datum of 1988 ("NAVD 88"). This first order conversion can be accomplished in real time using the precision ellipsoid height data provided by the RTK GPS system. These elevation data will later be refined as part of the post-processing routines.

As part of the survey activity, profile measurements of the physical characteristics of the water column will be obtained three or more times on each survey date using a Seabird SBE 19 Conductivity, Temperature, and Depth ("CTD") probe in order to determine sound velocity. Sound velocity is a product of water density, which is primarily influenced by temperature in a freshwater river system. The CTD profiles will be used to calculate a series of sound velocity correctors that will later be employed in the post-processing phase of the project to adjust the raw soundings obtained by the fathometer using a fixed, assumed sound velocity.

During the post-processing phase, all the raw depth soundings will be reviewed, corrected for water column sound velocity, and normalized to a vertical datum of NAVD 88 in HYPACK's single beam editor module. At the conclusion of the processing step, the data will be compiled into a single *.XYZ text file consisting of X and Y position information and depth represented as Z. The files will be ported to a geographic information system ("GIS") database for gridding and development of a digital elevation model for the study reach.

6.8.2 Temperature Surveys

The Will County Station sampling grid will consist of the same 13 primary transects used for the 2011 survey with three new transects (transects 14, 15, and 16); transects 14-16 in Figure 8 are approximate locations for the 2016-early 2017 surveys. The transect locations (negative distances indicate distance upstream from the discharge canal) and the number of vertical stations along each transect are summarized in the following table:

Transect	Distance from Will County Discharge (ft)	No. of Verticals	Transect (cont.)	Distance from Will County Discharge (ft)	No. of Verticals
1	-3,380	3	9	3,000	3
2	-250	3	10	4,000	3
3	0	4	11	5,000	3
4	180	3	12	6,000	3
5	525	3	13	7,000	3
6	1,000	3	14	14,000	3
7	1,500	3	15	21,000	3
8	2,200	3	16	28,000	3

Transect distances are determined from the end of Will County Station's discharge canal. The end of the Will County Station discharge canal is located at Transect 3.

In addition to the cross channel transects, surface temperature data will also be collected along diagonal transects between the primary transects from transect 1 to transect 13. Upstream transects 1 and 2 will be used to establish ambient temperature conditions and to evaluate potential upstream intrusion of the thermal plume, particularly under low canal flow conditions.

Vertical profiling stations will be established along each of the primary transects. The vertical stations will be evenly spaced along each transect. More stations are located along the transect placed at the discharge canal to better characterize the lateral spread of the plumes in that area. Transect 3 has four vertical stations located at one-fifth, two-fifths, three-fifths, and four-fifths of the distance between the left and right banks. All other transects with three vertical stations have stations located at one-quarter, one-half, and three-quarters of the distance between the left and right banks. Vertical profiling stations are numbered from the left descending bank (i.e., 1/4 or 1/5 is near the left bank). In addition, one vertical station will be located at the mid-point of the Will County Station's discharge canal cross-channel transect. The thermal plume survey transects and vertical profile stations from the 2011 surveys are illustrated in Figure 7. For the 2016-early 2017 surveys, the locations of the 2011 thermal survey transects will be re-established using GPS coordinates recorded during the 2011 surveys. The approximate location of new transects (14-16) downstream of the Will County Station are shown on Figure 8; these transects and the location of the vertical profiles will be adjusted as necessary during the field surveys. The Illinois State Plane (East) NAD83 coordinate system will be used for the Will County Station surveys.

In order to reduce the total elapsed time of the surveys, particularly during the winter, the surface transect temperature measurements and the vertical temperature profile measurements will be collected concurrently by two different field crews. The surface temperature recording system consists of a Logan Enterprises thermistor probe (model 4701-2.50-25ft-TH44018-PH) interfaced with a Deban 500 module and a Trimble GeoXH DGPS (or equivalent system). The Deban module receives the signal from the thermistor and sends a voltage that responds linearly with temperature to the Campbell CR10X datalogger. The Logan/Deban temperature system has an accuracy of 0.1% full span, which corresponds to 0.05°C (0.09°F). Output from the thermistor will be stored at one second intervals in the datalogger. The DGPS stores the X and Y coordinates of the temperature probe position at one second intervals to internal memory. The system clocks on the datalogger and the DGPS are set to identical times at the beginning of each survey. Synchronized temperature and DGPS data are recorded along the primary transects, as well as along the diagonal or centerline transects.

The thermistor is attached to a fixed strut mounted on the side of the boat at a depth of 18 inches. Two thermistors, a primary and a replicate, are used during each survey. During collection of surface temperatures, the boat is driven along each transect, turned as close as possible to the shoreline, and then typically moved on a diagonal to the next transect, producing a zigzag pattern. This method is used to assist in the delineation of the surface plume between the primary transects.

Plume definition within the water column is obtained by measuring vertical temperature profiles using a Seabird CTD profiler (model SBE 19 plus). The instrument collects temperature and depth data at 0.25 second intervals as it is slowly lowered to the bottom and pulled back up to the surface. This typically results in the collection of four to six data points within every 1-ft depth interval. The DGPS is used to position the boat at the same vertical profiling stations during each survey.

Pre- and post-calibration of temperature and pressure (depth) for the Seabird CTD Profiler will be performed and documented by the vendor. During each surface plume mapping survey, two temperature probes will be deployed (designated primary and secondary) to provide a backup in case of equipment malfunctions. For each survey date, the surface temperature thermistor will be compared to the Seabird CTD by placing both instruments side-by-side in the water.

For each survey date, hourly CSSC flows will be obtained from the USGS Station at Lemont, IL (05536890). The Lemont gage is located approximately five miles upstream of the Will County Station.

6.8.3 Thermal Model

In order to predict the lateral and longitudinal dispersion of the Will County Station's thermal plume, it will be necessary to develop a hydrothermal model of the CSSC between the USACE electric fish barrier and the Lockport Lock and Dam. The Danish Hydraulic Institute's MIKE 3 model will be used to evaluate operational and ATL scenarios. MIKE 3 is a state-of-art, three-dimensional hydrodynamic model that has been accepted for use in §316(a) Demonstrations by various state environmental agencies, including IEPA. For the Will County Station, the upstream model boundary will be downstream of the USACE Electric fish barrier. The downstream model boundary will be at the Lockport Lock and Dam. A finer cell grid will be used in the vicinity of the Will County Station's discharge to the CSSC to provide increased resolution in the initial mixing region. Each cell is typically divided into 8-10 vertical layers. The model grid will include the Will County Station's intake area and discharge canal. The upstream model boundaries are parameterized by providing temperature and flow time-series files. The temperature boundary file can incorporate vertical stratification. The downstream boundary is parameterized by a time-series file of flow and/or elevation.

The MIKE 3 model will be calibrated using thermal field survey data. A calibration model run is typically started a day prior to the thermal survey to allow build-up to conditions present at the time of the survey. Hourly Station cooling water flow, intake temperature, and discharge temperature data will be provided by the Will County Station. The upstream boundary temperatures will be based on the thermographs deployed during the surveys and flow data from the Lemont USGS gage. Stratification as observed during the survey's vertical profiles in the vicinity of the upstream boundaries will be incorporated into the model. Surface heat exchange is calculated from hourly meteorological data provided to the model. Model calibration primarily consists of adjusting horizontal and vertical dispersion, and bottom friction coefficients.

During 2011, six thermal plume surveys were conducted between 13 July and 21 September and concurrent Station operational, temperature, and river flow data were compiled. The 2016-early

2017 hydrothermal modeling effort will augment the 2011 study. A final model calibration will be completed following the performance of ~~two~~ three additional thermal plume surveys, once during the summer of 2016 and ~~once~~ twice during the winter of 2016-early 2017. Station operational, river flow, and temperature data will be updated from the 2011 study data using 2016-early 2017 information. Various model scenarios will be executed with the final calibrated model. The output files from the model scenarios will be processed with particular attention given to plume behavior and zone-of-passage as a function of operations and flow.

The MIKE 3 model provides the capability to predict the three-dimensional and temporal extent of the thermal plume under complex operating conditions. The model will be used to predict plume temperatures and configuration (e.g., surface and bottom temperature distribution maps, area and volume within selected isotherms) relative to available aquatic habitat for the predictive component of the §316(a) Demonstration. The analysis for the §316(a) Demonstration will focus on isotherms representing critical thermal thresholds (e.g., acute mortality, chronic mortality, avoidance, preference, spawning temperatures) for the RIS. This model was recently used for the predictive thermal assessment at the Dresden Generating Station on LDIP, which has been accepted by the IEPA. The analysis will utilize approximately two years (~~2016~~2015-~~2017~~2016) of hourly temperature monitoring data from the Will County Station intake and discharge, and cooling water flow under the current operating conditions to support the thermal modeling effort.

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7. SCHEDULE FOR DATA COLLECTION

Multiple study years are required in order to characterize the potential variability in aquatic communities and habitat conditions, as well as decipher their trends. Although the long-term fishery program for the UIW provides a robust database for evaluating temporal trends and spatial patterns, ~~it has not been conducted during a full year of~~ two years of data will be needed under one-unit operation at Will County Station, which began in mid-April 2015. Therefore, ~~2 years (2016-2017)~~2015 and 2016 ~~of additional~~ data ~~are required~~will be used to document the response of the fish community to changes in the temporal and geographical extent of the thermal plume under one-unit operation. Specifically, fish sampling in lower Lockport Pool was or will be conducted once in early May, once in early June, and twice per month in July, August, and September in ~~2016~~ 2015 and ~~2017~~2016. This sampling in 2016 will also include the collection of new habitat data using the QHEI.

New hydrothermal surveys will be conducted once during the summer (July-August) of 2016 and ~~once~~ twice during the winter ~~(January-February) of 2017~~2016-early 2017) to characterize the thermal plume under one-unit operation. The timing of the surveys will be coordinated to coincide with periods of typical operation at the Will County Station. In addition, ~~a minimum of~~approximately 2 years (~~2016~~2015-~~2017~~2016) of flow and temperature monitoring data from the Station's cooling water intake and discharge will be necessary to reasonably document and characterize the thermal loading patterns and capacity factors associated with one-unit operation. These data are required for the development of the MIKE 3 model that will be used for the predictive assessment of potential thermal effects to RIS under the new operating scenario for the Will County Station.

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8. REPORTING

Will County Station operational data, thermal modeling results, and data from the field studies will be compiled into a series of reports. These reports will then be used, in part, to develop a separate §316(a) Demonstration. Current and historical biological data will be used to describe the biotic categories of the at-risk aquatic community while the hydrothermal modeling results will determine the potential for regulatory compliance as well as describe conditions to which the aquatic community will be exposed (e.g., temperature range, areal extent, and zone of passage). Part of this overall evaluation will be based on the selected RIS. Collectively, the analyses presented in these reports will be used to determine whether a balanced indigenous community is present in the CSSC and, if so, whether the requested Alternative Thermal Limits will adversely affect that community. If it is determined that a balanced indigenous community is not present, the analyses presented in these reports will determine whether the establishment of such a community would be prevented by continued operation of the Will County Station under the requested Alternative Thermal Limits.

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FIGURES

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Figure 1. Commercial barge traffic and material barges tied up along the CSSC downstream of Will County Generating Station.

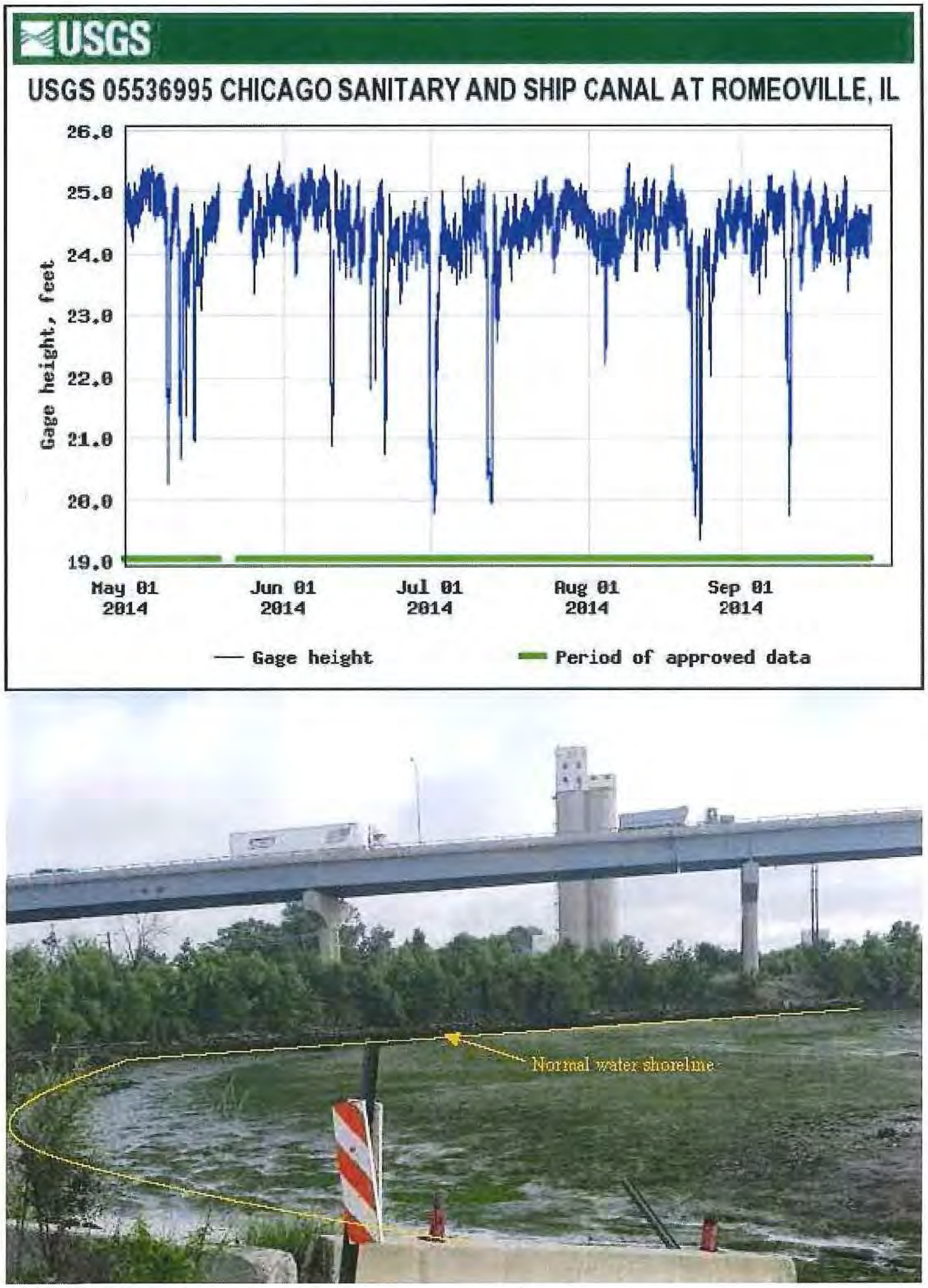

Figure 2. USGS data showing manipulations of water level in the CSSC near Will County Station and exposed littoral habitat above Lockport Lock and Dam during drawdown event, July 1, 2014.

Figure 3. Stressed and dead fish in the CSSC near Will County Station following a CSO event, 2014.

Figure 4. Location of USACE electric fish barrier in the CSSC immediately upstream of the Will County Station.

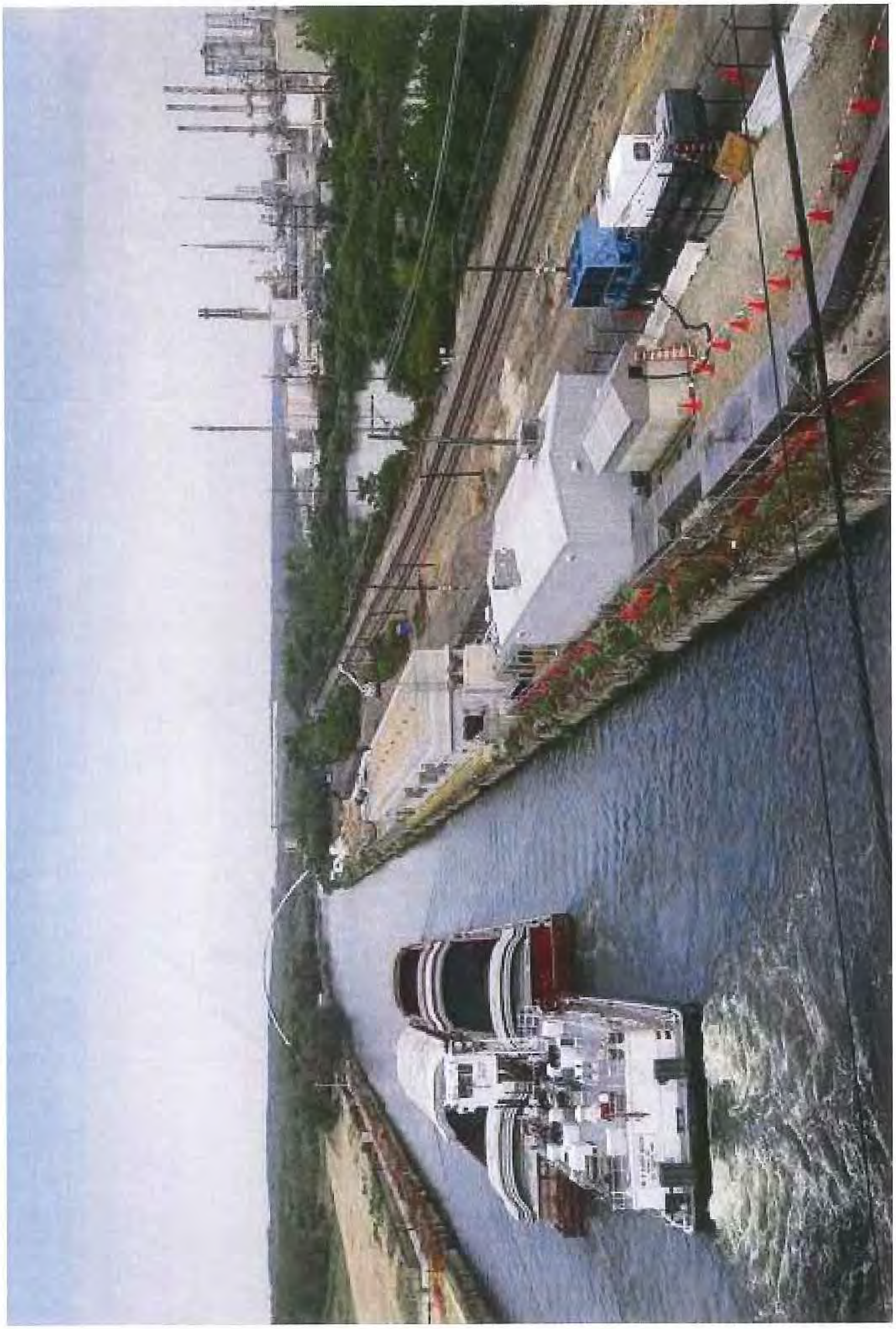

Figure 5. Reach of the CSSC in the vicinity of the electric fish barrier and the Will County Station with vertical walls and no littoral habitat.

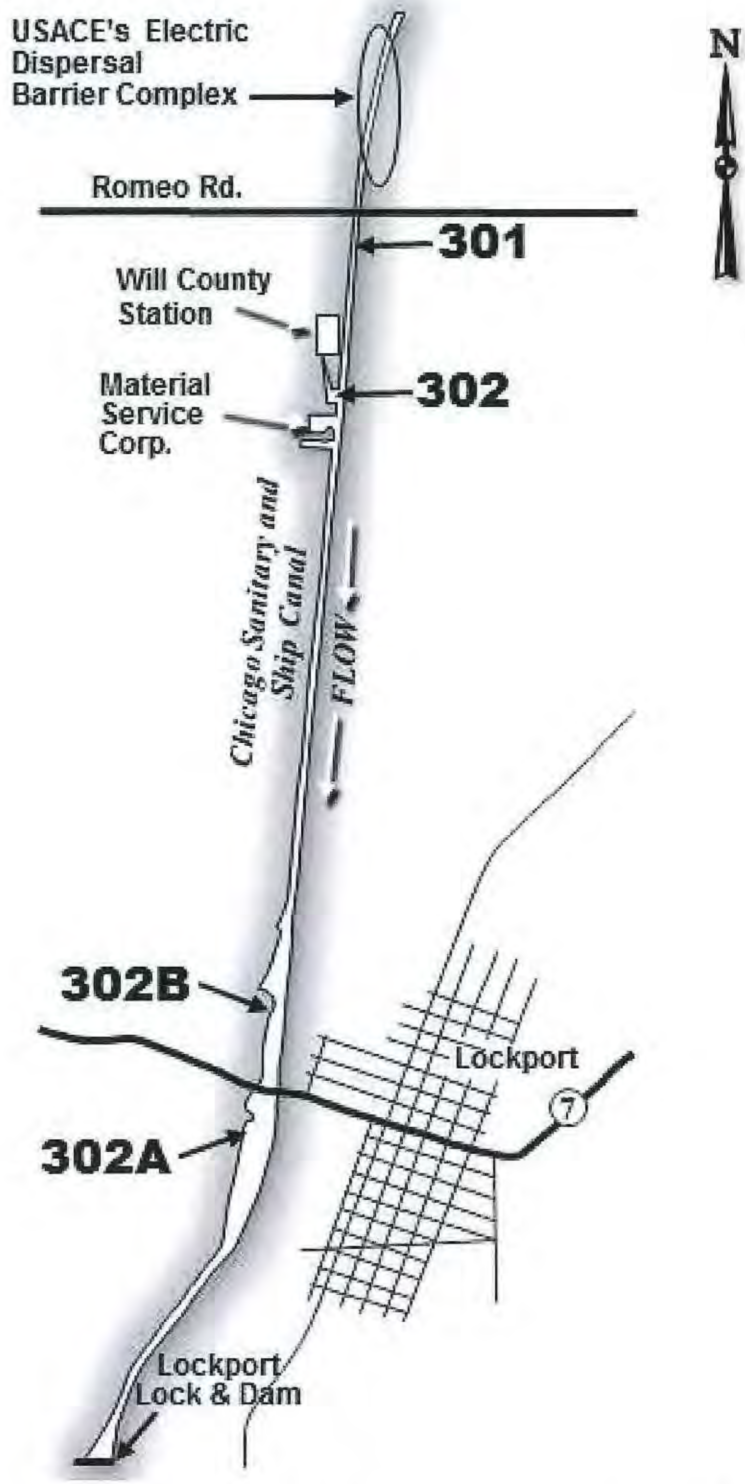

Figure 6. Fish sampling locations in Lower Lockport Pool in the vicinity of the Will County Station.


-3380
FLOW
-250
0
180
525
1000
1500
2200
1500
2200
3000
4000
FLOW
5000
6000
7000
Figure 7
Survey Transects and
Vertical Profile Locations at the
Will County Generating Station
Midwest Generation
Thermal Plume Mapping
Will County, Illinois
0 200 400
Feet
Transect
Vertical Profile
Transect Line
Shoreline
DATE
May 2012
PROJECT NO.
6241605

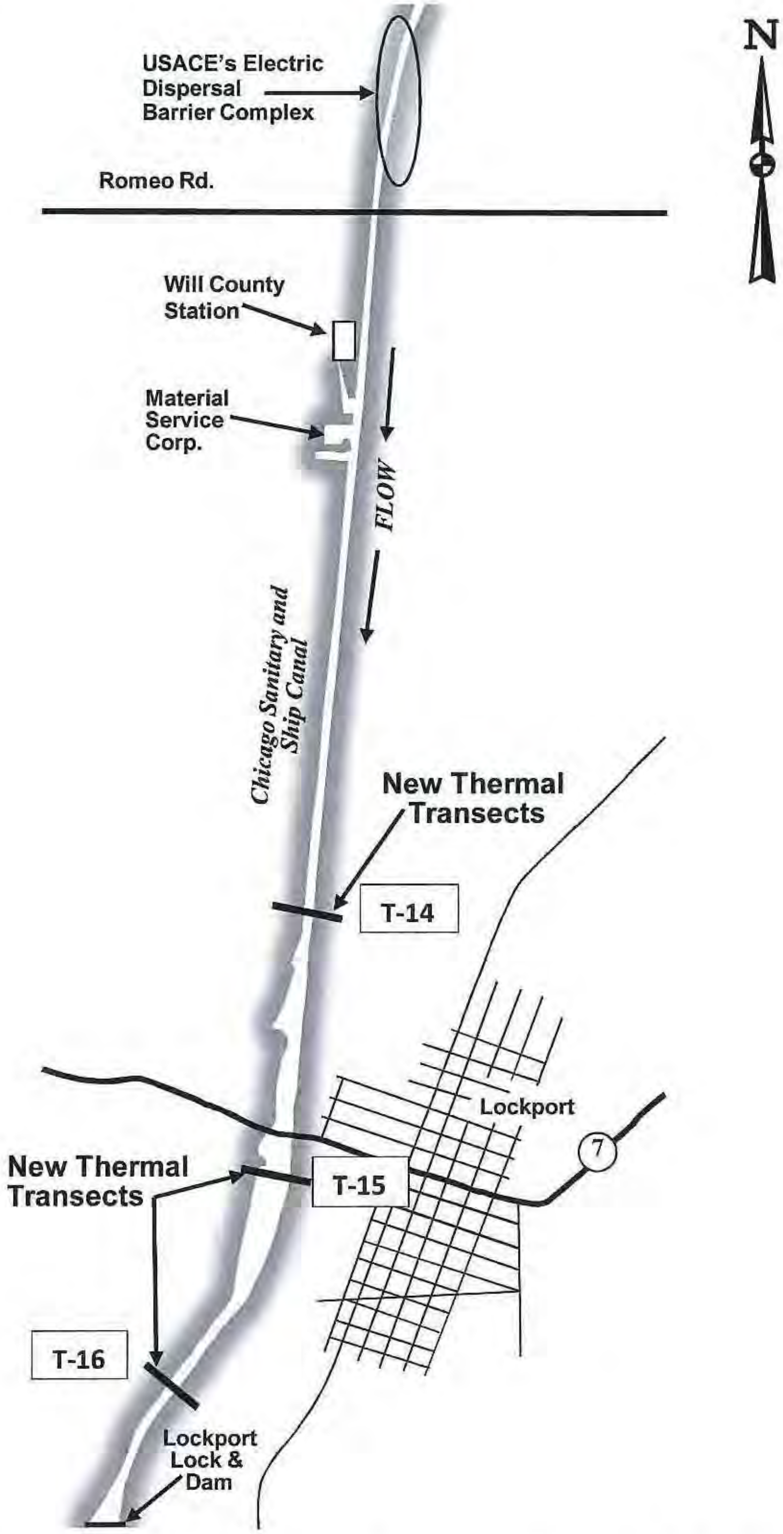

Figure 8. Approximate location of new surface temperature transects for the 2016-early 2017 hydrothermal surveys in Lower Lockport Pool in the vicinity of the Will County Station.

TABLE

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Table 1. Summary of fish abundance and relative abundance (%) in the Chicago Sanitary and Ship Canal in the vicinity of the Will County Station during 15 sampling years from 1994-2014.

SPECIES	1994		1995		2000		2001		2002		2005		2006		2007		2008	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
GIZZARD SHAD	1	1.7	33	20.6	404	64	1,615	66.8	2,500	75.8	1,245	71.2	629	61.5	1,113	61.7	932	53.2
BLUNTNOSE MINNOW	2	3.4	2	1.3	37	5.9	383	15.8	188	5.7	314	18	140	13.7	272	15.1	414	23.6
GREEN SUNFISH	1	1.7	6	3.8	16	2.5	75	3.1	110	3.3	14	0.8	31	3	84	4.7	85	4.9
EMERALD SHINER	3	5.2	21	13.1	50	7.9	178	7.4	178	5.4	24	1.4	59	5.8	134	7.4	46	2.6
BLUEGILL	2	3.4	--	--	4	0.6	19	0.8	27	0.8	10	0.6	7	0.7	24	1.3	45	2.6
PUMPKINSEED	--	--	--	--	3	0.5	3	0.1	10	0.3	--	--	55	5.4	20	1.1	69	3.9
COMMON CARP	29	50	18	11.3	53	8.4	70	2.9	140	4.2	80	4.6	38	3.7	41	2.3	26	1.5
LARGEMOUTH BASS	--	--	64	40	28	4.4	22	0.9	17	0.5	23	1.3	27	2.6	19	1.1	44	2.5
WESTERN MOSQUITOFISH	4	6.9	--	--	2	0.3	--	--	27	0.8	1	0.1	1	0.1	7	0.4	5	0.3
THREADFIN SHAD	--	--	--	--	4	0.6	--	--	--	--	--	--	--	--	--	--	8	0.5
CHANNEL CATFISH	--	--	1	0.6	5	0.8	20	0.8	22	0.7	10	0.6	13	1.3	11	0.6	5	0.3
GOLDFISH	8	13.8	2	1.3	--	--	--	--	2	0.1	--	--	--	--	1	0.1	1	0.1
ORIENTAL WEATHERFISH	--	--	--	--	1	0.2	--	--	--	--	1	0.1	3	0.3	2	0.1	2	0.1
SPOTFIN SHINER	1	1.7	--	--	16	2.5	6	0.2	20	0.6	2	0.1	--	--	7	0.4	16	0.9
ROUND GOBY	--	--	--	--	--	--	--	--	4	0.1	1	0.1	1	0.1	18	1	17	1
GOLDEN SHINER	1	1.7	--	--	--	--	--	--	15	0.5	--	--	--	--	4	0.2	--	--
YELLOW BULLHEAD	--	--	--	--	--	--	--	--	4	0.1	3	0.2	1	0.1	5	0.3	3	0.2
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	--	--	--	--	--	--	1	<0.1	3	0.1	5	0.3	6	0.6	4	0.2	6	0.3
FATHEAD MINNOW	1	1.7	1	0.6	--	--	1	<0.1	8	0.2	1	0.1	1	0.1	--	--	--	--
ORANGESPOTTED SUNFISH	--	--	--	--	--	--	--	--	3	0.1	--	--	1	0.1	1	0.1	--	--
NORTHERN SUNFISH	--	--	1	0.6	--	--	1	<0.1	--	--	--	--	--	--	7	0.4	--	--
WHITE PERCH	--	--	--	--	--	--	10	0.4	--	--	--	--	--	--	--	--	--	--
CENTRAL MUDMINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	--	--	1	0.2	--	--	3	0.1	1	0.1	--	--	--	--	1	0.1
SMALLMOUTH BASS	--	--	1	0.6	--	--	1	<0.1	1	<0.1	--	--	1	0.1	4	0.2	1	0.1
SPOTTAIL SHINER	--	--	--	--	--	--	3	0.1	1	<0.1	--	--	2	0.2	--	--	--	--
ALEWIFE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LONGNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS PICKEREL	--	--	--	--	5	0.8	1	<0.1	--	--	--	--	--	--	--	--	--	--
SKIPJACK HERRING	--	--	--	--	--	--	2	0.1	--	--	--	--	1	0.1	--	--	1	0.1
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WARMOUTH	--	--	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
WHITE SUCKER	--	--	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
YELLOW BASS	--	--	1	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BULLHEAD MINNOW	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--	--	--
BLACK CRAPPIE	--	--	1	0.6	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
WHITE CRAPPIE	--	--	--	--	--	--	--	--	2	0.1	--	--	--	--	--	--	--	--
BLACK BULLHEAD	--	--	--	--	--	--	--	--	3	0.1	--	--	--	--	--	--	--	--
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	--	--	1	0.1	--	--	--	--
SAND SHINER	--	--	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
TADPOLE MADTOM	--	--	--	--	--	--	1	<0.1	1	<0.1	--	--	--	--	--	--	--	--
BROOK SILVERSIDE	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--	--	--
WHITE BASS	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--	1	0.1
CENTRAL STONEROLLER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RAINBOW TROUT	--	--	--	--	1	0.2	--	--	--	--	--	--	--	--	--	--	--	--
THREESPINE STICKLEBACK	1	1.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
REDEAR SUNFISH	--	--	--	--	--	--	--	--	--	--	1	0.1	--	--	--	--	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LOGPERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other Taxa(b)	4	6.9	8	5.0	1	0.2	2	0.1	4	0.1	12	0.7	4	0.4	27	1.5	23	1.3
TOTAL FISH	58	100	160	100	631	100	2,417	100	3,297	100	1,748	100	1,022	100	1,805	100	1,751	100
CATCH PER GEAR EFFORT	4		11		16		60		82		44		26		45		44	
TOTAL SPECIES	12		13		16		22		28		17		20		20		21	

Table 1 (continued)

SPECIES	2009 #	2009 %	2010[a] #	2010[a] %	2011 #	2011 %	2012 #	2012 %	2013 #	2013 %	2014 #	2014 %	Average #	# Years Collected
GIZZARD SHAD	354	27.8	906	61.4	807	68.3	966	30.4	212	18.5	934	47.3	843.4	15
BLUNTNOSE MINNOW	354	27.8	237	16.1	69	5.8	417	13.1	141	12.3	138	7	207.2	15
GREEN SUNFISH	133	10.4	97	6.6	175	14.8	657	20.6	183	15.9	353	17.9	134.7	15
EMERALD SHINER	122	9.6	80	5.4	1	0.1	50	1.6	11	1	3	0.2	64.0	15
BLUEGILL	26	2	8	0.5	14	1.2	287	9	226	19.7	66	3.3	51.0	14
PUMPKINSEED	72	5.7	6	0.4	5	0.4	217	6.8	211	18.4	86	4.4	50.5	12
COMMON CARP	22	1.7	14	0.9	33	2.8	15	0.5	17	1.5	76	3.8	44.8	15
LARGEMOUTH BASS	33	2.6	29	2	22	1.9	25	0.8	53	4.6	74	3.7	32.0	14
WESTERN MOSQUITOFISH	--	--	--	--	2	0.2	265	8.3	--	--	--	--	20.9	9
THREADFIN SHAD	64	5	61	4.1	--	--	44	1.4	26	2.3	4	0.2	14.1	7
CHANNEL CATFISH	12	0.9	6	0.4	7	0.6	2	0.1	13	1.1	19	1	9.7	14
GOLDFISH	3	0.2	1	0.1	--	--	8	0.3	--	--	108	5.5	8.9	9
ORIENTAL WEATHERFISH	2	0.2	1	0.1	17	1.4	65	2	19	1.7	14	0.7	8.5	11
SPOTFIN SHINER	6	0.5	4	0.3	2	0.2	23	0.7	4	0.3	1	0.1	7.2	13
ROUND GOBY	45	3.5	--	--	1	0.1	1	<0.1	7	0.6	--	--	6.3	9
GOLDEN SHINER	4	0.3	1	0.1	--	--	25	0.8	4	0.3	17	0.9	4.7	8
YELLOW BULLHEAD	4	0.3	1	0.1	3	0.3	3	0.1	5	0.4	15	0.8	3.1	11
BANDED KILLIFISH	--	--	--	--	--	--	1	<0.1	3	0.3	39	2	2.9	3
FRESHWATER DRUM	1	0.1	2	0.1	1	0.1	--	--	3	0.3	--	--	2.1	10
FATHEAD MINNOW	--	--	1	0.1	1	0.1	7	0.2	--	--	1	0.1	1.5	10
ORANGESPOTTED SUNFISH	1	0.1	--	--	1	0.1	4	0.1	1	0.1	4	0.2	1.1	8
NORTHERN SUNFISH	--	--	--	--	1	0.1	--	--	2	0.2	--	--	0.8	5
WHITE PERCH	--	--	2	0.1	--	--	--	--	--	--	--	--	0.8	2
CENTRAL MUDMINNOW	1	0.1	4	0.3	1	0.1	1	<0.1	--	--	3	0.2	0.7	5
BLACKSTRIPE TOPMINNOW	--	--	2	0.1	--	--	--	--	1	0.1	--	--	0.6	6
SMALLMOUTH BASS	--	--	--	--	--	--	--	--	--	--	--	--	0.6	6
SPOTTAIL SHINER	--	--	1	0.1	--	--	--	--	--	--	2	0.1	0.6	5
ALEWIFE	--	--	--	--	9	0.8	--	--	--	--	--	--	0.6	1
LONGNOSE GAR	--	--	--	--	1	0.1	1	<0.1	2	0.2	3	0.2	0.5	4
GRASS PICKEREL	--	--	--	--	1	0.1	--	--	--	--	--	--	0.5	3
SKIPJACK HERRING	--	--	2	0.1	--	--	--	--	--	--	--	--	0.4	4
CREEK CHUB	--	--	2	0.1	--	--	--	--	--	--	4	0.2	0.4	2
WARMOUTH	--	--	--	--	1	0.1	2	0.1	1	0.1	--	--	0.3	4
WHITE SUCKER	--	--	--	--	--	--	--	--	--	--	4	0.2	0.3	2
YELLOW BASS	--	--	4	0.3	--	--	--	--	--	--	--	--	0.3	2
BULLHEAD MINNOW	--	--	2	0.1	--	--	--	--	1	0.1	--	--	0.3	3
BLACK CRAPPIE	--	--	1	0.1	--	--	--	--	--	--	--	--	0.2	3
WHITE CRAPPIE	--	--	1	0.1	--	--	--	--	--	--	--	--	0.2	2
BLACK BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	0.2	1
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	1	0.1	0.1	2
SAND SHINER	--	--	--	--	--	--	--	--	--	--	1	0.1	0.1	2
TADPOLE MADTOM	--	--	--	--	--	--	--	--	--	--	--	--	0.1	2
BROOK SILVERSIDE	--	--	--	--	1	0.1	--	--	--	--	--	--	0.1	2
WHITE BASS	--	--	--	--	--	--	--	--	--	--	--	--	0.1	2
CENTRAL STONEROLLER	--	--	--	--	--	--	--	--	--	--	2	0.1	0.1	1
RAINBOW TROUT	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
THREESPINE STICKLEBACK	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
REDEAR SUNFISH	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
YELLOW PERCH	--	--	--	--	1	0.1	--	--	--	--	--	--	0.1	1
LOGPERCH	1	0.1	--	--	--	--	--	--	--	--	--	--	0.1	1
Other Taxa[b]	13	1.0	--	--	5	0.4	96	3.0	3	0.3	3	0.2	13.7	--
TOTAL FISH	1,273	100	1,476	100	1,182	100	3,182	100	1,149	100	1,975	100	1,541.7	
CATCH PER GEAR EFFORT	34		37		30		80		29		49		--	
TOTAL SPECIES	20		27		25		23		23		26		50	

(a) 2010 results were likely affected by the rotenone application that occurred in December 2009.

(b) Other Taxa represent hybrids and non-species level identifications. **RIS Species** **State-listed RIS Species**

EXHIBIT B

DETAILED STUDY PLAN FOR §316(a) DEMONSTRATION TO SUPPORT APPLICATION FOR ALTERNATIVE THERMAL LIMITS AT THE JOLIET #29 GENERATING STATION

Prepared for

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Prepared by

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EA Project No. 6241617
Version: FINAL DRAFT
3 December 2015

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ALU	Aquatic Life Use
ANOVA	Analysis of Variance
AS	Adjusted Standard, thermal
ATL	Alternative Thermal Limit
BIC	Balanced, Indigenous Community
C	Celsius
CAWS	Chicago Area Waterway System
CMC	Carboxymethyl Cellulose
CPE	Catch-per-unit-effort
CSSC	Chicago Sanitary and Ship Canal
CTD	Conductivity, Temperature, and Depth
DELT	Deformities+Erosion+Lesions+Tumors
DGPS	Differential Global Positioning System
EA	EA Engineering, Science, and Technology, Inc., PBC
EPT	Ephemeroptera+Plecoptera+Trichoptera
F	Fahrenheit
ft	foot (feet)
g	gram (grams)
GIS	Geographic Information System
GPS	Global Positioning System
HD	Hester-Dendy
IEPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
IWB	Index of Well-Being
IWBmod	modified Index of Well-Being
Joliet #9 Station	Joliet #9 Generating Station
Joliet #29 Station	Joliet #29 Generating Station
km	kilometer
LDIP	Lower Dresden Island Pool
LLC	Limited Liability Company

m	meter (meters)
Midwest Generation	Midwest Generation, LLC
mm	millimeter (millimeters)
MRWG	Monitoring and Response Work Group
NAD83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
No. (#)	Number
NPDES	National Pollutant Discharge Elimination System
pp.	pages
PAH	Polycyclic Aromatic Hydrocarbons
PBC	Public Benefit Corporation
Plan	Detailed Study Plan
QHEI	Qualitative Habitat Evaluation Index
RAS	Representative Aquatic Species
RIS	Representative Important Species
RM	River Mile
RTK	Real Time Kinematic
Station	Joliet #29 Generating Station
Stations	Joliet #9 Generating Station and Joliet #29 Generating Station
UDIP	Upper Dresden Island Pool
UIW	Upper Illinois Waterway
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

Pursuant to Section 106.1120 of the Illinois Subpart K thermal variance regulations, 35 Illinois Administrative Code §106.1100 et seq. (the "Subpart K Regulations"), this document presents the Detailed Study Plan (the "Plan") for the Joliet #29 Generating Station ("Joliet #29 Station" or "the Station"). The Joliet #29 Station is located on the lower Des Plaines River ("LDPR") in the Upper Dresden Island Pool ("UDIP"). The water quality standards, including water temperature limits for UDIP, have recently been reviewed and modified by the Illinois Pollution Control Board ("IPCB") (IPCB Docket No. 2008-09, Subdocket D). The new thermal standards, which were adopted by the IPCB on 16 June 2015 and codified on 10 July 2015, will be applicable on 1 July 2018.

Midwest Generation, LLC ("Midwest Generation") intends to petition the IPCB for Alternative Thermal Limits ("ATLs") for the Station. This Plan is designed to provide necessary data for the preparation of a Clean Water Act §316(a) Demonstration under the Subpart K Regulations to support an application for ATLs in National Pollutant Discharge Elimination System ("NPDES") Permit No. IL0064254. Because of the timing of the planned modifications to the Station operations and the duration of studies to be conducted to support the application for ATLs, Midwest Generation will require additional time beyond the 1 July 2018 applicability date of the new thermal standards to complete the process of obtaining ATLs. Therefore, on 21 July 2015, Midwest Generation filed a variance petition with the IPCB, Docket No. 16-19, seeking a 2-year variance from the new thermal standards for the period from the 1 July 2018 applicability date through 30 June 2020 for its Will County, Joliet #9, and Joliet #29 Generating Stations.

As specified in §106.1115(b) of the Subpart K Regulations, Midwest Generation met with the Illinois Environmental Protection Agency ("IEPA") on 4 November 2015 to discuss the elements of the Conceptual Study Plan that had been submitted to IEPA on 7 October 2015. Input from those discussions with IEPA is incorporated into this Plan. This Plan provides specific sampling locations, methods, frequency, and schedule, as well as sample processing, data management, and quality assurance/quality control procedures. As appropriate, the new sampling effort and sampling locations will be integrated into the ongoing Upper Illinois Waterway ("UIW") fish sampling program in the vicinity of the Joliet #29 Station that fulfills Special Condition 18 of the Station's NPDES permit. Although the additional electrofishing and seining locations will be added to the 2016 fish monitoring program, the other studies described in Section 5 will be conducted in 2017 and 2018 in order to collect the data after the planned modifications to the Joliet #9 and #29 Stations are completed. Midwest Generation is in the process of converting the Joliet #9 and #29 Generating Stations from coal-fueled to natural gas. Thereafter, they will be operated as "peaking facilities" only during periods of peak system electrical demand. The 2017 and 2018 studies will be initiated a minimum of seven months after repowering is completed and modified operations begin at both the Joliet #9 and Joliet #29 Stations, which is currently scheduled to occur by 1 June 2016. This approximate seven-month period is necessary to allow sufficient time for any potential changes in the receiving waterbody associated with the modified operations to be detected by the studies.

The receiving waterbody for the thermal discharge from the Joliet #29 Station is part of the UDIP, which has been extensively studied by various dischargers, agencies, and other stakeholders over the last four decades. Site-specific studies have been conducted for the Joliet #29 Station by the power plant owners and/or operators over this time. Additionally, state and federal partners have recently conducted a variety of studies to support efforts to limit the range expansion of non-native nuisance species, including several species of Asian carp, between the Mississippi River and Great Lakes drainage basins. This additional sampling, particularly by simultaneously electrofishing and netting, has likely had a negative influence on the results from several Midwest Generation sampling locations since 2010 (EA 2015). Midwest Generation will continue to coordinate its sampling program with the ongoing sampling efforts by these other entities in order to avoid electrofishing at the same locations during the same week or on the same day, which has occurred previously.

2. COMPONENTS FOR A COMPLETE DEMONSTRATION TO SUPPORT APPLICATION FOR ALTERNATIVE THERMAL LIMITS

In cooperation with the Atomic Energy Commission (predecessor to the Nuclear Regulatory Commission), the United States Environmental Protection Agency ("USEPA") developed the *Draft Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements* (1977) ("Technical Guidance Manual"). Although the Technical Guidance Manual has not been finalized, it remains the primary guidance for preparation of §316(a) Demonstrations to support a request for a variance from thermal standards in NPDES permits for electric generating stations. The Technical Guidance Manual presents several approaches for developing a complete Demonstration: Retrospective, Predictive, and a "combined" approach.

2.1 RETROSPECTIVE APPROACH

For power plants similar to the Joliet #29 Station that have been in operation for a long period and have assembled an extensive database related to the aquatic community, the retrospective analysis uses these historical data to demonstrate that the thermal discharge has not resulted in *prior appreciable harm to the balanced, indigenous population* (community). In the case of the Joliet #29 Station, historical operation in compliance with the Secondary Contact and AS 96-10 Temperature Standards has not caused appreciable harm to the aquatic community in the UDIP. The retrospective analysis will look at the historical effects of the thermal discharge on several community biotic categories that may, depending on site-specific conditions, include phytoplankton, zooplankton, benthic macroinvertebrates, habitat formers, and fish. This analysis may look at the abundance, distribution, diversity, long-term trends, and other indicators of the health of these biotic categories relative to areas affected by the thermal discharge and areas beyond the influence of the discharge. Based on the rationale presented in the Conceptual Study Plan and input from the IEPA, the §316(a) Demonstration for the Joliet #29 Station will primarily focus on the available aquatic habitat and benthic macroinvertebrate and fish communities in the vicinity of the Station.

2.2 PREDICTIVE APPROACH

The predictive analysis uses various metrics for measuring the physiological and behavioral responses of resident aquatic organisms to water temperature derived from laboratory studies and, in some cases, field observations. Such measures may include: mortality under acute and chronic exposure to high or low temperatures, temperature avoidance and preference, and temperature effects on spawning, development, and growth. A hydrothermal model of the receiving water will be developed to predict the rate of heat dissipation, dilution, and configuration of the thermal plume under various ambient river flows and temperatures, meteorological conditions, and Station operating conditions. The laboratory predicted range of response temperatures of organisms can then be compared to the model predicted distribution of temperatures within the thermal discharge plume to assess the potential for mortality, blockage of migration, avoidance/exclusion from critical habitat or excessively large areas, and potential effects on spawning success, development, and growth.

2.3 APPROACH FOR THE §316(a) DEMONSTRATION FOR THE JOLIET #29 GENERATING STATION

Several recent §316(a) Demonstrations in support of ATLs that follow the USEPA's (1977) Technical Guidance Manual have been filed with IEPA, including one for the Dresden Generating Station located on the Lower Dresden Island Pool ("LDIP") of the Illinois River at the confluence of the LDPR and the Kankakee River. These recent Demonstrations have integrated the retrospective and predictive approaches. Given the long operating history and extensive historical fish community data available for the Joliet #29 Station, EA Engineering, Science, and Technology, Inc., PBC ("EA") will use a similar approach, integrating retrospective and predictive methods to prepare the §316(a) Demonstration for the Station.

Specifically, the extensive historical database (Section 3) and new sampling data (Section 5) will be used to develop a rationale demonstrating that the thermal discharge from the Station under the Secondary Contact and AS 96-10 Temperature Standards has resulted in no "prior appreciable harm" to the balanced, indigenous community ("BIC"). Statistical evaluation of the data will be used to compare conditions upstream, within, and downstream of the thermal discharge, and to evaluate long-term trends in community metrics. Laboratory-generated biothermal response data for Representative Important Species ("RIS") (Section 2.4) will be used in conjunction with predictive hydrothermal modeling of the UDIP to estimate the potential effects of the modified thermal discharge (Section 4) on the BIC under selected operating and environmental conditions.

2.4 LIST OF REPRESENTATIVE IMPORTANT SPECIES

Acknowledging that it is not possible, feasible, or necessary to evaluate every species in a receiving water body, USEPA (1977) provides guidance for selection of RIS to be used for evaluating the effects of thermal discharges on the balanced, indigenous community. The selected species are representative of specific components of the aquatic community and include:

- Target species of commercial or recreational fisheries
- Nuisance species
- State or federally listed threatened or endangered species
- Species important to the trophic structure/food chain
- Forage species
- Top level predatory species
- Thermally sensitive species.

In a report prepared for USEPA Region 5 and IEPA, Midwest Biodiversity Institute (Yoder and Rankin 2005) identified a master list of potential Representative Aquatic Species ("RAS") for evaluation of use categories and thermal standards; use of RAS in the evaluation of ATLs is equivalent to USEPA's (1977) RIS rationale. The RIS list for the Joliet #29 Station considered species listed by Yoder and Rankin (2005) and the UDIP Aquatic Life Use ("ALU") classification.

In its June 16, 2015 Final Opinion and Order (Docket No. 2008-09, Subdocket D), the IPCB decided that General Use Temperature Standards would apply to the UDIP ALU classification in which the Joliet #29 Station is located. Selection of the RIS is based on review of 20 years of fish sampling data collected between 1994 and 2014 from the UDIP (between Brandon Road Lock and Dam and the I-55 Bridge); these data are summarized by EA (2015) in the 2014 annual fisheries report[1] (Table 1). These data were used to identify species representative of the fish community in the UDIP, e.g., numerically dominant species, various trophic levels, targets for recreational or commercial fisheries, potential nuisance species, thermally sensitive species, and state-listed threatened and endangered species; no federally-listed species occur in the UDIP. During the 20 sampling years, a total of 82 species has been collected. The number of species collected per year ranged from 36 in 1994 and 1995 to 58 in 2014. Twenty-one species were collected in all 20 sampling years and another 10 in at least 17 years. The 15 most abundant species accounted for nearly 90 percent of the fish collected in the UDIP and include forage species, top predators, commercial, and recreational species. Seven of these most abundant species have been selected as RIS: Bluntnose Minnow, Gizzard Shad, Bluegill, Largemouth Bass, Common Carp, Channel Catfish, and Freshwater Drum. Other species among the 15 most abundant are forage and/or recreational species that are adequately represented by the selected species. White Sucker, considered to be a thermally sensitive species, was also selected as a RIS; however, White Sucker is uncommon in the UDIP. Although it has been collected in 17 of the past 20 years, the collection rate was less than five per year. Banded killifish, a state-listed species, has been collected in relatively low numbers (nine or fewer) during the three most recent sampling years reported (2012-2014). Only two River Redhorse have been collected, one in 1994 and one in 2003. Nevertheless, both of these state-listed species have been included as RIS. The River Redhorse and White Sucker prefer riffle and run habitat with clean coarse substrate, particularly for spawning and, therefore, would not be expected to be common in the UDIP that consists of slow water currents and predominantly soft, fine substrates.

The retrospective portion of the §316(a) Demonstration will assess the distribution and condition of the BIC as a whole, as well as the distribution of the RIS, comparing the aquatic community within and outside of the influence of the Joliet #29 Station's thermal plume. For the predictive portion of the §316(a) Demonstration, thermal effects data are limited for some RIS (e.g., state-listed species such as River Redhorse), in which case surrogate species will be used. For example, the limited thermal effects data for various redhorse species will be pooled as a surrogate for River Redhorse. Similarly, thermal effects data will be pooled for various species of *Fundulus* spp. as a surrogate for Banded Killifish; this species was not collected in the UDIP prior to 2012 (Table 1).

[1] The 2014 annual fisheries report was submitted to IEPA in September 2015.

The following species are the RIS selected for evaluation of ATLs for the Joliet #29 Station and UDIP:

Species	Abundant	Commercial[a]	Recreational[b]	Nuisance	Threatened and Endangered	Forage	Predator	Sensitive
Gizzard Shad	X					X		
Bluntnose Minnow	X					X		
Banded Killifish					X			
River Redhorse			X		X			X
White Sucker								X
Common Carp	X			X				
Channel Catfish			X					
Bluegill	X		X				X	
Largemouth Bass	X		X				X	
Freshwater Drum		X					X	

a. No commercial fishing currently takes place in this waterway.
b. Recreational fishing occurs; however, due to the presence of legacy contaminants, there is a long-standing fish consumption advisory.

3. DATA GAP ANALYSIS – REVIEW OF EXISTING DATA SOURCES

Commonwealth Edison and Midwest Generation have conducted a variety of studies since 1977 to monitor and document the condition and composition of the aquatic community and the physicochemical conditions in the vicinity of the Joliet #29 Station (e.g., Commonwealth Edison 1996 and EA 2015). The longest running sampling programs have targeted the fish community. In addition to the work by Commonwealth Edison and Midwest Generation, the Asian Carp Regional Coordinating Committee's Monitoring and Response Work Group (MRWG) has conducted annual monitoring of various aquatic trophic groups in the UIW since 2010, including the UDIP near the Joliet #29 Station. The table below briefly summarizes the years of studies conducted or ongoing.

Data Category	Midwest Generation	MRWG
Fish	1977-1995 and 1997-2015	2010-2015
Aquatic Macrophytes	1985 and 1995	
Phytoplankton	1991 and 1993	2010-2015[(a)]
Zooplankton		2010-2015[(a)]
Macroinvertebrates	1993 and 1994	
Ichthyoplankton	2004-2005 and 2016 at Joliet #9[(b)]	2010-2015[(a)]
Sediment	1994-1995 and 2008	
Habitat Characterization	1993-1995, 2003, and 2008	
Thermal Plume Studies	2002 and 2012	
Mixing Zone	2002 and 2012	
Intake Temperature Monitoring	Continuously for most recent 5-year period (Station collected data)	
Discharge Temperature Monitoring	Continuously for most recent 5-year period (Station collected data)	
Thermal Modeling		

a. Near the I-55 Bridge in UDIP.
b. Midwest Generation is currently planning to conduct this §316(b)-related study in 2016 at the Joliet #9 Station.

The information presented in the table above has been used to identify existing data gaps that would need to be addressed in order to meet the criteria (USEPA 1977) for a §316(a) Demonstration in support of the application for appropriate ATLs for the Station.

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4. FUTURE STATION OPERATING SCENARIOS

Midwest Generation is in the process of converting the Joliet #9 and #29 Generating Stations from coal-fueled to natural gas, which is currently scheduled to be completed by 1 June 2016. Thereafter, they will be operated as "peaking facilities" only during periods of peak system electrical demand. Two years (2017-2018) of flow and temperature monitoring data from the Stations' cooling water intakes and discharges, including helper cooling tower operations at the Joliet #29 Station, will be necessary to reasonably document and characterize the thermal loading patterns and capacity factors associated with the future operations. Barring unusual meteorological conditions and/or atypical Station operation during the 2017-2018 study period, this two-year study period will provide adequate data for the development of the Danish Hydraulic Institute's MIKE 3 model (Section 5.8) that will be used for the predictive assessment of potential thermal effects to RIS under the new operating scenarios for the Joliet Stations. In the event meteorological or Station operating conditions during the 2017-2018 study period do not provide adequate data for the model's predictive assessment, the study period will be extended as necessary to collect the additional data required.

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5. STUDY PLAN FOR DEMONSTRATION TO SUPPORT ALTERNATIVE THERMAL LIMITS

5.1 PHYTOPLANKTON

Except in a few unusual circumstances, phytoplankton have generally been viewed as a biotic category with low potential for impact associated with thermal discharges to rivers. The 1977 Technical Guidance Manual supports this assumption. High reproductive capacity and short generation times of most phytoplankton species allow rapid recovery and limit potential effects to a very small spatial and temporal extent. Thermal sensitivity testing has demonstrated that phytoplankton typically have relatively high thermal tolerance levels. Relatively high nutrient availability in the UIW further promotes rapid reproduction and growth.

Annual monitoring of phytoplankton productivity (chlorophyll *a*) since 2010 by the MRWG near the I-55 Bridge in the UDIP provides data that can be used to assess the status of the phytoplankton community in the vicinity of the Joliet #29 Station. Phytoplankton studies conducted as part of the UIW studies in the UDIP during 1991 and 1993 provide an historical context for changes in the phytoplankton community in response to other water quality changes over the last two decades. Given that phytoplankton are typically a low impact biotic category, the available existing information is considered adequate to characterize this component of the aquatic community and therefore, no additional studies of phytoplankton are proposed to support development of a §316(a) Demonstration.

Existing historical data for the UDIP and thermal tolerance data from scientific literature will be reviewed in the §316(a) Demonstration for the Joliet #29 Station to support the finding that phytoplankton is a low potential impact biotic category at this site.

5.2 SUBMERGED AQUATIC VEGETATION

Aquatic vegetation can provide cover and spawning habitat for some species/life stages of fish and invertebrates. Large, dense stands of macrophytes can, however, adversely affect dissolved oxygen concentrations, particularly during the nighttime respiratory phase. During recent fisheries surveys, EA (2015) has documented significant increases in distribution and areal extent of macrophytes in the UDIP and occasional low dissolved oxygen associated with dense mats of duckweed/algae, which impair habitat for some fish species.

As part of the habitat mapping (Section 5.7), a survey of macrophytes in the reach of the UDIP between the entrance to the Joliet #29 Station's intake canal and the I-55 Bridge will be conducted to document the extent and dominant macrophyte species. The survey will be performed once during the peak of the growing season, July-August 2017. The survey will consist of mapping the approximate boundary of these macrophyte beds using a Global Positioning System ("GPS") and identifying the dominant species at selected transects from the outer edge of the bed to the shoreline.

Transects will be established at the rate of approximately two transects (one right bank and one left bank) per half mile of the study area. Approximately 15 paired right and left bank transects will be surveyed:

- Six between the Joliet #29 intake canal and the mouth of Rock Run;
- Four from Rock Run to the head of Treats Island;
- One at the upstream and a second at the downstream end of Treats Island; and
- Three between Treats Island and the I-55 Bridge.

Transect locations will be selected by the aquatic botanist directing the survey based on field observation of conditions at the time of the survey. The dominant species will be identified and an estimate will be made of the percent coverage of the area by each dominant species along each transect. GPS coordinates will be uploaded to a project geographic information system (GIS) to generate vegetation shape files that will be overlayed on plume maps generated from the MIKE 3 model and the bathymetric survey maps.

5.3 ZOOPLANKTON

Similar to phytoplankton (Section 5.1), zooplankton have generally been demonstrated to be a biotic category with low potential for impact associated with thermal discharges (USEPA 1977). High reproductive capacity and short generation times allow rapid recovery and limit potential effects to very small spatial and temporal extents. Thermal testing has demonstrated that zooplankton typically have relatively high thermal tolerance levels.

Annual monitoring of the zooplankton community since 2010 by the MRWG near the I-55 Bridge in the UDIP provides data that can be used to assess the status of the zooplankton community in the vicinity of the Joliet #29 Station. Given that zooplankton are typically a low impact biotic category, the available existing information is considered adequate to characterize this component of the aquatic community; therefore, no additional studies of zooplankton are proposed to support development of a §316(a) Demonstration.

Existing historical data for UDIP and thermal tolerance data from scientific literature will be reviewed in the §316(a) Demonstration for the Joliet #29 Station to support the finding that zooplankton is a low potential impact biotic category at this site.

5.4 BENTHIC MACROINVERTEBRATES

Because benthic macroinvertebrates can be an important source of food for many fish species, this biotic category will receive more detailed analysis in the §316(a) Demonstration than the phytoplankton and zooplankton communities described above. Benthic macroinvertebrates were sampled during the summers of 1993 and 1994 in the vicinity of the Joliet #29 Station as part of the UIW study (Commonwealth Edison 1996). Data for this biotic category are now more than 20 years old.

Because the Joliet #29 Station’s thermal discharge results in a buoyant thermal plume, the warmest temperatures associated with the thermal discharge are near the surface of the UDIP;

therefore, habitat for benthic macroinvertebrates has minimal exposure to the warmest portions of the plume that occur in the immediate vicinity of the Station. Consequently, exposure of benthic macroinvertebrates to higher temperatures in the thermal plume is typically limited in the vicinity of the Joliet #29 Station.

Given the importance of macroinvertebrates to the aquatic food chain, this Plan will implement 2 years (2017 and 2018) of benthic macroinvertebrate sampling to document the condition of this biotic category and provide information to evaluate the potential effects of the thermal plume from the Joliet #29 Station. The objectives of this study will be to determine/compare the composition, distribution, and abundance of the benthic community among segments above, within, and below the Station's discharge. The 2017-2018 results will be compared with those obtained during 1993 and 1994 to evaluate spatial and temporal trends within the benthic macroinvertebrate community.

5.4.1 Field

Because the distribution and community composition of benthic macroinvertebrates is strongly influenced by the physical and chemical characteristics of the substrate, this study will use standard artificial substrate samplers (Hester-Dendy plates ["HD"]) in order to factor out the effects of substrate variability for the evaluation of thermal effects. Benthic macroinvertebrates will be sampled at 12 locations upstream and downstream of the thermal mixing zone for the Station with the study area extending from the mouth of the Brandon Road Lock and Dam tailwater (~RM 285.5) to the I-55 Bridge (RM 277.8). Samplers will be deployed at the left and right banks in the following six approximate areas: RM 285.5, RM 285.0, RM 283.8, RM 281.7, RM 280.3, and RM 277.8 (Figure 1). The selection of actual sampling locations will depend upon field observations of reliable areas to deploy the samplers; GPS coordinates will be recorded for each sampling location. The same sampling locations will be used in each year to provide information on inter-annual variability.

Each modified HD artificial substrate sampler will consist of eight 3x3-inch plates constructed from 1/8-inch tempered hardboard and twelve 1/8-inch plastic spacers. The plates and spacers will be arranged on a 1/4-inch eyebolt so that each sampler has three 1/8-inch spaces, three 1/4-inch spaces, and one 3/8-inch space among the plates. The total surface area of a single sampler, excluding the eyebolt, will be 1.01 square feet. A single sample will consist of five HDs suspended approximately 30-50 cm below the water surface. Triplicate HD sets will be deployed at each location to minimize the loss of samplers (e.g., vandalism). They will be placed at each location in July and remain in place for at least a six-week colonization period. Retrieval of the HDs will be accomplished by enclosing the samplers in a fine-mesh sweep-net and then carefully lifting the sampler array and net to the surface. The HDs will be disassembled from the array, placed into a single labeled container, and preserved with 10 percent formalin.

5.4.2 Sample Processing

Prior to analysis, each sample will be rinsed on a U.S. No. 35 mesh sieve to remove preservative. Two samplers will be processed for each location. The sample material will be sorted, a small portion at a time, under a dissecting microscope at 10X magnification. All benthic macroinvertebrates found will be sorted by major taxonomic groups (e.g., Oligochaeta and Chironomidae). Specimens will be preserved in 70 percent ethyl alcohol. All benthic macroinvertebrates will be identified to the lowest practical taxon using the latest taxonomic keys. Oligochaetes and chironomids will be mounted on glass slides using CMC-10 mounting media prior to examination under a compound binocular microscope at 40-1000X magnification.

5.4.3 Analysis and Data Interpretation

Spatial and temporal comparisons will be made using density (#/m^2), relative abundance (percentage), Ephemeroptera+Plecoptera+Trichoptera ("EPT") taxa richness, and total taxa richness. In addition, an analysis of variance ("ANOVA") will be performed using the replicate data to statistically compare community structure metrics such as taxa richness, total density, Oligochaeta (aquatic worm) density, Chironomidae (midge) density, and Ephemeroptera (mayfly) density among the sample areas upstream (RM 285.5 and RM 285.0) of the Joliet Station's discharge, within the mixing zone (RM 283.8), and downstream of the mixing zone (RM 281.7, RM 280.3, and RM 277.8).

5.5 FRESHWATER MUSSELS

The Illinois River and its headwaters once provided habitat to a diverse community of freshwater mussels; however, those populations declined dramatically following construction of the Chicago Sanitary and Ship Canal ("CSSC") and the navigational lock and dam system.

Ecological Specialists (2008) conducted a survey for freshwater mussels in a 0.5-mile reach below Brandon Road Lock and Dam as part of pre-licensing application studies for proposed hydropower development to identify existing unionid species, their relative abundance, and evaluate the habitat potentially affected by construction and operation of a hydropower facility at this site immediately upstream of the Joliet #29 Station. Ecological Specialists (2008) found no live mussels within survey area and reported that habitat was not suitable for unionid mussels. Substrate was generally not suitable, consisting mostly of gravel and cobble with little sand and silt throughout the survey area. Only weathered shells of three common species were identified (*Lampsilis siliquoidea*, *Pyganodon grandis*, and *Utterbackia imbecillis*) and it was hypothesized that these shells may have drifted down from an upstream community.

The Illinois Natural History Survey (Price et al. 2012) conducted a regional survey for freshwater mussels in the Des Plaines River basin and other tributaries to Lake Michigan. This survey identified live specimens of nine freshwater mussel species; shells for another 10 species were identified, but with no live specimens. The authors reported that many species collected historically in the Des Plaines River basin have not been documented in the basin since at least 1920. Only three species (represented by dead specimens or relic shells) were identified from the one sampling location downstream of Lockport Lock and Dam in Brandon Pool. They also reported no evidence of successful reproduction (recruitment of individuals less than 30 mm or with three or fewer growth rings). Price et al. (2012) concluded that:

> *the Des Plaines River basin has undergone significant freshwater mussel species loss, and unless water and sediment quality improve, species loss will likely continue. Urbanization in the region has profoundly impacted the aquatic habitat available for freshwater mussels. The navigable waterways throughout the Des Plaines River basin are highly modified for navigation and waste disposal, and waterways that were formerly rivers exist now as dredged canals with artificial walls.*

Although information on current mussel distribution in the Des Plaines River is limited, the available evidence indicates that potential freshwater mussel habitat in the UDIP is of poor quality and that living mussel populations are not likely to exist in the vicinity of the Station. Therefore, no mussel surveys are proposed in this Plan. Existing historical data for the UDIP, if available, will be reviewed in the §316(a) Demonstration for the Joliet #29 Station to determine whether it supports the finding that freshwater mussels are not expected to be affected by its thermal discharge.

5.6 FISHERIES

The objective of this study will be to determine/compare the composition, distribution, abundance, condition, and incidence of anomalies of fish upstream, within the mixing zone, and downstream of the Joliet #29 Station's discharge. The 2017 and 2018 results will be compared with those obtained since 1994 to evaluate spatial and temporal trends within the fish community.

Sampling of the juvenile and adult fish community of the UDIP has been conducted for more than 37 years (1977-1995 and 1997-2015) by Commonwealth Edison or Midwest Generation. The ongoing fish sampling program fulfills the requirements of Special Condition 17 of the Joliet Station #9 NPDES Permit (Permit Number IL0002216) and Special Condition 18 of the Joliet Station #29 NPDES Permit (Permit Number IL0064254). Sampling has included the use of electrofishing and beach seines in appropriate habitat. Except as noted below, the overall geographic and temporal coverage of these surveys are more than adequate to characterize the fish community in the vicinity of the Joliet #29 Station and any changes that have occurred over time in response to Station operation, upstream discharger operations, and other environmental changes in the aquatic system. Due to the change in electrofishing methods in 1994, any historical comparisons will be confined to data collected since then.

5.6.1 Field

The ongoing fish sampling program includes two locations upstream of the Station's discharge (Locations 402 and 402A), a location within the discharge canals of both Joliet Stations (Location 403), and a location within Joliet #29 Station's conceptual mixing zone (Location 403A) (Figure 2). Three additional UDIP sampling locations (404A, 405, and 408) are located three to five miles downstream of the Station. To provide better spatial distribution of sampling locations relative to the thermal plume downstream of the estimated edge of that mixing zone, two new sampling locations will be added between Location 403A and the confluence of Rock Run (approximately one to two miles downstream of the discharge), one along each bank (Figure 2). The new sampling locations will be similar to existing locations; that is, each will consist of a 500-meter electrofishing zone. If possible, seining will be conducted within these two new locations.

Electrofishing will be conducted at all nine UDIP locations using a boat-mounted electrofishing system energized by a 230-volt, 5,000-watt three-phase AC generator. Each electrofishing zone is 500 m long. Electrofishing will be conducted in a downstream direction at all locations. Electrofishing will begin no earlier than 0.5 hours after sunrise and will finish no later than 0.5 hours before sunset. The sampling crew will consist of a driver and a netter. Both crew members will have long-handled dip nets for catching stunned fish.

Seining will be conducted at seven UDIP locations (all except Locations 402A and 403) using a 25-ft long x 6-ft deep straight seine with 3/16-inch Ace mesh. The sampling distance will depend on the area available at each location and to the extent possible, will be kept constant during each sampling period. If electrofishing and seining are to be conducted in the same area on the same day, seining will be conducted first and at least one hour elapsed before electrofishing is conducted.

Historically and under the Joliet Stations' NPDES Special Permit Conditions, sampling is conducted once in mid-May, once in June, and twice monthly in July, August, and September, for a total of eight sampling events. With completion of the conversion to gas-fueled operations, the Joliet Stations will operate as peaking facilities primarily during the warmest and coldest portions of the year. To evaluate the effects of winter operations, the Plan adds two winter sampling events each year, once in December (2016 and 2017) and once in January/February (2017 and 2018). The winter sampling will be coordinated to occur in conjunction with operating cycles of the Joliet Stations.

5.6.2 Physicochemical Measurements

Water temperature, dissolved oxygen concentration, percent oxygen saturation, specific conductance, and Secchi disk depth will be measured at each electrofishing location during each trip. Sampling techniques and calibration procedures/frequencies will be the same as those used historically during the UIW studies (EA 2015).

5.6.3 Sample Processing

All fish will be held in source water immediately after collection and until processing. All fish will be counted and identified to the lowest practical taxonomic level, usually species. For each location and gear, a maximum of 30 specimens of each species collected will be measured for total length (mm) and weight (g). If over 30 individuals of a species are collected at any location, then 30 representative individuals will be measured and weighed. The remaining individuals of that species will be counted and a group (batch) weight recorded. Minnows (excluding all carp species, Goldfish, and their hybrids) and other small species such as darters and topminnows will be identified, counted, and batch weighed. After processing, all live fish will be returned to the river. All fish not processed in the field will be preserved in formalin, labeled, and returned to the laboratory for processing. In the laboratory, fish will be processed in the same manner as in the field.

A voucher collection of unusual or taxonomically difficult species will be compiled. All observed threatened or endangered species will be photo documented and returned live, if possible, and will not be routinely included in the voucher collection.

All fish encountered will be examined for external anomalies. External anomalies will be classified as DELT anomalies (Deformities, Erosions, Lesions, and Tumors), parasites, or "other" abnormalities. The following is a review of DELT anomalies and their causes in freshwater fishes:

1) Deformities - These anomalies can affect the head, spine, fins, and have a variety of causes including toxic chemicals, viruses, bacteria (e.g., *Mycobacterium* sp.), and protozoan parasites (e.g., *Myxosoma cerebalis*).

2) Eroded fins - These are the result of chronic disease principally caused by flexibacteria invading the fins causing a necrosis of the tissue. Necrosis of the fins may also be caused by gryodactylids, a small trematode parasite. For this study, fin erosion will be separated into three categories: slight erosion <1/3 of fin eroded; moderate erosion 1/3 to 2/3 of fin eroded, and severe erosion >2/3 of fin eroded.

3) Lesions and Ulcers - These appear as open sores or exposed tissue and can be caused by viral (e.g., *Lymphocystis* sp.) or bacterial (e.g., *Flexibacter columnaris*, *Aeromonas* spp., *Vibrio* sp.) infections.

4) Tumors - Tumors result from the loss of carefully regulated cellular proliferative growth in tissue and are generally referred to as neoplasia. In wild fish populations tumors can be the result of exposure to toxic chemicals such as polycyclic aromatic hydrocarbons (PAHs). Viral infections (e.g., *Lymphocystis*) can also cause tumors. Parasites (e.g., *Glugea anomala* and *Ceratomyxa shasta*) may cause tumor-like masses, but are not considered tumors. Parasite masses can be squeezed and broken between the thumb and forefinger whereas true tumors are firm and not easily broken.

An external anomaly will be defined as the presence of externally visible skin or subcutaneous disorders, and is expressed as percent of affected fish among all fish processed. Only those anomalies visible to the naked eye will be recorded. The exact counts of anomalies present (e.g., the number of tumors or lesions per fish) will not be recorded.

5.6.4 Data Analysis and Interpretation

Data from electrofishing and seining will be reported as number, catch-per-unit-effort ("CPE", No./km for electrofishing and No./haul for seining), and percent abundance for each species.

Index of Well-Being ("IWB") and modified IWB ("IWBmod") scores will be calculated for the electrofishing data and species richness will be calculated for both gears.

Electrofishing and seining data will be segregated by location, segment, and trip. Mean electrofishing and seining community parameters (i.e., CPEs, species richness, and IWBmod scores [electrofishing only]) will be compared on intra-year (segment vs. segment by year) and inter-year (year vs. year by segment) basis. Statistical testing (ANOVA and Tukey's Studentized Range Test) will be conducted on the electrofishing data. Analyses of relative weight and DELT anomaly data will also be on inter-year and intra-year basis. Physicochemical data collected in conjunction with these studies will be compared on a spatial basis (e.g., location vs. location and segment vs. segment).

Entrainment studies conducted at the Joliet Stations in 2004-2005 are a source of ichthyoplankton data in the immediate vicinity of both Stations. In addition, ichthyoplankton entrainment data is currently planned to be collected at the Joliet #9 Station in 2016 as part of §316(b) requirements. These data will be used to characterize the species and life stages susceptible to the Stations' thermal plumes. No additional ichthyoplankton studies are proposed to support development of the §316(a) Demonstration.

5.7 AQUATIC HABITAT

EA has conducted extensive habitat surveys in various portions of the UDIP and LDIP between Brandon Road Lock and Dam and Dresden Island Lock and Dam (1993-1995, 2003, and 2008). Habitat quality was evaluated for all surveys using the Qualitative Habitat Evaluation Index ("QHEI") developed by Rankin (1989). The results of these studies were submitted and discussed in pre-filed testimony (8 September 2008) by Mr. Greg Seegert (EA) on proposed amendments to Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System (CAWS) and LDPR (IPCB Docket No. R08-9, Subdocket C). The 2003 study encompassed the entire Dresden Pool with habitat evaluated at 0.5-mile intervals. The 2008 study provides comprehensive, contiguous QHEI data for both banks of UDIP in the vicinity of the Joliet Stations from Brandon Road Lock and Dam downstream to the I-55 Bridge. The findings of these studies generally showed that habitat was poor upstream of Brandon Road Lock and Dam. Although habitat conditions improved downstream of Brandon Road Lock and Dam, QHEI scores were still typically in the "poor" range of the scale. QHEI scores will again be determined at each UDIP electrofishing location beginning in 2016.

EA conducted thermal surveys in the vicinity of the Joliet #9 and #29 Stations in 2012 that provided some bathymetric information for the reach in the vicinity of the conceptual mixing zones of these Stations. These data combined with the QHEI data can be used to generate preliminary habitat maps for these reaches. However, to support a predictive thermal assessment of the effects of the Stations' thermal plumes, additional characterization of habitat types in the area from Brandon Road Lock and Dam to the I-55 Bridge will be required.

A new bathymetric survey, extending downstream to near the I-55 Bridge (Section 5.8.1), will be used to delineate channel, edge of channel and shallow (less than 2 m) littoral habitat. The only riffle/run habitat in the UDIP is the Brandon Road Lock and Dam tailwater area located between the Dam and Brandon Road; the approximate downstream edge of this tailwater will be mapped using a GPS. Submerged aquatic vegetation surveys (Section 5.2) will describe the extent and dominant types of aquatic vegetation in shallow habitat. During the vegetation survey, shoreline characteristics will be described (e.g., bulkhead, riprap or otherwise armored, or "natural"). Substrate type will be determined along each vegetation transect using a rod to gauge general categories such as soft/mud, sand, gravel, cobble or larger. Also during the vegetation survey, the boundary of backwater and tributary mouth areas will be mapped using a GPS and compared with the information provided by the bathymetric survey. Other significant structure observed during the vegetation and bathymetric surveys that could attract fish or provide cover will be identified and mapped. QHEI scores determined for each UDIP electrofishing location will also be used to characterize the type and quality of aquatic habitat.

These data will be used in the predictive portion of the §316(a) Demonstration to interpret availability and distribution of preferred habitat for the RIS within and outside of the thermal mixing zone and selected isothermal contours of the Station's thermal plume.

5.8 THERMAL PLUME SURVEYS AND HYDROTHERMAL MODELING

Eight thermal plume surveys were conducted along the LDPR at the Joliet Stations during the summer of 2002. Each survey consisted of surface plume mapping and vertical profiles along predetermined transects. Transects encompassed an area from 3,350 ft upstream of the Joliet #29 Station's discharge to 7,000 ft downstream of the discharge.

A series of surveys were also conducted during the summer of 2012 to characterize the distribution of temperatures in the thermal mixing zones of the Joliet Stations. Conditions during the July 2012 surveys encompassed a period of extreme high ambient water temperatures associated with a severe regional drought. The surveys included measurement of surface temperatures at a series of 14 transects (Figure 3), plus three to five vertical temperature profiles (depending on the river width and proximity to the Joliet Stations' discharges) spaced equidistant along each transect. The 14 transects during the 2012 survey encompassed an area from 4,620 ft upstream of the Joliet #29 Station's discharge to 7,000 ft downstream of the discharge. In order to more completely document the downstream distribution and dissipation of thermal plume temperatures and support hydrothermal modeling of the plume for the predictive assessment, five additional transects will be established downstream of the 7,000-ft transect (Figure 4) and upstream of the I-55 Bridge.

The survey data collected in 2002 and 2012, as well as the new survey data to be collected once during the winter (January-February) and once during the summer (July-August) of 2017, will be used to calibrate and validate a thermal model that will be used to predict the configuration of the Joliet #29 thermal plume under various river flow, meteorological, and the future operating scenarios (Section 4).

5.8.1 Bathymetry Survey

Bathymetric data will be collected along each study transect (Figures 3 and 4). They will be collected along 19 transects, oriented perpendicular to flow, beginning at the mouth of the Brandon Road Lock and Dam tailwater and ending just upstream of the I-55 Bridge. Labeled headstakes and survey flagging will be set on each shore to provide a visual cue during the survey. As part of the survey effort, additional data will be obtained along a diagonal line between the end of one transect and the beginning of the next transect for all but the three most downstream transects (Transects 16 to 17, Transects 17 to 18, and Transects 18 to 19), and as a continuous transect along the approximate centerline of the river to serve as cross-lines for each of the 19 survey transects. Cross-line data will be used following processing as part of the quality assurance/quality control procedures. Figures 3 and 4 show the estimated location of the 19 survey transects; the exact locations may be adjusted in the field based on observed flow conditions and safety considerations.

Individual depth soundings will be collected acoustically using a Teledyne Odom Hydrotrac precision, survey fathometer interfaced with a 200 kHz, narrow beam (3°) transducer (or equivalent system). The transducer will be set at a fixed depth below the waterline of the survey vessel (draft) and a correction will be applied to the soundings by the fathometer to reflect the actual depth between the water surface and riverbed. The raw depth soundings obtained by the fathometer will be ported directly to HYPACK and saved as negative elevation values. During the survey operation, HYPACK will merge the raw soundings with time and Real Time Kinematic ("RTK") GPS position information, and store these data in files for post-processing. As HYPACK collects the raw soundings, it will also employ a geoid model to convert the negative elevation values (water depths) to elevation relative to the vertical control of North American Vertical Datum of 1988 ("NAVD 88"). This first order conversion can be accomplished in real time using the precision ellipsoid height data provided by the RTK GPS system. These elevation data will later be refined as part of the post-processing routines.

As part of the survey activity, profile measurements of the physical characteristics of the water column will be obtained three or more times on each survey date using a Seabird SBE 19 Conductivity, Temperature, and Depth ("CTD") probe in order to determine sound velocity. Sound velocity is a product of water density, which is primarily influenced by temperature in a freshwater river system. The CTD profiles will be used to calculate a series of sound velocity correctors that will later be employed in the post-processing phase of the project to adjust the raw soundings obtained by the fathometer using a fixed, assumed sound velocity.

During the post-processing phase, all the raw depth soundings will be reviewed, corrected for water column sound velocity, and normalized to a vertical datum of NAVD 88 in HYPACK's single beam editor module. At the conclusion of the processing step, the data will be compiled into a single *.XYZ text file consisting of X and Y position information and depth represented as Z. The files will be ported to a GIS database for gridding and development of a digital elevation model for the study reach.

5.8.2 Temperature Surveys

The Joliet Stations' sampling grid will consist of the same 14 primary transects used for the 2012 survey (Figure 3); Transects 15-19 in Figure 4 are approximate new locations for the 2017 surveys. The transect locations and the number of vertical stations along each transect are summarized in the following table:

Transect	Distance (ft) from Joliet #29's Discharge	No. of Verticals	Transect (cont.)	Distance (ft) from Joliet #29's Discharge	No. of Verticals
1	-4,620	0	11	2,750	4
2	-3,350	3	12	4,000	3
3	-1,720	4	13	5,500	3
4	-1,250	4	14	7,000	3
5	-750	4	15	8,500	3
6	-250	4	16	10,500	3
7	250	5	17	12,700	3
8	750	5	18	16,900	3
9	1,250	5	19	29,600	3
10	2,000	4			

Transect distances are determined from the end of Joliet #29 Station's discharge canal. The end of the Joliet #9 Station's discharge canal is located at Transect 3 and the Joliet #29 Station's discharge canal is located between Transects 6 and 7 on the opposite bank. Three additional transects will be located in the Joliet #29 Station's discharge canal; two cross channel transects and one center-line transect.

In addition to the cross channel transects, surface temperature data will also be collected along diagonal transects between the primary transects from Transect 3 to Transect 14. Between Transects 1 and 2, Transects 2 and 3, and Transects 15-19 several bank to bank zigzags will be made. Upstream Transects 1 and 2 will be used to establish ambient temperature conditions and to evaluate potential upstream intrusion of the thermal plume, particularly under low river flow conditions.

Vertical profiling stations will be established along each of the primary transects except Transect 1 located near the mouth of the Brandon Road Lock and Dam tailwater. The vertical stations will be evenly spaced along each transect. More stations are located along the transects that are closer to the discharge canals to better characterize the lateral spread of the plumes in those areas. For example, Transects 3 through 6 each have four vertical stations located at one-fifth, two-fifths, three-fifths, and four-fifths of the distance between the left and right banks. The transects with three vertical stations have stations located at one-quarter, one-half, and three-quarters of the distance between the left and right banks. Vertical profiling stations are numbered from the left descending bank (i.e., 1/4 or 1/5 is closest to the left bank). The thermal plume survey transects and vertical profile stations from the 2012 surveys are illustrated in Figure 3. For the 2017 surveys, the locations of the 2012 thermal survey transects will be re-established using GPS coordinates recorded during the 2012 surveys. The approximate location of new transects (15-19) downstream of the Joliet Stations are shown on Figure 4; these transects and the location of the vertical profiles will be adjusted as necessary during the field surveys. The Illinois State Plane (East) coordinate system and the North American Datum of 1983 ("NAD83") will be used for the Joliet Stations' surveys. Within the Joliet #29 Station's discharge canal, two stations will be located at the downstream cross-channel transect and one station at the upstream cross-channel transect.

In order to reduce the total elapsed time of the surveys, particularly during the winter, the surface transect temperature measurements and the vertical temperature profile measurements will be collected concurrently by two different field crews. The surface temperature recording system consists of a Logan Enterprises thermistor probe (model 4701-2.50-25ft-TH44018-PH) interfaced with a Deban 500 module and a Trimble GeoXH DGPS (or equivalent system). The Deban module receives the signal from the thermistor and sends a voltage that responds linearly with temperature to the Campbell CR10X datalogger. The Logan/Deban temperature system has an accuracy of 0.1% full span, which corresponds to 0.05°C (0.09°F). Output from the thermistor will be stored at one second intervals in the datalogger. The DGPS stores the X and Y coordinates of the temperature probe position at one second intervals to internal memory. The system clocks on the datalogger and the DGPS are set to identical times at the beginning of each survey. Synchronized temperature and DGPS data are recorded along the primary transects, as well as along the diagonal or centerline transects.

The thermistor is attached to a fixed strut mounted on the side of the boat at a depth of 18 inches. Two thermistors, a primary and a replicate, are used during each survey. During collection of surface temperatures, the boat is driven along each transect, turned as close as possible to the shoreline, and then typically moved on a diagonal to the next transect, producing a zigzag pattern. This method is used to assist in the delineation of the surface plume between the primary transects.

Plume definition within the water column is obtained by measuring vertical temperature profiles using a Seabird CTD profiler (model SBE 19 plus). The instrument collects temperature and depth data at 0.25 second intervals as it is slowly lowered to the bottom and pulled back up to the surface. This typically results in the collection of four to six data points within every 1-ft depth interval. The DGPS is used to position the boat at the same vertical profiling stations during each survey.

Pre- and post-calibration of temperature and pressure (depth) for the Seabird CTD Profiler will be performed and documented by the vendor. During each surface plume mapping survey, two temperature probes will be deployed (designated primary and secondary) to provide a backup in case of equipment malfunctions. For each survey date, the surface temperature thermistor will be compared to the Seabird CTD by placing both instruments side-by-side in the water.

For each survey date, LDPR flows will be obtained from the Brandon Road Lock and Dam, located 1.6 river miles upstream from the mouth of the Joliet #29 Station's discharge canal.

5.8.3 Thermal Model

In order to predict the lateral and longitudinal dispersion of the Joliet #29 Station's thermal plume, it will be necessary to develop a hydrothermal model of the UDIP. The Danish Hydraulic Institute's MIKE 3 model will be used to evaluate operational and ATL scenarios. MIKE 3 is a state-of-art, three-dimensional hydrodynamic model that has been accepted for use in §316(a) Demonstrations by various state environmental agencies, including IEPA. For the Joliet Stations, the upstream model boundary will be at the mouth of the Brandon Road Lock and Dam, and the downstream model boundary will be at the I-55 Bridge. A finer cell grid will be used in the vicinity of the Joliet Stations' discharges to provide increased resolution in the initial mixing region. Each cell is typically divided into 8-10 vertical layers. The model grid will include the Joliet Stations' intake areas and discharge canals. The upstream model boundaries are parameterized by providing temperature and flow time-series files. The temperature boundary file can incorporate vertical stratification. The downstream boundary at the I-55 Bridge is parameterized by a time-series file of flow and/or elevation.

The MIKE 3 model will be calibrated using thermal field survey data. A calibration model run is typically started a day prior to the thermal survey to allow build-up to conditions present at the time of the survey. Hourly Station cooling water flow, intake temperature, and discharge temperature data will be provided by the Joliet #9 and Joliet #29 Stations. The upstream boundary temperatures will be based on the thermographs deployed during the surveys and flow data from the Brandon Road Lock and Dam. Stratification as observed during the survey's vertical profiles in the vicinity of the upstream boundaries will be incorporated into the model. Surface heat exchange is calculated from hourly meteorological data provided to the model. Model calibration primarily consists of adjusting horizontal and vertical dispersion, and bottom friction coefficients.

During 2012, six thermal plume surveys were conducted between 20 June and 12 September and concurrent Station operational, thermal, and hydrological data were compiled. The 2017-2018 hydrothermal modeling effort will augment the 2012 study. A final model calibration will be completed following the performance of two additional thermal plume surveys during winter and summer 2017. Station operational data and river flow and temperature data will be updated from the 2012 study data using 2017-2018 information. Various model scenarios will be executed with the final calibrated model. The output files from the model scenarios will be processed with particular attention given to plume behavior and zone-of-passage as a function of operations and flow.

The MIKE 3 model provides the capability to predict the three-dimensional and temporal extent of the thermal plumes under the complex operating conditions typical of peaking facility operations. The model will be used to predict plume temperatures and configurations (e.g., surface and bottom temperature distribution maps, area and volume within selected isotherms) relative to available aquatic habitat for the predictive component of the §316(a) Demonstration. The analysis for the §316(a) Demonstration will focus on isotherms representing critical thermal thresholds (e.g., acute mortality, chronic mortality, avoidance, preference, spawning temperatures) for the RIS. This model was recently used for the predictive thermal assessment at the Dresden Generating Station on the LDIP, which has been accepted by the IEPA. Two years (2017-2018) of hourly temperature monitoring data from the Joliet #9 and Joliet #29 Stations' intakes and discharges, and cooling water flow (including helper cooling tower operations at the Joliet #29 Station), under the future operating scenarios, will be utilized to support the thermal modeling effort.

As part of the evaluation of ATLs, IEPA is requiring Midwest Generation to assess the potential effect of the Joliet Stations' future thermal discharges on downstream ambient temperatures in the vicinity of downstream thermal discharges. IEPA will assist Midwest Generation to identify downstream thermal discharges between the Joliet Stations' discharges and the I-55 Bridge to be included in this assessment. Three potential dischargers include Flint Hills Resources, LLC, Stepan Chemical, and the ExxonMobil Joliet Refinery. Midwest Generation will contact each of these dischargers to request discharge flow and intake and discharge temperature data for their facilities. To the extent available, two years (2017 and 2018) of daily intake and discharge flow and temperature data for each facility identified will be input into the MIKE 3 model to evaluate the potential interaction between the Joliet Stations' thermal plumes and these downstream dischargers to the UDIP. The location of the intake and discharge for each facility identified will be set up as a distinct cell in the MIKE 3 Model.

6. SCHEDULE FOR DATA COLLECTION

Multiple study years are required in order to characterize the potential variability in aquatic communities and habitat conditions and to decipher their trends. The long-term fishery program for the UDIP provides a robust database for evaluating temporal trends and spatial patterns. Data for most other components of the aquatic community are more than 20 years old, necessitating 2 years (2017-2018) of new data collection following changes in Station operation for key biotic categories (e.g., benthic macroinvertebrates).

Fish sampling in the UDIP will be conducted once in early May, once in early June, and twice per month in July, August, and September in 2017 and 2018. Based upon the information presented above, sampling at the additional electrofishing and seining locations in the UDIP will be initiated during 2016 as part of the ongoing fish monitoring program. The Joliet #29 Station is scheduled to be fully operational following conversion to natural gas by 1 June 2016. Because this Station will be operated to provide power during periods of peak electrical demand, it is expected to be brought online and taken offline on a frequent and unpredictable basis, particularly during summer and winter. Although the ongoing fish sampling program will be conducted in 2016, it will be necessary to allow sufficient time for any potential changes in the receiving waterbody to be detected as a result of the new thermal conditions under the new Station operations. Consequently, the data collected during 2016 will not be representative of habitat utilization under the new operating conditions. In the UDIP, the additional electrofishing and seining locations will be sampled as part of the ongoing fish monitoring program for 2 years (2017-2018) subsequent to the change in operations.

When fish are attracted to and acclimate to a thermal discharge during winter, the potential for cold shock increases if a facility rapidly reduces its thermal discharges. Given the expected operating scenario of a peaking facility, this Plan adds two winter fish sampling events each year, once in December (2016 and 2017) and once in January/February (2017 and 2018). The winter sampling will be coordinated to occur in conjunction with operating cycles of the Joliet Stations that may occur during these times.

New hydrothermal surveys will be conducted once during the winter (January-February) and once during the summer (July-August) of 2017 to characterize the thermal plumes under the new operating conditions. Peaking operations can be difficult to predict and will complicate collection of thermal survey data for typical peaking operations; however, the surveys will only be conducted during periods of Station operation. Under the new peaking operations, 2 years (2017-2018) of hourly temperature monitoring data from the Joliet Stations' intakes and discharges, and cooling water flow (including helper cooling tower operations at the Joliet #29 Station) will be required to support the thermal modeling effort.

The data collection schedules for other studies in this Plan are:

- HD sampling for benthic macroinvertebrates will be conducted for 2 years subsequent to the change in operations (i.e., 2017 and 2018) of the Joliet Stations;
- The submerged aquatic vegetation and habitat survey will be performed once during the peak of the growing season during July-August 2017; and
- The collection of new bathymetry will occur during the summer of 2017.

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7. REPORTING

Joliet #29 Station operational data, thermal modeling results, and data from the field biology studies will be compiled into a series of reports. These reports will then be used, in part, to develop a separate §316(a) Demonstration. Current and historical biological data will be used to describe the biotic categories of the at-risk aquatic community while the hydrothermal modeling results will determine the potential for regulatory compliance as well as describe conditions to which the aquatic community will be exposed (e.g., temperature range, areal extent, and zone of passage). Part of this overall evaluation will be based on the selected RIS. Collectively, the analyses presented in these reports will be used to determine whether a balanced indigenous community is present in the UDIP and, if so, whether the requested Alternative Thermal Limits will adversely affect that community. If it is determined that a balanced indigenous community is not present, the analyses presented in these reports will determine whether the establishment of such a community would be prevented by peaking operations of the Joliet #29 Station under the requested Alternative Thermal Limits.

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8. REFERENCES

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FIGURES

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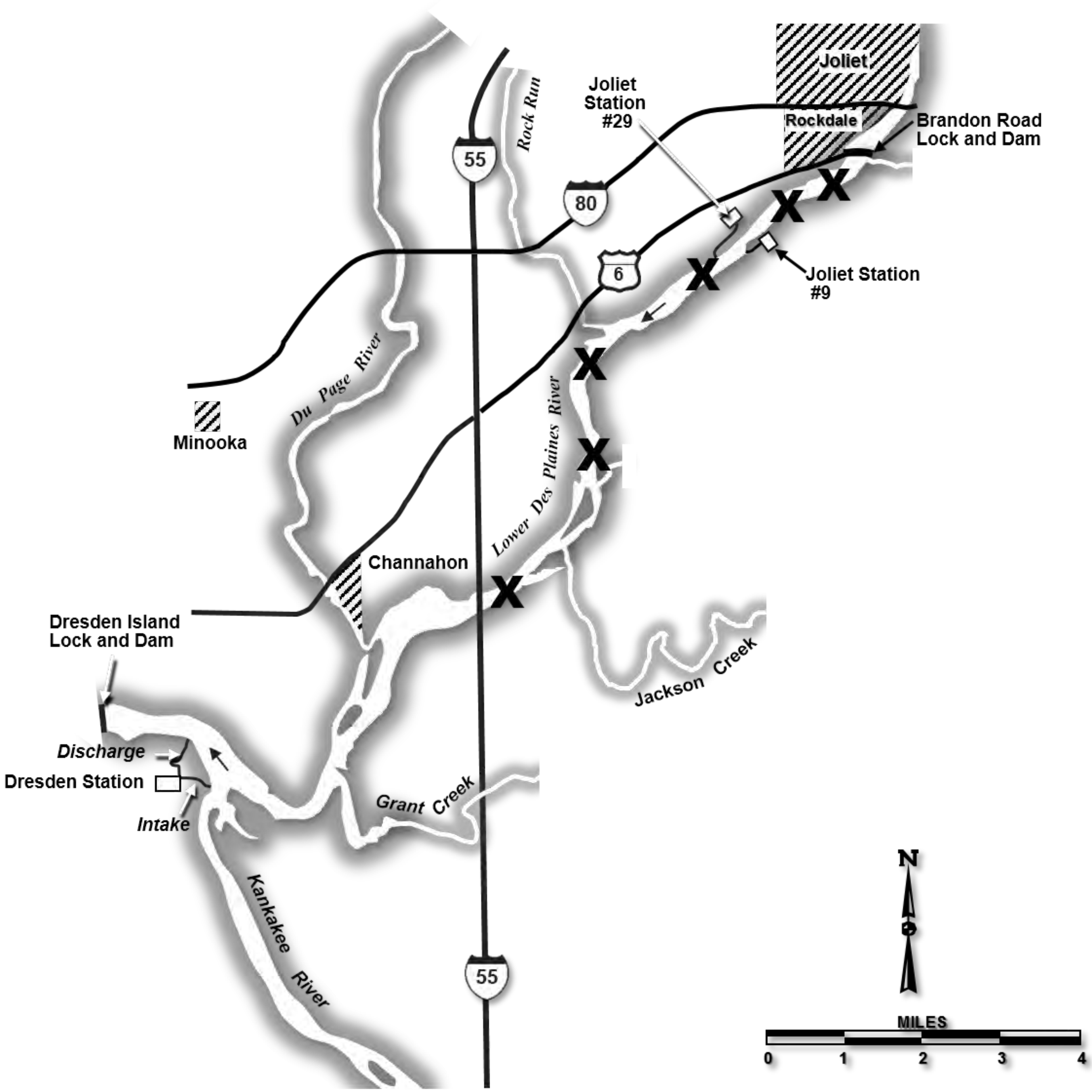

Figure 1. Sampling locations for benthic macroinvertebrates in the Upper Dresden Island Pool near the Joliet #9 and #29 Generating Stations.

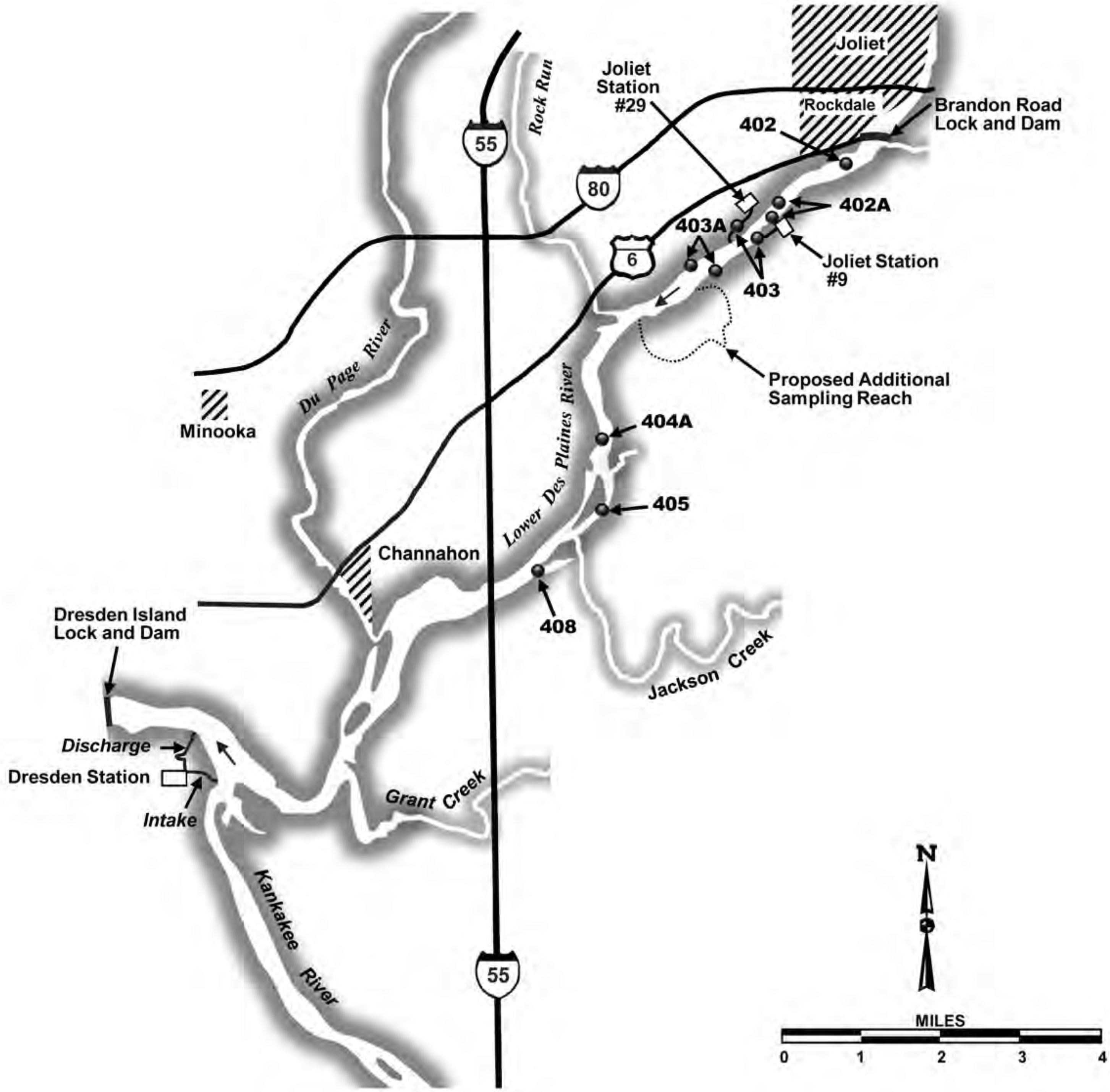

Figure 2. Sampling locations for fish in the Upper Dresden Island Pool near the Joliet #9 and #29 Generating Stations

FIGURE 3
Survey Transects and Vertical Profile Stations at Joliet Generating Stations #9 and #29, 2012

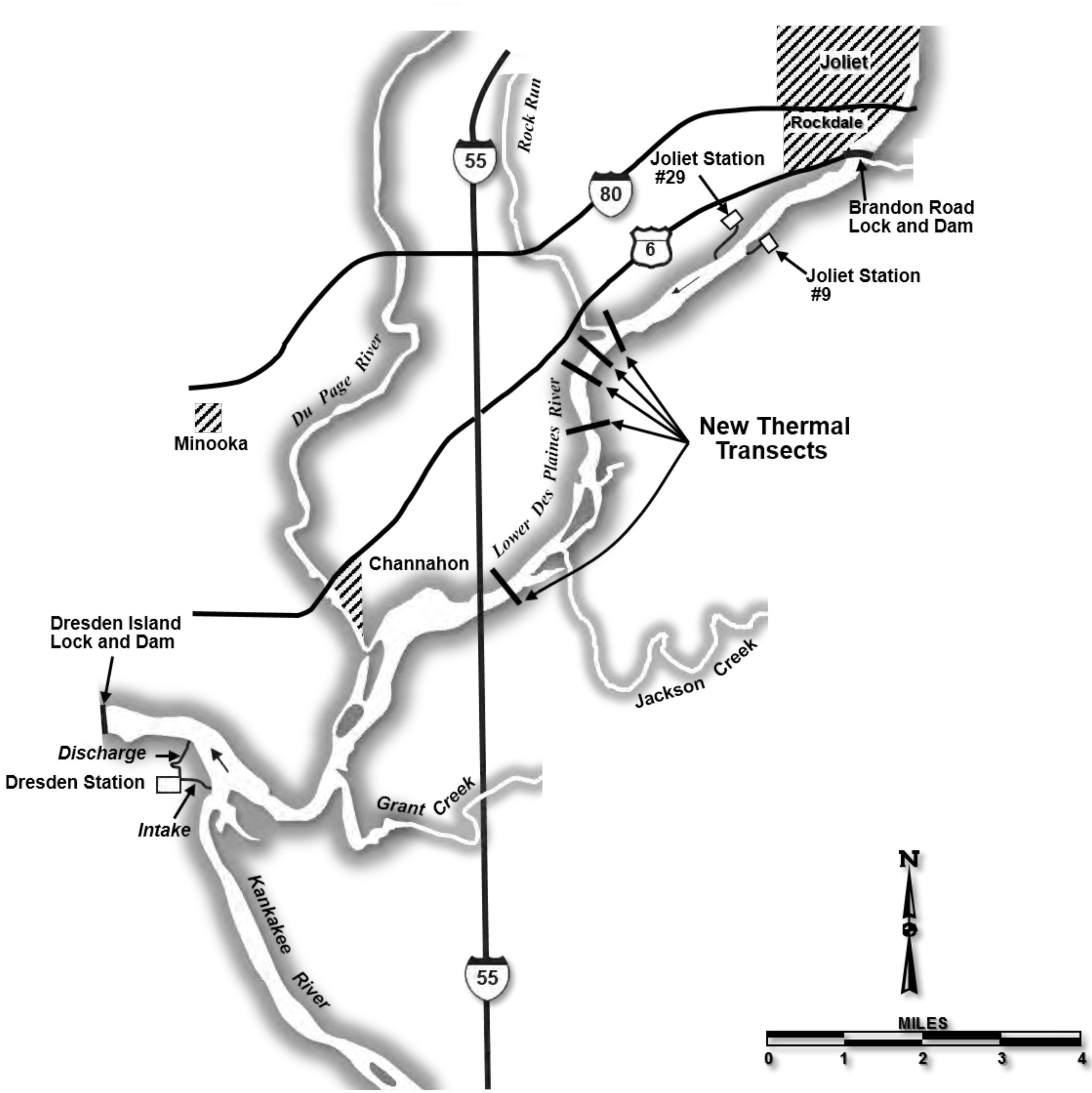

Figure 4. Location of new surface temperature transects included to augment the hydrothermal surveys of the Upper Dresden Island Pool to support the Joliet #9 and #29 Generating Stations' thermal model development.

TABLE

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Table 1. Summary of fish abundance and relative abundance (%) for sampling in the Upper Dresden Island Pool near the Joliet #9 and #29 Generating Stations during 20 sampling years from 1994-2014.

	1994		1995		1997		1998		1999		2000		2001	
SPECIES	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BLUNTNOSE MINNOW	552	40.0	408	30.7	554	19.0	1,228	21.4	266	9.6	262	9.3	1,290	22.2
GIZZARD SHAD	87	6.3	191	14.4	400	13.7	747	13.0	580	20.8	542	19.1	1,571	27.0
BLUEGILL	11	0.8	36	2.7	122	4.2	291	5.1	212	7.6	404	14.3	572	9.8
GREEN SUNFISH	103	7.5	82	6.2	298	10.2	767	13.3	521	18.7	492	17.4	398	6.8
EMERALD SHINER	109	7.9	35	2.6	402	13.8	1,424	24.8	318	11.4	173	6.1	392	6.7
LARGEMOUTH BASS	28	2.0	43	3.2	121	4.2	185	3.2	152	5.5	169	6.0	132	2.3
COMMON CARP	156	11.3	180	13.5	411	14.1	310	5.4	195	7.0	188	6.6	299	5.1
CHANNEL CATFISH	24	1.7	27	2.0	99	3.4	101	1.8	56	2.0	73	2.6	86	1.5
SPOTFIN SHINER	2	0.2	8	0.6	9	0.3	29	0.5	13	0.5	28	1.0	80	1.4
SPOTTAIL SHINER	113	8.2	93	7.0	14	0.5	86	1.5	13	0.5	14	0.5	435	7.5
BLACKSTRIPE TOPMINNOW	9	0.7	1	0.1	6	0.2	12	0.2	14	0.5	11	0.4	9	0.2
FRESHWATER DRUM	27	2.0	25	1.9	94	3.2	82	1.4	52	1.9	91	3.2	71	1.2
SMALLMOUTH BUFFALO	19	1.4	29	2.2	59	2.0	60	1.0	60	2.2	48	1.7	58	1.0
SMALLMOUTH BASS	10	0.7	10	0.8	29	1.0	41	0.7	22	0.8	7	0.3	26	0.5
ORANGESPOTTED SUNFISH	3	0.2	7	0.5	57	2.0	63	1.1	51	1.8	29	1.0	2	<0.1
STRIPED SHINER	19	1.4	1	0.1	--	--	6	0.1	--	--	--	--	21	0.4
BULLHEAD MINNOW	2	0.2	6	0.5	14	0.5	26	0.5	3	0.1	12	0.4	126	2.2
PUMPKINSEED	--	--	--	--	--	--	6	0.1	1	<0.1	--	--	--	--
ROUND GOBY	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
THREADFIN SHAD	--	--	--	--	--	--	--	--	--	--	25	0.9	6	0.1
SAND SHINER	16	1.2	8	0.6	9	0.3	23	0.4	5	0.2	10	0.4	26	0.5
WESTERN MOSQUITOFISH	--	--	--	--	--	--	1	<0.1	1	<0.1	6	0.2	3	0.1
NORTHERN SUNFISH	5	0.4	1	0.1	6	0.2	3	0.1	1	<0.1	25	0.9	24	0.4
LONGNOSE GAR	--	--	1	0.1	5	0.2	10	0.2	2	0.1	9	0.3	12	0.2
YELLOW BULLHEAD	1	0.1	2	0.2	7	0.2	3	0.1	6	0.2	11	0.4	1	<0.1
GOLDFISH	4	0.3	4	0.3	3	0.1	2	<0.1	--	--	4	0.1	5	0.1
BROOK SILVERSIDE	--	--	--	--	6	0.2	--	--	1	<0.1	1	<0.1	1	<0.1
GOLDEN SHINER	2	0.2	--	--	--	--	12	0.2	1	<0.1	1	<0.1	2	<0.1
RIVER CARPSUCKER	8	0.6	7	0.5	21	0.7	8	0.1	11	0.4	11	0.4	7	0.1
GHOST SHINER	3	0.2	--	--	1	<0.1	2	<0.1	1	<0.1	--	--	2	<0.1
JOHNNY DARTER	--	--	41	3.1	--	--	--	--	--	--	1	<0.1	--	--
QUILLBACK	4	0.3	7	0.5	18	0.6	11	0.2	4	0.1	11	0.4	5	0.1
GOLDEN REDHORSE	2	0.2	2	0.2	1	<0.1	3	0.1	2	0.1	1	<0.1	--	--
ROCK BASS	--	--	--	--	1	<0.1	3	0.1	3	0.1	3	0.1	5	0.1
CENTRAL STONEROLLER	2	0.2	--	--	2	0.1	2	<0.1	1	<0.1	--	--	18	0.3
SHORTHEAD REDHORSE	3	0.2	7	0.5	13	0.5	6	0.1	7	0.3	12	0.4	8	0.1
BLACK CRAPPIE	--	--	1	0.1	1	<0.1	9	0.2	4	0.1	4	0.1	2	<0.1
WHITE SUCKER	8	0.6	12	0.9	3	0.1	6	0.1	2	0.1	1	<0.1	4	0.1
FATHEAD MINNOW	--	--	3	0.2	--	--	2	<0.1	1	<0.1	--	--	1	<0.1
TADPOLE MADTOM	--	--	--	--	3	0.1	--	--	--	--	--	--	1	<0.1
WHITE BASS	1	0.1	--	--	3	0.1	4	0.1	3	0.1	4	0.1	6	0.1
LOGPERCH	--	--	--	--	3	0.1	1	<0.1	2	0.1	2	0.1	1	<0.1

Table 1 (continued)

SPECIES (cont.)	1994		1995		1997		1998		1999		2000		2001	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BLACKSIDE DARTER	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
REDFIN SHINER	--	--	--	--	--	--	2	<0.1	--	--	--	--	2	<0.1
FLATHEAD CATFISH	--	--	--	--	1	<0.1	1	<0.1	--	--	2	0.1	1	<0.1
SILVER REDHORSE	--	--	--	--	--	--	4	0.1	1	<0.1	1	<0.1	1	<0.1
SKIPJACK HERRING	1	0.1	--	--	1	<0.1	2	<0.1	2	0.1	1	<0.1	7	0.1
MIMIC SHINER	9	0.7	4	0.3	--	--	--	--	--	--	--	--	--	--
HORNYHEAD CHUB	--	--	--	--	--	--	--	--	--	--	--	--	2	<0.1
WHITE PERCH	--	--	--	--	1	<0.1	1	<0.1	4	0.1	5	0.2	3	0.1
SUCKERMOUTH MINNOW	--	--	--	--	--	--	2	<0.1	1	<0.1	--	--	--	--
YELLOW BASS	--	--	1	0.1	--	--	--	--	3	0.1	2	0.1	2	<0.1
BLACK BUFFALO	4	0.3	--	--	--	--	2	<0.1	3	0.1	2	0.1	2	<0.1
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIGMOUTH BUFFALO	--	--	2	0.2	1	<0.1	--	--	1	<0.1	3	0.1	2	<0.1
GRASS PICKEREL	--	--	--	--	1	<0.1	--	--	--	--	2	0.1	1	<0.1
NORTHERN PIKE	--	--	2	0.2	--	--	1	<0.1	--	--	--	--	1	<0.1
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS CARP	--	--	--	--	--	--	--	--	--	--	--	--	2	<0.1
WHITE CRAPPIE	--	--	--	--	--	--	2	<0.1	1	<0.1	2	0.1	--	--
BIGMOUTH SHINER	--	--	--	--	--	--	1	<0.1	1	<0.1	--	--	--	--
PALLID SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
REDEAR SUNFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	1	0.1	1	0.1	--	--	5	0.1	--	--	1	<0.1	--	--
SPOTTED SUCKER	--	--	--	--	2	0.1	--	--	--	--	--	--	1	<0.1
YELLOW PERCH	--	--	--	--	2	0.1	2	<0.1	--	--	--	--	--	--
ORANGETHROAT DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WALLEYE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CREEK CHUB	--	--	1	0.1	1	<0.1	--	--	--	--	--	--	--	--
BIGHEAD CARP	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOWFIN	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
SHORTNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RED SHINER	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
RIVER REDHORSE	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
SLENDERHEAD DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WARMOUTH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALEWIFE	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--
COMMON SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHANNEL SHINER	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
HIGHFIN CARPSUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORIENTAL WEATHERFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAUGER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other Taxa[(a)]	30	2.2	40	3.0	112	3.8	148	2.6	180	6.5	126	4.4	76	1.3
TOTAL FISH	1,379	100	1,329	100	2,918	100	5,749	100	2,784	100	2,832	100	5,815	100
TOTAL SPECIES	36		36		43		50		45		45		55	

Table 1 (continued)

SPECIES	2002 #	2002 %	2003 #	2003 %	2004 #	2004 %	2005 #	2005 %	2006 #	2006 %	2007 #	2007 %	2008 #	2008 %
BLUNTNOSE MINNOW	747	11.8	4,672	41.0	1,086	21.8	2,654	25.5	3,475	44.5	3,379	37.8	1,840	25.0
GIZZARD SHAD	1,754	27.7	520	4.6	647	13.0	4,116	39.6	738	9.5	1,514	16.9	1,416	19.2
BLUEGILL	733	11.6	1,688	14.8	706	14.2	1,137	10.9	876	11.2	963	10.8	1,251	17.0
GREEN SUNFISH	761	12.0	1,296	11.4	688	13.8	373	3.6	386	5.0	505	5.6	705	9.6
EMERALD SHINER	977	15.4	385	3.4	141	2.8	314	3.0	606	7.8	543	6.1	205	2.8
LARGEMOUTH BASS	219	3.5	416	3.7	324	6.5	127	1.2	228	2.9	185	2.1	202	2.7
COMMON CARP	239	3.8	192	1.7	132	2.7	218	2.1	113	1.5	166	1.9	168	2.3
CHANNEL CATFISH	98	1.6	203	1.8	192	3.9	107	1.0	151	1.9	137	1.5	138	1.9
SPOTFIN SHINER	90	1.4	290	2.5	114	2.3	210	2.0	176	2.3	249	2.8	179	2.4
SPOTTAIL SHINER	84	1.3	252	2.2	23	0.5	47	0.5	112	1.4	260	2.9	91	1.2
BLACKSTRIPE TOPMINNOW	11	0.2	42	0.4	47	0.9	49	0.5	127	1.6	50	0.6	92	1.3
FRESHWATER DRUM	87	1.4	82	0.7	85	1.7	50	0.5	47	0.6	63	0.7	51	0.7
SMALLMOUTH BUFFALO	71	1.1	68	0.6	71	1.4	73	0.7	58	0.7	58	0.7	47	0.6
SMALLMOUTH BASS	63	1.0	96	0.8	59	1.2	21	0.2	18	0.2	81	0.9	84	1.1
ORANGESPOTTED SUNFISH	14	0.2	76	0.7	45	0.9	15	0.1	25	0.3	44	0.5	73	1.0
STRIPED SHINER	37	0.6	65	0.6	2	<0.1	90	0.9	152	2.0	188	2.1	53	0.7
BULLHEAD MINNOW	7	0.1	31	0.3	52	1.0	292	2.8	7	0.1	32	0.4	14	0.2
PUMPKINSEED	--	--	1	<0.1	--	--	3	<0.1	17	0.2	11	0.1	66	0.9
ROUND GOBY	1	<0.1	45	0.4	47	0.9	35	0.3	11	0.1	40	0.5	40	0.5
THREADFIN SHAD	9	0.1	--	--	25	0.5	--	--	46	0.6	--	--	53	0.7
SAND SHINER	41	0.7	94	0.8	11	0.2	21	0.2	22	0.3	22	0.3	21	0.3
WESTERN MOSQUITOFISH	4	0.1	5	<0.1	13	0.3	18	0.2	44	0.6	22	0.3	8	0.1
NORTHERN SUNFISH	26	0.4	36	0.3	9	0.2	13	0.1	13	0.2	21	0.2	33	0.5
LONGNOSE GAR	8	0.1	22	0.2	8	0.2	5	0.1	17	0.2	13	0.2	24	0.3
YELLOW BULLHEAD	19	0.3	10	0.1	13	0.3	9	0.1	9	0.1	16	0.2	18	0.2
GOLDFISH	4	0.1	7	0.1	--	--	14	0.1	7	0.1	40	0.5	18	0.2
BROOK SILVERSIDE	2	<0.1	14	0.1	--	--	44	0.4	6	0.1	6	0.1	5	0.1
GOLDEN SHINER	6	0.1	16	0.1	1	<0.1	4	<0.1	6	0.1	4	<0.1	23	0.3
RIVER CARPSUCKER	12	0.2	5	<0.1	2	<0.1	3	<0.1	2	<0.1	2	<0.1	5	0.1
GHOST SHINER	3	0.1	15	0.1	3	0.1	1	<0.1	5	0.1	5	0.1	3	<0.1
JOHNNY DARTER	--	--	11	0.1	1	<0.1	3	<0.1	7	0.1	16	0.2	5	0.1
QUILLBACK	5	0.1	4	<0.1	14	0.3	--	--	5	0.1	7	0.1	5	0.1
GOLDEN REDHORSE	6	0.1	6	0.1	11	0.2	1	<0.1	3	<0.1	8	0.1	25	0.3
ROCK BASS	5	0.1	3	<0.1	2	<0.1	3	<0.1	5	0.1	25	0.3	15	0.2
CENTRAL STONEROLLER	--	--	9	0.1	--	--	6	0.1	2	<0.1	4	<0.1	7	0.1
SHORTHEAD REDHORSE	4	0.1	7	0.1	1	<0.1	1	<0.1	1	<0.1	3	<0.1	4	0.1
BLACK CRAPPIE	9	0.1	6	0.1	9	0.2	--	--	2	<0.1	8	0.1	3	<0.1
WHITE SUCKER	2	<0.1	12	0.1	4	0.1	--	--	--	--	1	<0.1	--	--
FATHEAD MINNOW	--	--	5	<0.1	--	--	17	0.2	3	<0.1	4	<0.1	8	0.1
TADPOLE MADTOM	2	<0.1	--	--	--	--	8	0.1	8	0.1	2	<0.1	14	0.2
WHITE BASS	12	0.2	8	0.1	4	0.1	3	<0.1	3	<0.1	1	<0.1	4	0.1
LOGPERCH	3	0.1	--	--	--	--	7	0.1	--	--	4	<0.1	3	<0.1

Table 1 (continued)

SPECIES (cont.)	2002 #	2002 %	2003 #	2003 %	2004 #	2004 %	2005 #	2005 %	2006 #	2006 %	2007 #	2007 %	2008 #	2008 %
BLACKSIDE DARTER	--	--	2	<0.1	5	0.1	2	<0.1	--	--	4	<0.1	10	0.1
REDFIN SHINER	1	<0.1	--	--	1	<0.1	1	<0.1	2	<0.1	2	<0.1	3	<0.1
FLATHEAD CATFISH	2	<0.1	8	0.1	3	0.1	5	0.1	2	<0.1	2	<0.1	3	<0.1
SILVER REDHORSE	3	0.1	1	<0.1	1	<0.1	--	--	6	0.1	--	--	--	--
SKIPJACK HERRING	6	0.1	--	--	4	0.1	1	<0.1	--	--	1	<0.1	8	0.1
MIMIC SHINER	--	--	7	0.1	--	--	2	<0.1	--	--	1	<0.1	--	--
HORNYHEAD CHUB	1	<0.1	3	<0.1	--	--	3	<0.1	15	0.2	1	<0.1	--	--
WHITE PERCH	5	0.1	2	<0.1	--	--	--	--	--	--	1	<0.1	3	<0.1
SUCKERMOUTH MINNOW	1	<0.1	--	--	--	--	1	<0.1	--	--	--	--	5	0.1
YELLOW BASS	--	--	--	--	2	<0.1	1	<0.1	--	--	1	<0.1	2	<0.1
BLACK BUFFALO	1	<0.1	4	<0.1	1	<0.1	--	--	--	--	--	--	--	--
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIGMOUTH BUFFALO	3	0.1	2	<0.1	1	<0.1	--	--	2	<0.1	--	--	--	--
GRASS PICKEREL	1	<0.1	--	--	--	--	--	--	--	--	1	<0.1	1	<0.1
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	1	<0.1	6	0.1
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS CARP	1	<0.1	1	<0.1	--	--	2	<0.1	--	--	1	<0.1	1	<0.1
WHITE CRAPPIE	1	<0.1	1	<0.1	1	<0.1	--	--	1	<0.1	--	--	--	--
BIGMOUTH SHINER	1	<0.1	1	<0.1	--	--	--	--	--	--	2	<0.1	1	<0.1
PALLID SHINER	--	--	2	<0.1	--	--	--	--	--	--	--	--	--	--
REDEAR SUNFISH	2	<0.1	2	<0.1	--	--	--	--	2	<0.1	1	<0.1	--	--
BLACK BULLHEAD	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
SPOTTED SUCKER	--	--	--	--	1	<0.1	--	--	--	--	1	<0.1	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORANGETHROAT DARTER	--	--	1	<0.1	1	<0.1	--	--	--	--	--	--	--	--
WALLEYE	--	--	--	--	3	0.1	--	--	--	--	--	--	--	--
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	1	<0.1	--	--
BIGHEAD CARP	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOWFIN	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SHORTNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RED SHINER	1	<0.1	--	--	--	--	--	--	--	--	--	--	--	--
RIVER REDHORSE	--	--	1	<0.1	--	--	--	--	--	--	--	--	--	--
SLENDERHEAD DARTER	1	<0.1	--	--	--	--	--	--	--	--	--	--	--	--
WARMOUTH	--	--	--	--	2	<0.1	--	--	--	--	--	--	--	--
ALEWIFE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COMMON SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHANNEL SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HIGHFIN CARPSUCKER	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
ORIENTAL WEATHERFISH	--	--	--	--	--	--	--	--	1	<0.1	--	--	--	--
SAUGER	1	<0.1	--	--	--	--	--	--	--	--	--	--	--	--
Other Taxa[a]	121	1.9	645	5.7	367	7.4	266	2.6	232	3.0	227	2.5	299	4.1
TOTAL FISH	6,328	100	11,398	100	4,987	100	10,396	100	7,802	100	8,950	100	7,361	100
TOTAL SPECIES	55		54		50		47		49		56		52	

Table 1 (continued)

SPECIES	2009		2010		2011		2012		2013		2014		Average	Number
	#	%	#	%	#	%	#	%	#	%	#	%	#	Years
BLUNTNOSE MINNOW	2,441	35.4	1,486	21.7	790	13.2	1,365	18.9	1,119	23.2	1,479	21.7	1,554.7	20
GIZZARD SHAD	646	9.4	1,187	17.3	1,226	20.5	1,206	16.7	709	14.7	1,383	20.3	1,059.0	20
BLUEGILL	710	10.3	967	14.1	1,271	21.3	1,433	19.8	1,208	25.1	610	8.9	760.1	20
GREEN SUNFISH	708	10.3	626	9.1	949	15.9	903	12.5	371	7.7	793	11.6	586.3	20
EMERALD SHINER	160	2.3	157	2.3	102	1.7	105	1.5	29	0.6	51	0.8	331.4	20
LARGEMOUTH BASS	358	5.2	378	5.5	260	4.4	184	2.6	315	6.5	823	12.1	242.5	20
COMMON CARP	94	1.4	105	1.5	96	1.6	77	1.1	75	1.6	138	2.0	177.6	20
CHANNEL CATFISH	164	2.4	113	1.7	126	2.1	51	0.7	96	2.0	117	1.7	108.0	20
SPOTFIN SHINER	133	1.9	89	1.3	59	1.0	186	2.6	85	1.8	85	1.2	105.7	20
SPOTTAIL SHINER	98	1.4	50	0.7	24	0.4	16	0.2	3	0.1	111	1.6	97.0	20
BLACKSTRIPE TOPMINNOW	84	1.2	75	1.1	83	1.4	410	5.7	67	1.4	24	0.4	61.2	20
FRESHWATER DRUM	57	0.8	61	0.9	45	0.8	29	0.4	42	0.9	53	0.8	59.7	20
SMALLMOUTH BUFFALO	61	0.9	54	0.8	40	0.7	54	0.8	39	0.8	53	0.8	54.0	20
SMALLMOUTH BASS	133	1.9	57	0.8	44	0.7	34	0.5	15	0.3	67	1.0	45.9	20
ORANGESPOTTED SUNFISH	66	1.0	101	1.5	75	1.3	112	1.6	12	0.3	10	0.2	44.0	20
STRIPED SHINER	41	0.6	3	<0.1	17	0.3	9	0.1	11	0.2	30	0.4	37.3	17
BULLHEAD MINNOW	5	0.1	6	0.1	1	<0.1	5	0.1	1	<0.1	4	0.1	32.3	20
PUMPKINSEED	15	0.2	19	0.3	25	0.4	171	2.4	89	1.9	140	2.1	28.2	13
ROUND GOBY	57	0.8	61	0.9	13	0.2	23	0.3	32	0.7	135	2.0	27.1	14
THREADFIN SHAD	31	0.5	64	0.9	26	0.4	105	1.5	7	0.2	117	1.7	25.7	12
SAND SHINER	49	0.7	16	0.2	17	0.3	34	0.5	9	0.2	30	0.4	24.2	20
WESTERN MOSQUITOFISH	23	0.3	10	0.2	68	1.1	207	2.9	16	0.3	--	--	22.5	16
NORTHERN SUNFISH	29	0.4	33	0.5	18	0.3	30	0.4	45	0.9	47	0.7	20.9	20
LONGNOSE GAR	30	0.4	36	0.5	28	0.5	29	0.4	24	0.5	52	0.8	16.8	19
YELLOW BULLHEAD	12	0.2	10	0.2	12	0.2	8	0.1	18	0.4	19	0.3	10.2	20
GOLDFISH	15	0.2	6	0.1	1	<0.1	6	0.1	7	0.2	26	0.4	8.7	18
BROOK SILVERSIDE	6	0.1	19	0.3	13	0.2	11	0.2	3	0.1	28	0.4	8.3	16
GOLDEN SHINER	6	0.1	16	0.2	8	0.1	19	0.3	2	<0.1	25	0.4	7.7	18
RIVER CARPSUCKER	2	<0.1	5	0.1	4	0.1	3	<0.1	9	0.2	20	0.3	7.4	20
GHOST SHINER	96	1.4	3	<0.1	--	--	--	--	1	<0.1	1	<0.1	7.3	16
JOHNNY DARTER	5	0.1	17	0.3	5	0.1	4	0.1	2	<0.1	23	0.3	7.1	14
QUILLBACK	3	<0.1	11	0.2	7	0.1	7	0.1	2	<0.1	7	0.1	6.9	19
GOLDEN REDHORSE	12	0.2	17	0.3	14	0.2	2	<0.1	1	<0.1	3	<0.1	6.0	19
ROCK BASS	6	0.1	12	0.2	5	0.1	5	0.1	9	0.2	10	0.2	6.0	18
CENTRAL STONEROLLER	25	0.4	3	<0.1	1	<0.1	2	<0.1	1	<0.1	26	0.4	5.6	16
SHORTHEAD REDHORSE	1	<0.1	3	<0.1	2	<0.1	6	0.1	7	0.2	6	0.1	5.1	20
BLACK CRAPPIE	2	<0.1	6	0.1	1	<0.1	--	--	2	<0.1	26	0.4	4.8	17
WHITE SUCKER	2	<0.1	1	<0.1	2	<0.1	1	<0.1	2	<0.1	22	0.3	4.3	17
FATHEAD MINNOW	19	0.3	--	--	3	0.1	5	0.1	5	0.1	2	<0.1	3.9	14
TADPOLE MADTOM	14	0.2	11	0.2	1	<0.1	1	<0.1	1	<0.1	7	0.1	3.7	13
WHITE BASS	1	<0.1	3	<0.1	--	--	4	0.1	5	0.1	2	<0.1	3.6	18
LOGPERCH	10	0.2	6	0.1	9	0.2	2	<0.1	1	<0.1	16	0.2	3.5	15

Table 1 (continued)

SPECIES (cont.)	2009 #	2009 %	2010 #	2010 %	2011 #	2011 %	2012 #	2012 %	2013 #	2013 %	2014 #	2014 %	Average #	Number Years
BLACKSIDE DARTER	8	0.1	4	0.1	3	0.1	--	--	12	0.3	10	0.2	3.1	11
REDFIN SHINER	23	0.3	--	--	--	--	5	0.1	--	--	--	--	2.1	10
FLATHEAD CATFISH	--	--	1	<0.1	1	<0.1	1	<0.1	2	<0.1	6	0.1	2.1	16
SILVER REDHORSE	3	<0.1	5	0.1	3	0.1	5	0.1	1	<0.1	1	<0.1	1.8	14
SKIPJACK HERRING	--	--	--	--	2	<0.1	--	--	--	--	--	--	1.8	12
MIMIC SHINER	1	<0.1	3	<0.1	--	--	1	<0.1	3	0.1	4	0.1	1.8	10
HORNYHEAD CHUB	--	--	1	<0.1	--	--	--	--	1	<0.1	2	<0.1	1.5	9
WHITE PERCH	--	--	3	<0.1	--	--	--	--	--	--	--	--	1.4	10
SUCKERMOUTH MINNOW	4	0.1	--	--	4	0.1	1	<0.1	--	--	5	0.1	1.2	9
YELLOW BASS	--	--	7	0.1	--	--	--	--	--	--	2	<0.1	1.2	10
BLACK BUFFALO	--	--	--	--	1	<0.1	--	--	2	<0.1	--	--	1.1	10
ROSYFACE SHINER	--	--	--	--	--	--	--	--	9	0.2	13	0.2	1.1	2
BIGMOUTH BUFFALO	--	--	1	<0.1	--	--	1	<0.1	--	--	2	<0.1	1.1	12
GRASS PICKEREL	2	<0.1	--	--	2	<0.1	1	<0.1	1	<0.1	6	0.1	1.0	11
NORTHERN PIKE	1	<0.1	3	<0.1	2	<0.1	1	<0.1	--	--	--	--	0.9	9
BANDED KILLIFISH	--	--	--	--	--	--	2	<0.1	5	0.1	9	0.1	0.8	3
GRASS CARP	3	<0.1	--	--	1	<0.1	--	--	--	--	1	<0.1	0.7	9
WHITE CRAPPIE	2	<0.1	2	<0.1	--	--	--	--	--	--	--	--	0.7	9
BIGMOUTH SHINER	--	--	--	--	4	0.1	--	--	--	--	--	--	0.6	7
PALLID SHINER	3	<0.1	2	<0.1	--	--	2	<0.1	--	--	1	<0.1	0.5	5
REDEAR SUNFISH	--	--	--	--	--	--	--	--	1	<0.1	1	<0.1	0.5	6
BLACK BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	0.5	5
SPOTTED SUCKER	--	--	2	<0.1	--	--	--	--	--	--	1	<0.1	0.4	6
YELLOW PERCH	1	<0.1	--	--	1	<0.1	--	--	2	<0.1	--	--	0.4	5
ORANGETHROAT DARTER	--	--	--	--	1	<0.1	--	--	3	0.1	--	--	0.3	4
WALLEYE	1	<0.1	1	<0.1	1	<0.1	--	--	--	--	--	--	0.3	4
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	1	<0.1	0.2	4
BIGHEAD CARP	--	--	4	0.1	--	--	--	--	--	--	--	--	0.2	1
BOWFIN	--	--	2	<0.1	--	--	--	--	--	--	--	--	0.2	2
SHORTNOSE GAR	--	--	--	--	1	<0.1	--	--	--	--	1	<0.1	0.1	2
RED SHINER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	2
RIVER REDHORSE	--	--	--	--	--	--	--	--	--	--	--	--	0.1	2
SLENDERHEAD DARTER	--	--	--	--	1	<0.1	--	--	--	--	--	--	0.1	2
WARMOUTH	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
ALEWIFE	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
COMMON SHINER	1	<0.1	--	--	--	--	--	--	--	--	--	--	0.1	1
CHANNEL SHINER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
HIGHFIN CARPSUCKER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
ORIENTAL WEATHERFISH	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
SAUGER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
Other Taxa[a]	408	5.9	909	13.3	453	7.6	345	4.8	276	5.7	143	2.1	270.2	--
TOTAL FISH	6,891	100	6,853	100	5,972	100	7,229	100	4,815	100	6,830	100	5,930.9	
TOTAL SPECIES	55		56		55		50		54		58		82	

(a) Other Taxa represent hybrids and non-species level identifications. **RIS Species** **State-listed RIS Species**

EXHIBIT C

DETAILED STUDY PLAN FOR §316(a) DEMONSTRATION TO SUPPORT APPLICATION FOR ALTERNATIVE THERMAL LIMITS AT THE JOLIET #9 GENERATING STATION

Prepared for

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EA Project No. 6241617
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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ALU	Aquatic Life Use
ANOVA	Analysis of Variance
AS	Adjusted Standard, thermal
ATL	Alternative Thermal Limit
BIC	Balanced, Indigenous Community
C	Celsius
CAWS	Chicago Area Waterway System
CMC	Carboxymethyl Cellulose
CPE	Catch-per-unit-effort
CSSC	Chicago Sanitary and Ship Canal
CTD	Conductivity, Temperature, and Depth
DELT	Deformities+Erosion+Lesions+Tumors
DGPS	Differential Global Positioning System
EA	EA Engineering, Science, and Technology, Inc., PBC
EPT	Ephemeroptera+Plecoptera+Trichoptera
F	Fahrenheit
ft	foot (feet)
g	gram (grams)
GIS	Geographic Information System
GPS	Global Positioning System
HD	Hester-Dendy
IEPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
IWB	Index of Well-Being
IWBmod	modified Index of Well-Being
Joliet #9 Station	Joliet #9 Generating Station
Joliet #29 Station	Joliet #29 Generating Station
km	kilometer
LDIP	Lower Dresden Island Pool
LLC	Limited Liability Company

m	meter (meters)
Midwest Generation	Midwest Generation, LLC
mm	millimeter (millimeters)
MRWG	Monitoring and Response Work Group
NAD83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
No. (#)	Number
NPDES	National Pollutant Discharge Elimination System
pp.	pages
PAH	Polycyclic Aromatic Hydrocarbons
PBC	Public Benefit Corporation
Plan	Detailed Study Plan
QHEI	Qualitative Habitat Evaluation Index
RAS	Representative Aquatic Species
RIS	Representative Important Species
RM	River Mile
RTK	Real Time Kinematic
Station	Joliet #9 Generating Station
Stations	Joliet #9 Generating Station and Joliet #29 Generating Station
UDIP	Upper Dresden Island Pool
UIW	Upper Illinois Waterway
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

Pursuant to Section 106.1120 of the Illinois Subpart K thermal variance regulations, 35 Illinois Administrative Code §106.1100 et seq. (the "Subpart K Regulations"), this document presents the Detailed Study Plan (the "Plan") for the Joliet #9 Generating Station ("Joliet #9 Station" or "the Station"). The Joliet #9 Station is located on the lower Des Plaines River ("LDPR") in the Upper Dresden Island Pool ("UDIP"). The water quality standards, including water temperature limits for UDIP, have recently been reviewed and modified by the Illinois Pollution Control Board ("IPCB") (IPCB Docket No. 2008-09, Subdocket D). The new thermal standards, which were adopted by the IPCB on 16 June 2015 and codified on 10 July 2015, will be applicable on 1 July 2018.

Midwest Generation, LLC ("Midwest Generation") intends to petition the IPCB for Alternative Thermal Limits ("ATLs") for the Station. This Plan is designed to provide necessary data for the preparation of a Clean Water Act §316(a) Demonstration under the Subpart K Regulations to support an application for ATLs in National Pollutant Discharge Elimination System ("NPDES") Permit No. IL0002216. Because of the timing of the planned modifications to the Station operations and the duration of studies to be conducted to support the application for ATLs, Midwest Generation will require additional time beyond the 1 July 2018 applicability date of the new thermal standards to complete the process of obtaining ATLs. Therefore, on 21 July 2015, Midwest Generation filed a variance petition with the IPCB, Docket No. 16-19, seeking a 2-year variance from the new thermal standards for the period from the 1 July 2018 applicability date through 30 June 2020 for its Will County, Joliet #9, and Joliet #29 Generating Stations.

As specified in §106.1115(b) of the Subpart K Regulations, Midwest Generation met with the Illinois Environmental Protection Agency ("IEPA") on 4 November 2015 to discuss the elements of the Conceptual Study Plan that had been submitted to IEPA on 7 October 2015. Input from those discussions with IEPA is incorporated into this Plan. This Plan provides specific sampling locations, methods, frequency, and schedule, as well as sample processing, data management, and quality assurance/quality control procedures. As appropriate, the new sampling effort and sampling locations will be integrated into the ongoing Upper Illinois Waterway ("UIW") fish sampling program in the vicinity of the Joliet #9 Station that fulfills Special Condition 17 of the Station's NPDES permit. Although the additional electrofishing and seining locations will be added to the 2016 fish monitoring program, the other studies described in Section 5 will be conducted in 2017 and 2018 in order to collect the data after the planned modifications to the Joliet #9 and #29 Stations are completed. Midwest Generation is in the process of converting the Joliet #9 and #29 Generating Stations from coal-fueled to natural gas. Thereafter, they will be operated as "peaking facilities" only during periods of peak system electrical demand. The 2017 and 2018 studies will be initiated a minimum of seven months after repowering is completed and modified operations begin at both the Joliet #9 and Joliet #29 Stations, which is currently scheduled to occur by 1 June 2016. This approximate seven-month period is necessary to allow sufficient time for any potential changes in the receiving waterbody associated with the modified operations to be detected by the studies.

The receiving waterbody for the thermal discharge from the Joliet #9 Station is part of the UDIP, which has been extensively studied by various dischargers, agencies, and other stakeholders over the last four decades. Site-specific studies have been conducted for the Joliet #9 Station by the power plant owners and/or operators over this time. Additionally, state and federal partners have recently conducted a variety of studies to support efforts to limit the range expansion of non-native nuisance species, including several species of Asian carp, between the Mississippi River and Great Lakes drainage basins. This additional sampling, particularly by simultaneously electrofishing and netting, has likely had a negative influence on the results from several Midwest Generation sampling locations since 2010 (EA 2015). Midwest Generation will continue to coordinate its sampling program with the ongoing sampling efforts by these other entities in order to avoid electrofishing at the same locations during the same week or on the same day, which has occurred previously.

2. COMPONENTS FOR A COMPLETE DEMONSTRATION TO SUPPORT APPLICATION FOR ALTERNATIVE THERMAL LIMITS

In cooperation with the Atomic Energy Commission (predecessor to the Nuclear Regulatory Commission), the United States Environmental Protection Agency ("USEPA") developed the *Draft Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements* (1977) ("Technical Guidance Manual"). Although the Technical Guidance Manual has not been finalized, it remains the primary guidance for preparation of §316(a) Demonstrations to support a request for a variance from thermal standards in NPDES permits for electric generating stations. The Technical Guidance Manual presents several approaches for developing a complete Demonstration: Retrospective, Predictive, and a "combined" approach.

2.1 RETROSPECTIVE APPROACH

For power plants similar to the Joliet #9 Station that have been in operation for a long period and have assembled an extensive database related to the aquatic community, the retrospective analysis uses these historical data to demonstrate that the thermal discharge has not resulted in *prior appreciable harm to the balanced, indigenous population* (community). In the case of the Joliet #9 Station, historical operation in compliance with the Secondary Contact and AS 96-10 Temperature Standards has not caused appreciable harm to the aquatic community in the UDIP. The retrospective analysis will look at the historical effects of the thermal discharge on several community biotic categories that may, depending on site-specific conditions, include phytoplankton, zooplankton, benthic macroinvertebrates, habitat formers, and fish. This analysis may look at the abundance, distribution, diversity, long-term trends, and other indicators of the health of these biotic categories relative to areas affected by the thermal discharge and areas beyond the influence of the discharge. Based on the rationale presented in the Conceptual Study Plan and input from the IEPA, the §316(a) Demonstration for the Joliet #9 Station will primarily focus on the available aquatic habitat and benthic macroinvertebrate and fish communities in the vicinity of the Station.

2.2 PREDICTIVE APPROACH

The predictive analysis uses various metrics for measuring the physiological and behavioral responses of resident aquatic organisms to water temperature derived from laboratory studies and, in some cases, field observations. Such measures may include: mortality under acute and chronic exposure to high or low temperatures, temperature avoidance and preference, and temperature effects on spawning, development, and growth. A hydrothermal model of the receiving water will be developed to predict the rate of heat dissipation, dilution, and configuration of the thermal plume under various ambient river flows and temperatures, meteorological conditions, and Station operating conditions. The laboratory predicted range of response temperatures of organisms can then be compared to the model predicted distribution of temperatures within the thermal discharge plume to assess the potential for mortality, blockage of migration, avoidance/exclusion from critical habitat or excessively large areas, and potential effects on spawning success, development, and growth.

2.3 APPROACH FOR THE §316(a) DEMONSTRATION FOR THE JOLIET #9 GENERATING STATION

Several recent §316(a) Demonstrations in support of ATLs that follow the USEPA's (1977) Technical Guidance Manual have been filed with IEPA, including one for the Dresden Generating Station located on the Lower Dresden Island Pool ("LDIP") of the Illinois River at the confluence of the LDPR and the Kankakee River. These recent Demonstrations have integrated the retrospective and predictive approaches. Given the long operating history and extensive historical fish community data available for the Joliet #9 Station, EA Engineering, Science, and Technology, Inc., PBC ("EA") will use a similar approach, integrating retrospective and predictive methods to prepare the §316(a) Demonstration for the Station.

Specifically, the extensive historical database (Section 3) and new sampling data (Section 5) will be used to develop a rationale demonstrating that the thermal discharge from the Station under the Secondary Contact and AS 96-10 Temperature Standards has resulted in no "prior appreciable harm" to the balanced, indigenous community ("BIC"). Statistical evaluation of the data will be used to compare conditions upstream, within, and downstream of the thermal discharge, and to evaluate long-term trends in community metrics. Laboratory-generated biothermal response data for Representative Important Species ("RIS") (Section 2.4) will be used in conjunction with predictive hydrothermal modeling of the UDIP to estimate the potential effects of the modified thermal discharge (Section 4) on the BIC under selected operating and environmental conditions.

2.4 LIST OF REPRESENTATIVE IMPORTANT SPECIES

Acknowledging that it is not possible, feasible, or necessary to evaluate every species in a receiving water body, USEPA (1977) provides guidance for selection of RIS to be used for evaluating the effects of thermal discharges on the balanced, indigenous community. The selected species are representative of specific components of the aquatic community and include:

- Target species of commercial or recreational fisheries
- Nuisance species
- State or federally listed threatened or endangered species
- Species important to the trophic structure/food chain
- Forage species
- Top level predatory species
- Thermally sensitive species.

In a report prepared for USEPA Region 5 and IEPA, Midwest Biodiversity Institute (Yoder and Rankin 2005) identified a master list of potential Representative Aquatic Species ("RAS") for evaluation of use categories and thermal standards; use of RAS in the evaluation of ATLs is equivalent to USEPA's (1977) RIS rationale. The RIS list for the Joliet #9 Station considered species listed by Yoder and Rankin (2005) and the UDIP Aquatic Life Use ("ALU") classification.

In its June 16, 2015 Final Opinion and Order (Docket No. 2008-09, Subdocket D), the IPCB decided that General Use Temperature Standards would apply to the UDIP ALU classification in which the Joliet #9 Station is located. Selection of the RIS is based on review of 20 years of fish sampling data collected between 1994 and 2014 from the UDIP (between Brandon Road Lock and Dam and the I-55 Bridge); these data are summarized by EA (2015) in the 2014 annual fisheries report[1] (Table 1). These data were used to identify species representative of the fish community in the UDIP, e.g., numerically dominant species, various trophic levels, targets for recreational or commercial fisheries, potential nuisance species, thermally sensitive species, and state-listed threatened and endangered species; no federally-listed species occur in the UDIP. During the 20 sampling years, a total of 82 species has been collected. The number of species collected per year ranged from 36 in 1994 and 1995 to 58 in 2014. Twenty-one species were collected in all 20 sampling years and another 10 in at least 17 years. The 15 most abundant species accounted for nearly 90 percent of the fish collected in the UDIP and include forage species, top predators, commercial, and recreational species. Seven of these most abundant species have been selected as RIS: Bluntnose Minnow, Gizzard Shad, Bluegill, Largemouth Bass, Common Carp, Channel Catfish, and Freshwater Drum. Other species among the 15 most abundant are forage and/or recreational species that are adequately represented by the selected species. White Sucker, considered to be a thermally sensitive species, was also selected as a RIS; however, White Sucker is uncommon in the UDIP. Although it has been collected in 17 of the past 20 years, the collection rate was less than five per year. Banded killifish, a state-listed species, has been collected in relatively low numbers (nine or fewer) during the three most recent sampling years reported (2012-2014). Only two River Redhorse have been collected, one in 1994 and one in 2003. Nevertheless, both of these state-listed species have been included as RIS. The River Redhorse and White Sucker prefer riffle and run habitat with clean coarse substrate, particularly for spawning and, therefore, would not be expected to be common in the UDIP that consists of slow water currents and predominantly soft, fine substrates.

The retrospective portion of the §316(a) Demonstration will assess the distribution and condition of the BIC as a whole, as well as the distribution of the RIS, comparing the aquatic community within and outside of the influence of the Joliet #9 Station's thermal plume. For the predictive portion of the §316(a) Demonstration, thermal effects data are limited for some RIS (e.g., state-listed species such as River Redhorse), in which case surrogate species will be used. For example, the limited thermal effects data for various redhorse species will be pooled as a surrogate for River Redhorse. Similarly, thermal effects data will be pooled for various species of *Fundulus* spp. as a surrogate for Banded Killifish; this species was not collected in the UDIP prior to 2012 (Table 1).

[1] The 2014 annual fisheries report was submitted to IEPA in September 2015.

The following species are the RIS selected for evaluation of ATLs for the Joliet #9 Station and UDIP:

Species	Abundant	Commercial[(a)]	Recreational[(b)]	Nuisance	Threatened and Endangered	Forage	Predator	Sensitive
Gizzard Shad	X					X		
Bluntnose Minnow	X					X		
Banded Killifish					X			
River Redhorse			X		X			X
White Sucker								X
Common Carp	X			X				
Channel Catfish			X					
Bluegill	X		X				X	
Largemouth Bass	X		X				X	
Freshwater Drum		X					X	

a. No commercial fishing currently takes place in this waterway.
b. Recreational fishing occurs; however, due to the presence of legacy contaminants, there is a long-standing fish consumption advisory.

3. DATA GAP ANALYSIS – REVIEW OF EXISTING DATA SOURCES

Commonwealth Edison and Midwest Generation have conducted a variety of studies since 1977 to monitor and document the condition and composition of the aquatic community and the physicochemical conditions in the vicinity of the Joliet #9 Station (e.g., Commonwealth Edison 1996 and EA 2015). The longest running sampling programs have targeted the fish community. In addition to the work by Commonwealth Edison and Midwest Generation, the Asian Carp Regional Coordinating Committee's Monitoring and Response Work Group (MRWG) has conducted annual monitoring of various aquatic trophic groups in the UIW since 2010, including the UDIP near the Joliet #9 Station. The table below briefly summarizes the years of studies conducted or ongoing.

Data Category	Midwest Generation	MRWG
Fish	1977-1995 and 1997-2015	2010-2015
Aquatic Macrophytes	1985 and 1995	
Phytoplankton	1991 and 1993	2010-2015[a]
Zooplankton		2010-2015[a]
Macroinvertebrates	1993 and 1994	
Ichthyoplankton	2004-2005 and 2016 at Joliet #9[b]	2010-2015[a]
Sediment	1994-1995 and 2008	
Habitat Characterization	1993-1995, 2003, and 2008	
Thermal Plume Studies	2002 and 2012	
Mixing Zone	2002 and 2012	
Intake Temperature Monitoring	Continuously for most recent 5-year period (Station collected data)	
Discharge Temperature Monitoring	Continuously for most recent 5-year period (Station collected data)	
Thermal Modeling		

a. Near the I-55 Bridge in UDIP.
b. Midwest Generation is currently planning to conduct this §316(b)-related study in 2016 at the Joliet #9 Station.

The information presented in the table above has been used to identify existing data gaps that would need to be addressed in order to meet the criteria (USEPA 1977) for a §316(a) Demonstration in support of the application for appropriate ATLs for the Station.

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4. FUTURE STATION OPERATING SCENARIOS

Midwest Generation is in the process of converting the Joliet #9 and #29 Generating Stations from coal-fueled to natural gas, which is currently scheduled to be completed by 1 June 2016. Thereafter, they will be operated as "peaking facilities" only during periods of peak system electrical demand. Two years (2017-2018) of flow and temperature monitoring data from the Stations' cooling water intakes and discharges, including helper cooling tower operations at the Joliet #29 Station, will be necessary to reasonably document and characterize the thermal loading patterns and capacity factors associated with the future operations. Barring unusual meteorological conditions and/or atypical Station operation during the 2017-2018 study period, this two-year study period will provide adequate data for the development of the Danish Hydraulic Institute's MIKE 3 model (Section 5.8) that will be used for the predictive assessment of potential thermal effects to RIS under the new operating scenarios for the Joliet Stations. In the event meteorological or Station operating conditions during the 2017-2018 study period do not provide adequate data for the model's predictive assessment, the study period will be extended as necessary to collect the additional data required.

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5. STUDY PLAN FOR DEMONSTRATION TO SUPPORT ALTERNATIVE THERMAL LIMITS

5.1 PHYTOPLANKTON

Except in a few unusual circumstances, phytoplankton have generally been viewed as a biotic category with low potential for impact associated with thermal discharges to rivers. The 1977 Technical Guidance Manual supports this assumption. High reproductive capacity and short generation times of most phytoplankton species allow rapid recovery and limit potential effects to a very small spatial and temporal extent. Thermal sensitivity testing has demonstrated that phytoplankton typically have relatively high thermal tolerance levels. Relatively high nutrient availability in the UIW further promotes rapid reproduction and growth.

Annual monitoring of phytoplankton productivity (chlorophyll *a*) since 2010 by the MRWG near the I-55 Bridge in the UDIP provides data that can be used to assess the status of the phytoplankton community in the vicinity of the Joliet #9 Station. Phytoplankton studies conducted as part of the UIW studies in the UDIP during 1991 and 1993 provide an historical context for changes in the phytoplankton community in response to other water quality changes over the last two decades. Given that phytoplankton are typically a low impact biotic category, the available existing information is considered adequate to characterize this component of the aquatic community and therefore, no additional studies of phytoplankton are proposed to support development of a §316(a) Demonstration.

Existing historical data for the UDIP and thermal tolerance data from scientific literature will be reviewed in the §316(a) Demonstration for the Joliet #9 Station to support the finding that phytoplankton is a low potential impact biotic category at this site.

5.2 SUBMERGED AQUATIC VEGETATION

Aquatic vegetation can provide cover and spawning habitat for some species/life stages of fish and invertebrates. Large, dense stands of macrophytes can, however, adversely affect dissolved oxygen concentrations, particularly during the nighttime respiratory phase. During recent fisheries surveys, EA (2015) has documented significant increases in distribution and areal extent of macrophytes in the UDIP and occasional low dissolved oxygen associated with dense mats of duckweed/algae, which impair habitat for some fish species.

As part of the habitat mapping (Section 5.7), a survey of macrophytes in the reach of the UDIP between the entrance to the Joliet #29 Station's intake canal and the I-55 Bridge will be conducted to document the extent and dominant macrophyte species. The survey will be performed once during the peak of the growing season, July-August 2017. The survey will consist of mapping the approximate boundary of these macrophyte beds using a Global Positioning System ("GPS") and identifying the dominant species at selected transects from the outer edge of the bed to the shoreline.

Transects will be established at the rate of approximately two transects (one right bank and one left bank) per half mile of the study area. Approximately 15 paired right and left bank transects will be surveyed:

- Six between the Joliet #29 intake canal and the mouth of Rock Run;
- Four from Rock Run to the head of Treats Island;
- One at the upstream and a second at the downstream end of Treats Island; and
- Three between Treats Island and the I-55 Bridge.

Transect locations will be selected by the aquatic botanist directing the survey based on field observation of conditions at the time of the survey. The dominant species will be identified and an estimate will be made of the percent coverage of the area by each dominant species along each transect. GPS coordinates will be uploaded to a project geographic information system (GIS) to generate vegetation shape files that will be overlayed on plume maps generated from the MIKE 3 model and the bathymetric survey maps.

5.3 ZOOPLANKTON

Similar to phytoplankton (Section 5.1), zooplankton have generally been demonstrated to be a biotic category with low potential for impact associated with thermal discharges (USEPA 1977). High reproductive capacity and short generation times allow rapid recovery and limit potential effects to very small spatial and temporal extents. Thermal testing has demonstrated that zooplankton typically have relatively high thermal tolerance levels.

Annual monitoring of the zooplankton community since 2010 by the MRWG near the I-55 Bridge in the UDIP provides data that can be used to assess the status of the zooplankton community in the vicinity of the Joliet #9 Station. Given that zooplankton are typically a low impact biotic category, the available existing information is considered adequate to characterize this component of the aquatic community; therefore, no additional studies of zooplankton are proposed to support development of a §316(a) Demonstration.

Existing historical data for UDIP and thermal tolerance data from scientific literature will be reviewed in the §316(a) Demonstration for the Joliet #9 Station to support the finding that zooplankton is a low potential impact biotic category at this site.

5.4 BENTHIC MACROINVERTEBRATES

Because benthic macroinvertebrates can be an important source of food for many fish species, this biotic category will receive more detailed analysis in the §316(a) Demonstration than the phytoplankton and zooplankton communities described above. Benthic macroinvertebrates were sampled during the summers of 1993 and 1994 in the vicinity of the Joliet #9 Station as part of the UIW study (Commonwealth Edison 1996). Data for this biotic category are now more than 20 years old.

Because the Joliet #9 Station's thermal discharge results in a buoyant thermal plume, the warmest temperatures associated with the thermal discharge are near the surface of the UDIP;

therefore, habitat for benthic macroinvertebrates has minimal exposure to the warmest portions of the plume that occur in the immediate vicinity of the Station. Consequently, exposure of benthic macroinvertebrates to higher temperatures in the thermal plume is typically limited in the vicinity of the Joliet #9 Station.

Given the importance of macroinvertebrates to the aquatic food chain, this Plan will implement 2 years (2017 and 2018) of benthic macroinvertebrate sampling to document the condition of this biotic category and provide information to evaluate the potential effects of the thermal plume from the Joliet #9 Station. The objectives of this study will be to determine/compare the composition, distribution, and abundance of the benthic community among segments above, within, and below the Station's discharge. The 2017-2018 results will be compared with those obtained during 1993 and 1994 to evaluate spatial and temporal trends within the benthic macroinvertebrate community.

5.4.1 Field

Because the distribution and community composition of benthic macroinvertebrates is strongly influenced by the physical and chemical characteristics of the substrate, this study will use standard artificial substrate samplers (Hester-Dendy plates ["HD"]) in order to factor out the effects of substrate variability for the evaluation of thermal effects. Benthic macroinvertebrates will be sampled at 12 locations upstream and downstream of the thermal mixing zone for the Station with the study area extending from the mouth of the Brandon Road Lock and Dam tailwater (~RM 285.5) to the I-55 Bridge (RM 277.8). Samplers will be deployed at the left and right banks in the following six approximate areas: RM 285.5, RM 285.0, RM 283.8, RM 281.7, RM 280.3, and RM 277.8 (Figure 1). The selection of actual sampling locations will depend upon field observations of reliable areas to deploy the samplers; GPS coordinates will be recorded for each sampling location. The same sampling locations will be used in each year to provide information on inter-annual variability.

Each modified HD artificial substrate sampler will consist of eight 3x3-inch plates constructed from 1/8-inch tempered hardboard and twelve 1/8-inch plastic spacers. The plates and spacers will be arranged on a 1/4-inch eyebolt so that each sampler has three 1/8-inch spaces, three 1/4-inch spaces, and one 3/8-inch space among the plates. The total surface area of a single sampler, excluding the eyebolt, will be 1.01 square feet. A single sample will consist of five HDs suspended approximately 30-50 cm below the water surface. Triplicate HD sets will be deployed at each location to minimize the loss of samplers (e.g., vandalism). They will be placed at each location in July and remain in place for at least a six-week colonization period. Retrieval of the HDs will be accomplished by enclosing the samplers in a fine-mesh sweep-net and then carefully lifting the sampler array and net to the surface. The HDs will be disassembled from the array, placed into a single labeled container, and preserved with 10 percent formalin.

5.4.2 Sample Processing

Prior to analysis, each sample will be rinsed on a U.S. No. 35 mesh sieve to remove preservative. Two samplers will be processed for each location. The sample material will be sorted, a small portion at a time, under a dissecting microscope at 10X magnification. All benthic macroinvertebrates found will be sorted by major taxonomic groups (e.g., Oligochaeta and Chironomidae). Specimens will be preserved in 70 percent ethyl alcohol. All benthic macroinvertebrates will be identified to the lowest practical taxon using the latest taxonomic keys. Oligochaetes and chironomids will be mounted on glass slides using CMC-10 mounting media prior to examination under a compound binocular microscope at 40-1000X magnification.

5.4.3 Analysis and Data Interpretation

Spatial and temporal comparisons will be made using density (#/m^2), relative abundance (percentage), Ephemeroptera+Plecoptera+Trichoptera ("EPT") taxa richness, and total taxa richness. In addition, an analysis of variance ("ANOVA") will be performed using the replicate data to statistically compare community structure metrics such as taxa richness, total density, Oligochaeta (aquatic worm) density, Chironomidae (midge) density, and Ephemeroptera (mayfly) density among the sample areas upstream (RM 285.5 and RM 285.0) of the Joliet Station's discharge, within the mixing zone (RM 283.8), and downstream of the mixing zone (RM 281.7, RM 280.3, and RM 277.8).

5.5 FRESHWATER MUSSELS

The Illinois River and its headwaters once provided habitat to a diverse community of freshwater mussels; however, those populations declined dramatically following construction of the Chicago Sanitary and Ship Canal ("CSSC") and the navigational lock and dam system.

Ecological Specialists (2008) conducted a survey for freshwater mussels in a 0.5-mile reach below Brandon Road Lock and Dam as part of pre-licensing application studies for proposed hydropower development to identify existing unionid species, their relative abundance, and evaluate the habitat potentially affected by construction and operation of a hydropower facility at this site immediately upstream of the Joliet #9 Station. Ecological Specialists (2008) found no live mussels within survey area and reported that habitat was not suitable for unionid mussels. Substrate was generally not suitable, consisting mostly of gravel and cobble with little sand and silt throughout the survey area. Only weathered shells of three common species were identified (*Lampsilis siliquoidea*, *Pyganodon grandis*, and *Utterbackia imbecillis*) and it was hypothesized that these shells may have drifted down from an upstream community.

The Illinois Natural History Survey (Price et al. 2012) conducted a regional survey for freshwater mussels in the Des Plaines River basin and other tributaries to Lake Michigan. This survey identified live specimens of nine freshwater mussel species; shells for another 10 species were identified, but with no live specimens. The authors reported that many species collected historically in the Des Plaines River basin have not been documented in the basin since at least 1920. Only three species (represented by dead specimens or relic shells) were identified from the one sampling location downstream of Lockport Lock and Dam in Brandon Pool. They also reported no evidence of successful reproduction (recruitment of individuals less than 30 mm or with three or fewer growth rings). Price et al. (2012) concluded that:

> *the Des Plaines River basin has undergone significant freshwater mussel species loss, and unless water and sediment quality improve, species loss will likely continue. Urbanization in the region has profoundly impacted the aquatic habitat available for freshwater mussels. The navigable waterways throughout the Des Plaines River basin are highly modified for navigation and waste disposal, and waterways that were formerly rivers exist now as dredged canals with artificial walls.*

Although information on current mussel distribution in the Des Plaines River is limited, the available evidence indicates that potential freshwater mussel habitat in the UDIP is of poor quality and that living mussel populations are not likely to exist in the vicinity of the Station. Therefore, no mussel surveys are proposed in this Plan. Existing historical data for the UDIP, if available, will be reviewed in the §316(a) Demonstration for the Joliet #9 Station to determine whether it supports the finding that freshwater mussels are not expected to be affected by its thermal discharge.

5.6 FISHERIES

The objective of this study will be to determine/compare the composition, distribution, abundance, condition, and incidence of anomalies of fish upstream, within the mixing zone, and downstream of the Joliet #9 Station's discharge. The 2017 and 2018 results will be compared with those obtained since 1994 to evaluate spatial and temporal trends within the fish community.

Sampling of the juvenile and adult fish community of the UDIP has been conducted for more than 37 years (1977-1995 and 1997-2015) by Commonwealth Edison or Midwest Generation. The ongoing fish sampling program fulfills the requirements of Special Condition 17 of the Joliet Station #9 NPDES Permit (Permit Number IL0002216) and Special Condition 18 of the Joliet Station #29 NPDES Permit (Permit Number IL0064254). Sampling has included the use of electrofishing and beach seines in appropriate habitat. Except as noted below, the overall geographic and temporal coverage of these surveys are more than adequate to characterize the fish community in the vicinity of the Joliet #9 Station and any changes that have occurred over time in response to Station operation, upstream discharger operations, and other environmental changes in the aquatic system. Due to the change in electrofishing methods in 1994, any historical comparisons will be confined to data collected since then.

5.6.1 Field

The ongoing fish sampling program includes two locations upstream of the Station's discharge (Locations 402 and 402A), a location within the discharge canals of both Joliet Stations (Location 403), and a location just downstream of Joliet #9 Station's conceptual mixing zone (Location 403A) (Figure 2). Three additional UDIP sampling locations (404A, 405, and 408) are located three to five miles downstream of the Station. To provide better spatial distribution of sampling locations relative to the thermal plume further downstream of the estimated edge of that mixing zone, two new sampling locations will be added between Location 403A and the confluence of Rock Run (approximately one to two miles downstream of the discharge), one along each bank (Figure 2). The new sampling locations will be similar to existing locations; that is, each will consist of a 500-meter electrofishing zone. If possible, seining will be conducted within these two new locations.

Electrofishing will be conducted at all nine UDIP locations using a boat-mounted electrofishing system energized by a 230-volt, 5,000-watt three-phase AC generator. Each electrofishing zone is 500 m long. Electrofishing will be conducted in a downstream direction at all locations. Electrofishing will begin no earlier than 0.5 hours after sunrise and will finish no later than 0.5 hours before sunset. The sampling crew will consist of a driver and a netter. Both crew members will have long-handled dip nets for catching stunned fish.

Seining will be conducted at seven UDIP locations (all except Locations 402A and 403) using a 25-ft long x 6-ft deep straight seine with 3/16-inch Ace mesh. The sampling distance will depend on the area available at each location and to the extent possible, will be kept constant during each sampling period. If electrofishing and seining are to be conducted in the same area on the same day, seining will be conducted first and at least one hour elapsed before electrofishing is conducted.

Historically and under the Joliet Stations' NPDES Special Permit Conditions, sampling is conducted once in mid-May, once in June, and twice monthly in July, August, and September, for a total of eight sampling events. With completion of the conversion to gas-fueled operations, the Joliet Stations will operate as peaking facilities primarily during the warmest and coldest portions of the year. To evaluate the effects of winter operations, the Plan adds two winter sampling events each year, once in December (2016 and 2017) and once in January/February (2017 and 2018). The winter sampling will be coordinated to occur in conjunction with operating cycles of the Joliet Stations.

5.6.2 Physicochemical Measurements

Water temperature, dissolved oxygen concentration, percent oxygen saturation, specific conductance, and Secchi disk depth will be measured at each electrofishing location during each trip. Sampling techniques and calibration procedures/frequencies will be the same as those used historically during the UIW studies (EA 2015).

5.6.3 Sample Processing

All fish will be held in source water immediately after collection and until processing. All fish will be counted and identified to the lowest practical taxonomic level, usually species. For each location and gear, a maximum of 30 specimens of each species collected will be measured for total length (mm) and weight (g). If over 30 individuals of a species are collected at any location, then 30 representative individuals will be measured and weighed. The remaining individuals of that species will be counted and a group (batch) weight recorded. Minnows (excluding all carp species, Goldfish, and their hybrids) and other small species such as darters and topminnows will be identified, counted, and batch weighed. After processing, all live fish will be returned to the river. All fish not processed in the field will be preserved in formalin, labeled, and returned to the laboratory for processing. In the laboratory, fish will be processed in the same manner as in the field.

A voucher collection of unusual or taxonomically difficult species will be compiled. All observed threatened or endangered species will be photo documented and returned live, if possible, and will not be routinely included in the voucher collection.

All fish encountered will be examined for external anomalies. External anomalies will be classified as DELT anomalies (Deformities, Erosions, Lesions, and Tumors), parasites, or "other" abnormalities. The following is a review of DELT anomalies and their causes in freshwater fishes:

1) Deformities - These anomalies can affect the head, spine, fins, and have a variety of causes including toxic chemicals, viruses, bacteria (e.g., *Mycobacterium* sp.), and protozoan parasites (e.g., *Myxosoma cerebalis*).

2) Eroded fins - These are the result of chronic disease principally caused by flexibacteria invading the fins causing a necrosis of the tissue. Necrosis of the fins may also be caused by gryodactylids, a small trematode parasite. For this study, fin erosion will be separated into three categories: slight erosion <1/3 of fin eroded; moderate erosion 1/3 to 2/3 of fin eroded, and severe erosion >2/3 of fin eroded.

3) Lesions and Ulcers - These appear as open sores or exposed tissue and can be caused by viral (e.g., *Lymphocystis* sp.) or bacterial (e.g., *Flexibacter columnaris*, *Aeromonas* spp., *Vibrio* sp.) infections.

4) Tumors - Tumors result from the loss of carefully regulated cellular proliferative growth in tissue and are generally referred to as neoplasia. In wild fish populations tumors can be the result of exposure to toxic chemicals such as polycyclic aromatic hydrocarbons (PAHs). Viral infections (e.g., *Lymphocystis*) can also cause tumors. Parasites (e.g., *Glugea anomala* and *Ceratomyxa shasta*) may cause tumor-like masses, but are not considered tumors. Parasite masses can be squeezed and broken between the thumb and forefinger whereas true tumors are firm and not easily broken.

An external anomaly will be defined as the presence of externally visible skin or subcutaneous disorders, and is expressed as percent of affected fish among all fish processed. Only those anomalies visible to the naked eye will be recorded. The exact counts of anomalies present (e.g., the number of tumors or lesions per fish) will not be recorded.

5.6.4 Data Analysis and Interpretation

Data from electrofishing and seining will be reported as number, catch-per-unit-effort ("CPE", No./km for electrofishing and No./haul for seining), and percent abundance for each species.

Index of Well-Being ("IWB") and modified IWB ("IWBmod") scores will be calculated for the electrofishing data and species richness will be calculated for both gears.

Electrofishing and seining data will be segregated by location, segment, and trip. Mean electrofishing and seining community parameters (i.e., CPEs, species richness, and IWBmod scores [electrofishing only]) will be compared on intra-year (segment vs. segment by year) and inter-year (year vs. year by segment) basis. Statistical testing (ANOVA and Tukey's Studentized Range Test) will be conducted on the electrofishing data. Analyses of relative weight and DELT anomaly data will also be on inter-year and intra-year basis. Physicochemical data collected in conjunction with these studies will be compared on a spatial basis (e.g., location vs. location and segment vs. segment).

Entrainment studies conducted at the Joliet Stations in 2004-2005 are a source of ichthyoplankton data in the immediate vicinity of both Stations. In addition, ichthyoplankton entrainment data is currently planned to be collected at the Joliet #9 Station in 2016 as part of §316(b) requirements. These data will be used to characterize the species and life stages susceptible to the Stations' thermal plumes. No additional ichthyoplankton studies are proposed to support development of the §316(a) Demonstration.

5.7 AQUATIC HABITAT

EA has conducted extensive habitat surveys in various portions of the UDIP and LDIP between Brandon Road Lock and Dam and Dresden Island Lock and Dam (1993-1995, 2003, and 2008). Habitat quality was evaluated for all surveys using the Qualitative Habitat Evaluation Index ("QHEI") developed by Rankin (1989). The results of these studies were submitted and discussed in pre-filed testimony (8 September 2008) by Mr. Greg Seegert (EA) on proposed amendments to Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System (CAWS) and LDPR (IPCB Docket No. R08-9, Subdocket C). The 2003 study encompassed the entire Dresden Pool with habitat evaluated at 0.5-mile intervals. The 2008 study provides comprehensive, contiguous QHEI data for both banks of UDIP in the vicinity of the Joliet Stations from Brandon Road Lock and Dam downstream to the I-55 Bridge. The findings of these studies generally showed that habitat was poor upstream of Brandon Road Lock and Dam. Although habitat conditions improved downstream of Brandon Road Lock and Dam, QHEI scores were still typically in the "poor" range of the scale. QHEI scores will again be determined at each UDIP electrofishing location beginning in 2016.

EA conducted thermal surveys in the vicinity of the Joliet #9 and #29 Stations in 2012 that provided some bathymetric information for the reach in the vicinity of the conceptual mixing zones of these Stations. These data combined with the QHEI data can be used to generate preliminary habitat maps for these reaches. However, to support a predictive thermal assessment of the effects of the Stations' thermal plumes, additional characterization of habitat types in the area from Brandon Road Lock and Dam to the I-55 Bridge will be required.

A new bathymetric survey, extending downstream to near the I-55 Bridge (Section 5.8.1), will be used to delineate channel, edge of channel and shallow (less than 2 m) littoral habitat. The only riffle/run habitat in the UDIP is the Brandon Road Lock and Dam tailwater area located between the Dam and Brandon Road; the approximate downstream edge of this tailwater will be mapped using a GPS. Submerged aquatic vegetation surveys (Section 5.2) will describe the extent and dominant types of aquatic vegetation in shallow habitat. During the vegetation survey, shoreline characteristics will be described (e.g., bulkhead, riprap or otherwise armored, or "natural"). Substrate type will be determined along each vegetation transect using a rod to gauge general categories such as soft/mud, sand, gravel, cobble or larger. Also during the vegetation survey, the boundary of backwater and tributary mouth areas will be mapped using a GPS and compared with the information provided by the bathymetric survey. Other significant structure observed during the vegetation and bathymetric surveys that could attract fish or provide cover will be identified and mapped. QHEI scores determined for each UDIP electrofishing location will also be used to characterize the type and quality of aquatic habitat.

These data will be used in the predictive portion of the §316(a) Demonstration to interpret availability and distribution of preferred habitat for the RIS within and outside of the thermal mixing zone and selected isothermal contours of the Station's thermal plume.

5.8 THERMAL PLUME SURVEYS AND HYDROTHERMAL MODELING

Eight thermal plume surveys were conducted along the LDPR at the Joliet Stations during the summer of 2002. Each survey consisted of surface plume mapping and vertical profiles along predetermined transects. Transects encompassed an area from 3,350 ft upstream of the Joliet #29 Station's discharge to 7,000 ft downstream of the discharge.

A series of surveys were also conducted during the summer of 2012 to characterize the distribution of temperatures in the thermal mixing zones of the Joliet Stations. Conditions during the July 2012 surveys encompassed a period of extreme high ambient water temperatures associated with a severe regional drought. The surveys included measurement of surface temperatures at a series of 14 transects (Figure 3), plus three to five vertical temperature profiles (depending on the river width and proximity to the Joliet Stations' discharges) spaced equidistant along each transect. The 14 transects during the 2012 survey encompassed an area from 4,620 ft upstream of the Joliet #29 Station's discharge to 7,000 ft downstream of the discharge. In order to more completely document the downstream distribution and dissipation of thermal plume temperatures and support hydrothermal modeling of the plume for the predictive assessment, five additional transects will be established downstream of the 7,000-ft transect (Figure 4) and upstream of the I-55 Bridge.

The survey data collected in 2002 and 2012, as well as the new survey data to be collected once during the winter (January-February) and once during the summer (July-August) of 2017, will be used to calibrate and validate a thermal model that will be used to predict the configuration of the Joliet #9 thermal plume under various river flow, meteorological, and the future operating scenarios (Section 4).

5.8.1 Bathymetry Survey

Bathymetric data will be collected along each study transect (Figures 3 and 4). They will be collected along 19 transects, oriented perpendicular to flow, beginning at the mouth of the Brandon Road Lock and Dam tailwater and ending just upstream of the I-55 Bridge. Labeled headstakes and survey flagging will be set on each shore to provide a visual cue during the survey. As part of the survey effort, additional data will be obtained along a diagonal line between the end of one transect and the beginning of the next transect for all but the three most downstream transects (Transects 16 to 17, Transects 17 to 18, and Transects 18 to 19), and as a continuous transect along the approximate centerline of the river to serve as cross-lines for each of the 19 survey transects. Cross-line data will be used following processing as part of the quality assurance/quality control procedures. Figures 3 and 4 show the estimated location of the 19 survey transects; the exact locations may be adjusted in the field based on observed flow conditions and safety considerations.

Individual depth soundings will be collected acoustically using a Teledyne Odom Hydrotrac precision, survey fathometer interfaced with a 200 kHz, narrow beam (3°) transducer (or equivalent system). The transducer will be set at a fixed depth below the waterline of the survey vessel (draft) and a correction will be applied to the soundings by the fathometer to reflect the actual depth between the water surface and riverbed. The raw depth soundings obtained by the fathometer will be ported directly to HYPACK and saved as negative elevation values. During the survey operation, HYPACK will merge the raw soundings with time and Real Time Kinematic ("RTK") GPS position information, and store these data in files for post-processing. As HYPACK collects the raw soundings, it will also employ a geoid model to convert the negative elevation values (water depths) to elevation relative to the vertical control of North American Vertical Datum of 1988 ("NAVD 88"). This first order conversion can be accomplished in real time using the precision ellipsoid height data provided by the RTK GPS system. These elevation data will later be refined as part of the post-processing routines.

As part of the survey activity, profile measurements of the physical characteristics of the water column will be obtained three or more times on each survey date using a Seabird SBE 19 Conductivity, Temperature, and Depth ("CTD") probe in order to determine sound velocity. Sound velocity is a product of water density, which is primarily influenced by temperature in a freshwater river system. The CTD profiles will be used to calculate a series of sound velocity correctors that will later be employed in the post-processing phase of the project to adjust the raw soundings obtained by the fathometer using a fixed, assumed sound velocity.

During the post-processing phase, all the raw depth soundings will be reviewed, corrected for water column sound velocity, and normalized to a vertical datum of NAVD 88 in HYPACK's single beam editor module. At the conclusion of the processing step, the data will be compiled into a single *.XYZ text file consisting of X and Y position information and depth represented as Z. The files will be ported to a GIS database for gridding and development of a digital elevation model for the study reach.

5.8.2 Temperature Surveys

The Joliet Stations' sampling grid will consist of the same 14 primary transects used for the 2012 survey (Figure 3); Transects 15-19 in Figure 4 are approximate new locations for the 2017 surveys. The transect locations and the number of vertical stations along each transect are summarized in the following table:

Transect	Distance (ft) from Joliet #29's Discharge	No. of Verticals	Transect (cont.)	Distance (ft) from Joliet #29's Discharge	No. of Verticals
1	-4,620	0	11	2,750	4
2	-3,350	3	12	4,000	3
3	-1,720	4	13	5,500	3
4	-1,250	4	14	7,000	3
5	-750	4	15	8,500	3
6	-250	4	16	10,500	3
7	250	5	17	12,700	3
8	750	5	18	16,900	3
9	1,250	5	19	29,600	3
10	2,000	4			

Transect distances are determined from the end of Joliet #29 Station's discharge canal. The end of the Joliet #9 Station's discharge canal is located at Transect 3 and the Joliet #29 Station's discharge canal is located between Transects 6 and 7 on the opposite bank. Two additional transects will be located in the Joliet #9 Station's discharge canal; one cross channel transect and one center-line transect.

In addition to the cross channel transects, surface temperature data will also be collected along diagonal transects between the primary transects from Transect 3 to Transect 14. Between Transects 1 and 2, Transects 2 and 3, and Transects 15-19 several bank to bank zigzags will be made. Upstream Transects 1 and 2 will be used to establish ambient temperature conditions and to evaluate potential upstream intrusion of the thermal plume, particularly under low river flow conditions.

Vertical profiling stations will be established along each of the primary transects except Transect 1 located near the mouth of the Brandon Road Lock and Dam tailwater. The vertical stations will be evenly spaced along each transect. More stations are located along the transects that are closer to the discharge canals to better characterize the lateral spread of the plumes in those areas. For example, Transects 3 through 6 each have four vertical stations located at one-fifth, two-fifths, three-fifths, and four-fifths of the distance between the left and right banks. The transects with three vertical stations have stations located at one-quarter, one-half, and three-quarters of the distance between the left and right banks. Vertical profiling stations are numbered from the left descending bank (i.e., 1/4 or 1/5 is closest to the left bank). The thermal plume survey transects and vertical profile stations from the 2012 surveys are illustrated in Figure 3. For the 2017 surveys, the locations of the 2012 thermal survey transects will be re-established using GPS coordinates recorded during the 2012 surveys. The approximate location of new transects (15-19) downstream of the Joliet Stations are shown on Figure 4; these transects and the location of the vertical profiles will be adjusted as necessary during the field surveys. The Illinois State Plane (East) coordinate system and the North American Datum of 1983 ("NAD83") will be used for the Joliet Stations' surveys. Within the Joliet #9 Station's discharge canal, one vertical station will be located at the mid-point of the cross-channel transect.

In order to reduce the total elapsed time of the surveys, particularly during the winter, the surface transect temperature measurements and the vertical temperature profile measurements will be collected concurrently by two different field crews. The surface temperature recording system consists of a Logan Enterprises thermistor probe (model 4701-2.50-25ft-TH44018-PH) interfaced with a Deban 500 module and a Trimble GeoXH DGPS (or equivalent system). The Deban module receives the signal from the thermistor and sends a voltage that responds linearly with temperature to the Campbell CR10X datalogger. The Logan/Deban temperature system has an accuracy of 0.1% full span, which corresponds to 0.05°C (0.09°F). Output from the thermistor will be stored at one second intervals in the datalogger. The DGPS stores the X and Y coordinates of the temperature probe position at one second intervals to internal memory. The system clocks on the datalogger and the DGPS are set to identical times at the beginning of each survey. Synchronized temperature and DGPS data are recorded along the primary transects, as well as along the diagonal or centerline transects.

The thermistor is attached to a fixed strut mounted on the side of the boat at a depth of 18 inches. Two thermistors, a primary and a replicate, are used during each survey. During collection of surface temperatures, the boat is driven along each transect, turned as close as possible to the shoreline, and then typically moved on a diagonal to the next transect, producing a zigzag pattern. This method is used to assist in the delineation of the surface plume between the primary transects.

Plume definition within the water column is obtained by measuring vertical temperature profiles using a Seabird CTD profiler (model SBE 19 plus). The instrument collects temperature and depth data at 0.25 second intervals as it is slowly lowered to the bottom and pulled back up to the surface. This typically results in the collection of four to six data points within every 1-ft depth interval. The DGPS is used to position the boat at the same vertical profiling stations during each survey.

Pre- and post-calibration of temperature and pressure (depth) for the Seabird CTD Profiler will be performed and documented by the vendor. During each surface plume mapping survey, two temperature probes will be deployed (designated primary and secondary) to provide a backup in case of equipment malfunctions. For each survey date, the surface temperature thermistor will be compared to the Seabird CTD by placing both instruments side-by-side in the water.

For each survey date, LDPR flows will be obtained from the Brandon Road Lock and Dam, located 1.3 river miles upstream from the mouth of the Joliet #9 Station's discharge canal.

5.8.3 Thermal Model

In order to predict the lateral and longitudinal dispersion of the Joliet #9 Station's thermal plume, it will be necessary to develop a hydrothermal model of the UDIP. The Danish Hydraulic Institute's MIKE 3 model will be used to evaluate operational and ATL scenarios. MIKE 3 is a state-of-art, three-dimensional hydrodynamic model that has been accepted for use in §316(a) Demonstrations by various state environmental agencies, including IEPA. For the Joliet Stations, the upstream model boundary will be at the mouth of the Brandon Road Lock and Dam, and the downstream model boundary will be at the I-55 Bridge. A finer cell grid will be used in the vicinity of the Joliet Stations' discharges to provide increased resolution in the initial mixing region. Each cell is typically divided into 8-10 vertical layers. The model grid will include the Joliet Stations' intake areas and discharge canals. The upstream model boundaries are parameterized by providing temperature and flow time-series files. The temperature boundary file can incorporate vertical stratification. The downstream boundary at the I-55 Bridge is parameterized by a time-series file of flow and/or elevation.

The MIKE 3 model will be calibrated using thermal field survey data. A calibration model run is typically started a day prior to the thermal survey to allow build-up to conditions present at the time of the survey. Hourly Station cooling water flow, intake temperature, and discharge temperature data will be provided by the Joliet #9 and Joliet #29 Stations. The upstream boundary temperatures will be based on the thermographs deployed during the surveys and flow data from the Brandon Road Lock and Dam. Stratification as observed during the survey's vertical profiles in the vicinity of the upstream boundaries will be incorporated into the model. Surface heat exchange is calculated from hourly meteorological data provided to the model. Model calibration primarily consists of adjusting horizontal and vertical dispersion, and bottom friction coefficients.

During 2012, six thermal plume surveys were conducted between 20 June and 12 September and concurrent Station operational, thermal, and hydrological data were compiled. The 2017-2018 hydrothermal modeling effort will augment the 2012 study. A final model calibration will be completed following the performance of two additional thermal plume surveys during winter and summer 2017. Station operational data and river flow and temperature data will be updated from the 2012 study data using 2017-2018 information. Various model scenarios will be executed with the final calibrated model. The output files from the model scenarios will be processed with particular attention given to plume behavior and zone-of-passage as a function of operations and flow.

The MIKE 3 model provides the capability to predict the three-dimensional and temporal extent of the thermal plumes under the complex operating conditions typical of peaking facility operations. The model will be used to predict plume temperatures and configurations (e.g., surface and bottom temperature distribution maps, area and volume within selected isotherms) relative to available aquatic habitat for the predictive component of the §316(a) Demonstration. The analysis for the §316(a) Demonstration will focus on isotherms representing critical thermal thresholds (e.g., acute mortality, chronic mortality, avoidance, preference, spawning temperatures) for the RIS. This model was recently used for the predictive thermal assessment at the Dresden Generating Station on the LDIP, which has been accepted by the IEPA. Two years (2017-2018) of hourly temperature monitoring data from the Joliet #9 and Joliet #29 Stations' intakes and discharges, and cooling water flow (including helper cooling tower operations at the Joliet #29 Station), under the future operating scenarios, will be utilized to support the thermal modeling effort.

As part of the evaluation of ATLs, IEPA is requiring Midwest Generation to assess the potential effect of the Joliet Stations' future thermal discharges on downstream ambient temperatures in the vicinity of downstream thermal discharges. IEPA will assist Midwest Generation to identify downstream thermal discharges between the Joliet Stations' discharges and the I-55 Bridge to be included in this assessment. Three potential dischargers include Flint Hills Resources, LLC, Stepan Chemical, and the ExxonMobil Joliet Refinery. Midwest Generation will contact each of these dischargers to request discharge flow and intake and discharge temperature data for their facilities. To the extent available, two years (2017 and 2018) of daily intake and discharge flow and temperature data for each facility identified will be input into the MIKE 3 model to evaluate the potential interaction between the Joliet Stations' thermal plumes and these downstream dischargers to the UDIP. The location of the intake and discharge for each facility identified will be set up as a distinct cell in the MIKE 3 Model.

6. SCHEDULE FOR DATA COLLECTION

Multiple study years are required in order to characterize the potential variability in aquatic communities and habitat conditions and to decipher their trends. The long-term fishery program for the UDIP provides a robust database for evaluating temporal trends and spatial patterns. Data for most other components of the aquatic community are more than 20 years old, necessitating 2 years (2017-2018) of new data collection following changes in Station operation for key biotic categories (e.g., benthic macroinvertebrates).

Fish sampling in the UDIP will be conducted once in early May, once in early June, and twice per month in July, August, and September in 2017 and 2018. Based upon the information presented above, sampling at the additional electrofishing and seining locations in the UDIP will be initiated during 2016 as part of the ongoing fish monitoring program. The Joliet #9 Station is scheduled to be fully operational following conversion to natural gas by 1 June 2016. Because this Station will be operated to provide power during periods of peak electrical demand, it is expected to be brought online and taken offline on a frequent and unpredictable basis, particularly during summer and winter. Although the ongoing fish sampling program will be conducted in 2016, it will be necessary to allow sufficient time for any potential changes in the receiving waterbody to be detected as a result of the new thermal conditions under the new Station operations. Consequently, the data collected during 2016 will not be representative of habitat utilization under the new operating conditions. In the UDIP, the additional electrofishing and seining locations will be sampled as part of the ongoing fish monitoring program for 2 years (2017-2018) subsequent to the change in operations.

When fish are attracted to and acclimate to a thermal discharge during winter, the potential for cold shock increases if a facility rapidly reduces its thermal discharges. Given the expected operating scenario of a peaking facility, this Plan adds two winter fish sampling events each year, once in December (2016 and 2017) and once in January/February (2017 and 2018). The winter sampling will be coordinated to occur in conjunction with operating cycles of the Joliet Stations that may occur during these times.

New hydrothermal surveys will be conducted once during the winter (January-February) and once during the summer (July-August) of 2017 to characterize the thermal plumes under the new operating conditions. Peaking operations can be difficult to predict and will complicate collection of thermal survey data for typical peaking operations; however, the surveys will only be conducted during periods of Station operation. Under the new peaking operations, 2 years (2017-2018) of hourly temperature monitoring data from the Joliet Stations' intakes and discharges, and cooling water flow (including helper cooling tower operations at the Joliet #29 Station) will be required to support the thermal modeling effort.

The data collection schedules for other studies in this Plan are:

- HD sampling for benthic macroinvertebrates will be conducted for 2 years subsequent to the change in operations (i.e., 2017 and 2018) of the Joliet Stations;
- The submerged aquatic vegetation and habitat survey will be performed once during the peak of the growing season during July-August 2017; and
- The collection of new bathymetry will occur during the summer of 2017.

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7. REPORTING

Joliet #9 Station operational data, thermal modeling results, and data from the field biology studies will be compiled into a series of reports. These reports will then be used, in part, to develop a separate §316(a) Demonstration. Current and historical biological data will be used to describe the biotic categories of the at-risk aquatic community while the hydrothermal modeling results will determine the potential for regulatory compliance as well as describe conditions to which the aquatic community will be exposed (e.g., temperature range, areal extent, and zone of passage). Part of this overall evaluation will be based on the selected RIS. Collectively, the analyses presented in these reports will be used to determine whether a balanced indigenous community is present in the UDIP and, if so, whether the requested Alternative Thermal Limits will adversely affect that community. If it is determined that a balanced indigenous community is not present, the analyses presented in these reports will determine whether the establishment of such a community would be prevented by peaking operations of the Joliet #9 Station under the requested Alternative Thermal Limits.

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FIGURES

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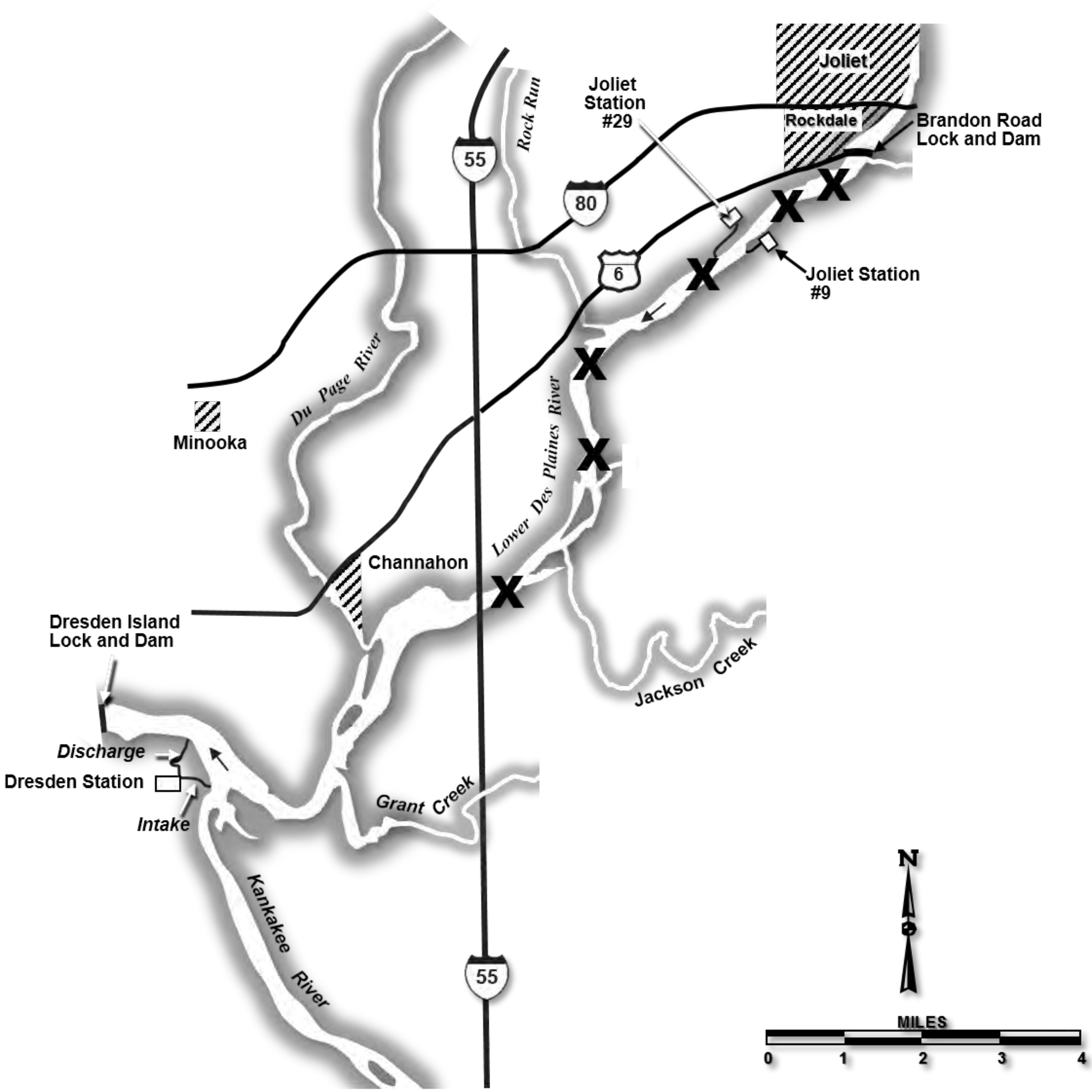

Figure 1. Sampling locations for benthic macroinvertebrates in the Upper Dresden Island Pool near the Joliet #9 and #29 Generating Stations.

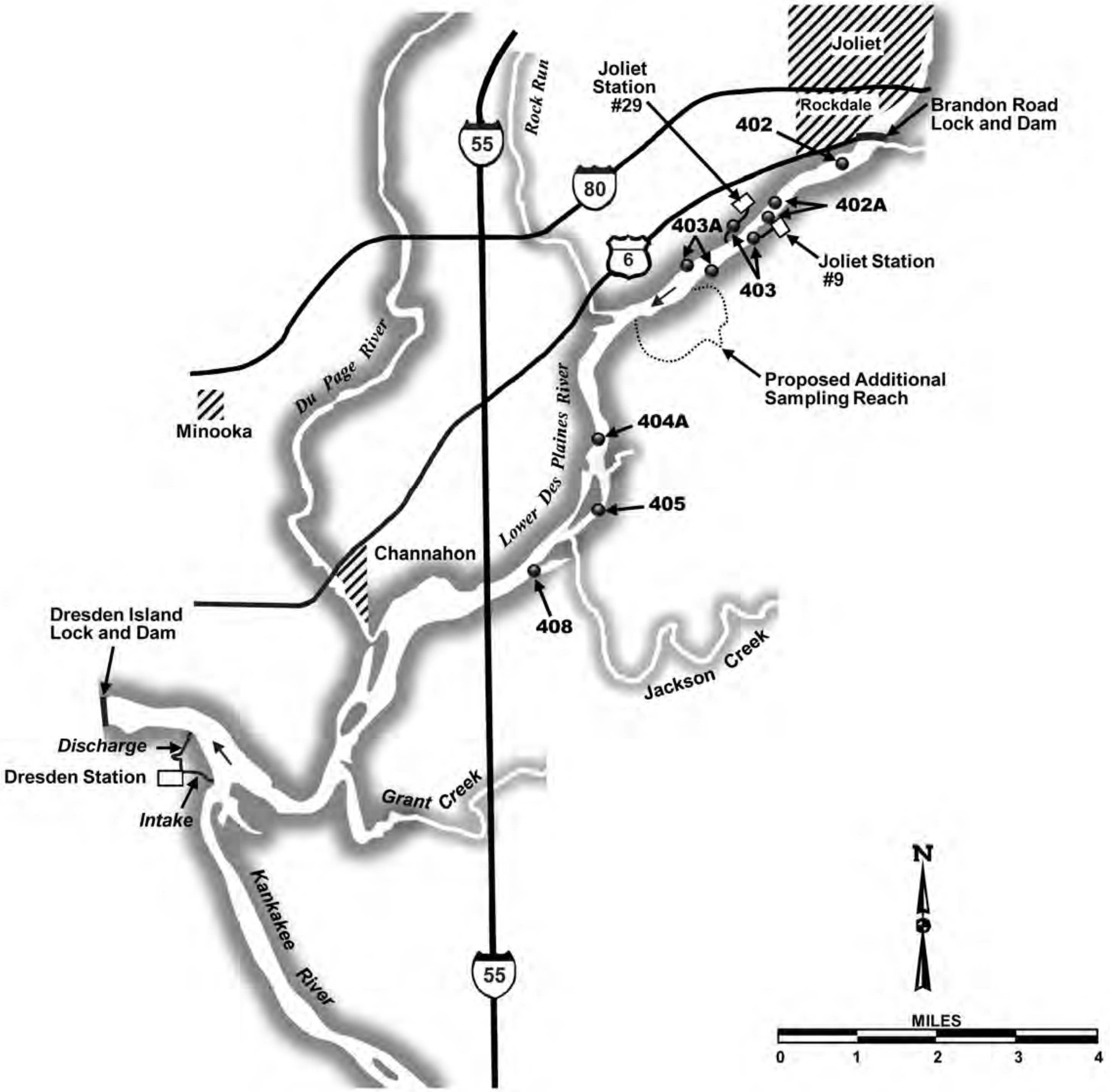

Figure 2. Sampling locations for fish in the Upper Dresden Island Pool near the Joliet #9 and #29 Generating Stations

FIGURE 3
Survey Transects and Vertical Profile Stations at Joliet Generating Stations #9 and #29, 2012

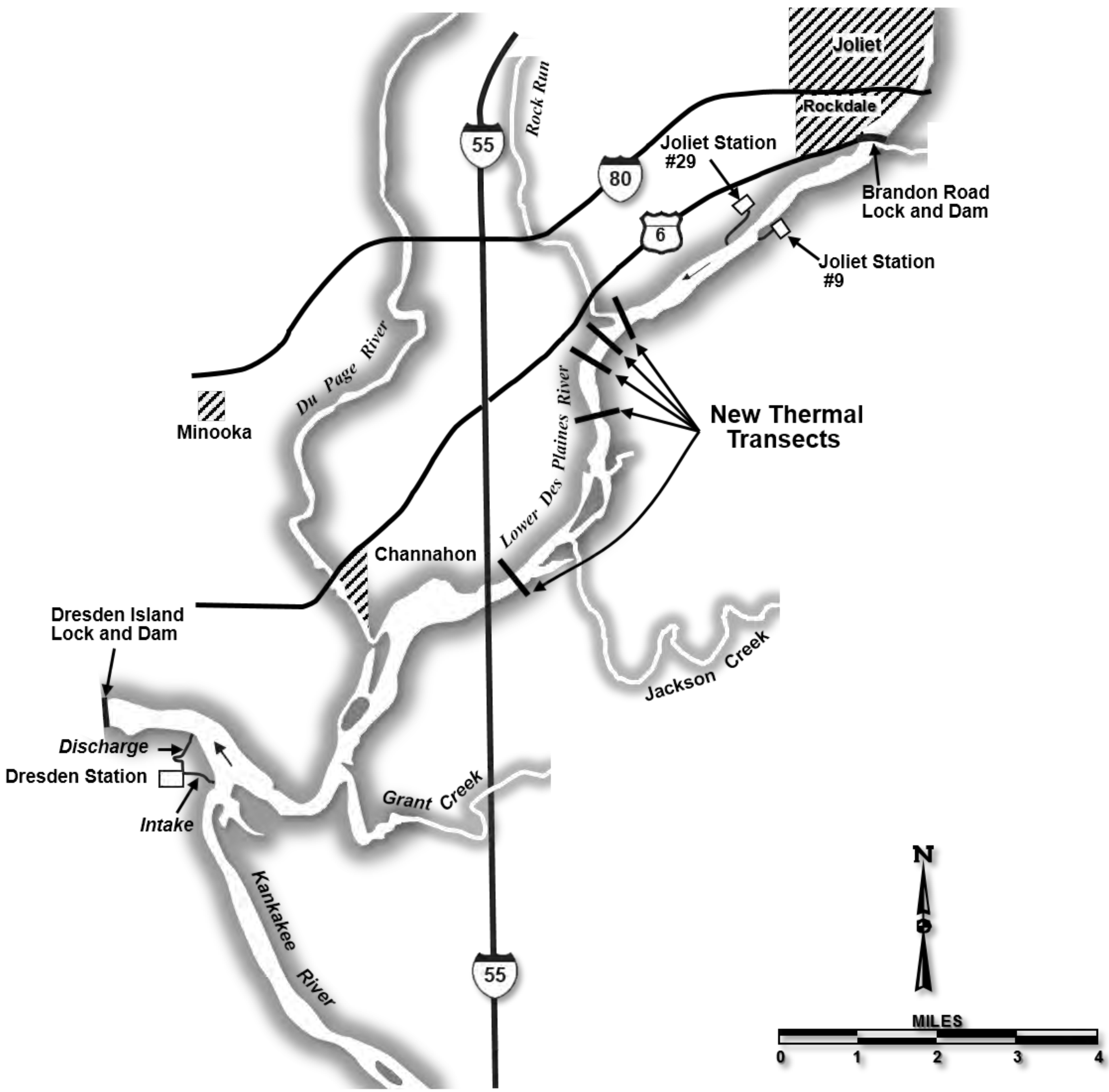

Figure 4. Location of new surface temperature transects included to augment the hydrothermal surveys of the Upper Dresden Island Pool to support the Joliet #9 and #29 Generating Stations' thermal model development.

TABLE

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Table 1. Summary of fish abundance and relative abundance (%) for sampling in the Upper Dresden Island Pool near the Joliet #9 and #29 Generating Stations during 20 sampling years from 1994-2014.

SPECIES	1994		1995		1997		1998		1999		2000		2001	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BLUNTNOSE MINNOW	552	40.0	408	30.7	554	19.0	1,228	21.4	266	9.6	262	9.3	1,290	22.2
GIZZARD SHAD	87	6.3	191	14.4	400	13.7	747	13.0	580	20.8	542	19.1	1,571	27.0
BLUEGILL	11	0.8	36	2.7	122	4.2	291	5.1	212	7.6	404	14.3	572	9.8
GREEN SUNFISH	103	7.5	82	6.2	298	10.2	767	13.3	521	18.7	492	17.4	398	6.8
EMERALD SHINER	109	7.9	35	2.6	402	13.8	1,424	24.8	318	11.4	173	6.1	392	6.7
LARGEMOUTH BASS	28	2.0	43	3.2	121	4.2	185	3.2	152	5.5	169	6.0	132	2.3
COMMON CARP	156	11.3	180	13.5	411	14.1	310	5.4	195	7.0	188	6.6	299	5.1
CHANNEL CATFISH	24	1.7	27	2.0	99	3.4	101	1.8	56	2.0	73	2.6	86	1.5
SPOTFIN SHINER	2	0.2	8	0.6	9	0.3	29	0.5	13	0.5	28	1.0	80	1.4
SPOTTAIL SHINER	113	8.2	93	7.0	14	0.5	86	1.5	13	0.5	14	0.5	435	7.5
BLACKSTRIPE TOPMINNOW	9	0.7	1	0.1	6	0.2	12	0.2	14	0.5	11	0.4	9	0.2
FRESHWATER DRUM	27	2.0	25	1.9	94	3.2	82	1.4	52	1.9	91	3.2	71	1.2
SMALLMOUTH BUFFALO	19	1.4	29	2.2	59	2.0	60	1.0	60	2.2	48	1.7	58	1.0
SMALLMOUTH BASS	10	0.7	10	0.8	29	1.0	41	0.7	22	0.8	7	0.3	26	0.5
ORANGESPOTTED SUNFISH	3	0.2	7	0.5	57	2.0	63	1.1	51	1.8	29	1.0	2	<0.1
STRIPED SHINER	19	1.4	1	0.1	--	--	6	0.1	--	--	--	--	21	0.4
BULLHEAD MINNOW	2	0.2	6	0.5	14	0.5	26	0.5	3	0.1	12	0.4	126	2.2
PUMPKINSEED	--	--	--	--	--	--	6	0.1	1	<0.1	--	--	--	--
ROUND GOBY	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
THREADFIN SHAD	--	--	--	--	--	--	--	--	--	--	25	0.9	6	0.1
SAND SHINER	16	1.2	8	0.6	9	0.3	23	0.4	5	0.2	10	0.4	26	0.5
WESTERN MOSQUITOFISH	--	--	--	--	--	--	1	<0.1	1	<0.1	6	0.2	3	0.1
NORTHERN SUNFISH	5	0.4	1	0.1	6	0.2	3	0.1	1	<0.1	25	0.9	24	0.4
LONGNOSE GAR	--	--	1	0.1	5	0.2	10	0.2	2	0.1	9	0.3	12	0.2
YELLOW BULLHEAD	1	0.1	2	0.2	7	0.2	3	0.1	6	0.2	11	0.4	1	<0.1
GOLDFISH	4	0.3	4	0.3	3	0.1	2	<0.1	--	--	4	0.1	5	0.1
BROOK SILVERSIDE	--	--	--	--	6	0.2	--	--	1	<0.1	1	<0.1	1	<0.1
GOLDEN SHINER	2	0.2	--	--	--	--	12	0.2	1	<0.1	1	<0.1	2	<0.1
RIVER CARPSUCKER	8	0.6	7	0.5	21	0.7	8	0.1	11	0.4	11	0.4	7	0.1
GHOST SHINER	3	0.2	--	--	1	<0.1	2	<0.1	1	<0.1	--	--	2	<0.1
JOHNNY DARTER	--	--	41	3.1	--	--	--	--	--	--	1	<0.1	--	--
QUILLBACK	4	0.3	7	0.5	18	0.6	11	0.2	4	0.1	11	0.4	5	0.1
GOLDEN REDHORSE	2	0.2	2	0.2	1	<0.1	3	0.1	2	0.1	1	<0.1	--	--
ROCK BASS	--	--	--	--	1	<0.1	3	0.1	3	0.1	3	0.1	5	0.1
CENTRAL STONEROLLER	2	0.2	--	--	2	0.1	2	<0.1	1	<0.1	--	--	18	0.3
SHORTHEAD REDHORSE	3	0.2	7	0.5	13	0.5	6	0.1	7	0.3	12	0.4	8	0.1
BLACK CRAPPIE	--	--	1	0.1	1	<0.1	9	0.2	4	0.1	4	0.1	2	<0.1
WHITE SUCKER	8	0.6	12	0.9	3	0.1	6	0.1	2	0.1	1	<0.1	4	0.1
FATHEAD MINNOW	--	--	3	0.2	--	--	2	<0.1	1	<0.1	--	--	1	<0.1
TADPOLE MADTOM	--	--	--	--	3	0.1	--	--	--	--	--	--	1	<0.1
WHITE BASS	1	0.1	--	--	3	0.1	4	0.1	3	0.1	4	0.1	6	0.1
LOGPERCH	--	--	--	--	3	0.1	1	<0.1	2	0.1	2	0.1	1	<0.1

Table 1 (continued)

SPECIES (cont.)	1994		1995		1997		1998		1999		2000		2001	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BLACKSIDE DARTER	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
REDFIN SHINER	--	--	--	--	--	--	2	<0.1	--	--	--	--	2	<0.1
FLATHEAD CATFISH	--	--	--	--	1	<0.1	1	<0.1	--	--	2	0.1	1	<0.1
SILVER REDHORSE	--	--	--	--	--	--	4	0.1	1	<0.1	1	<0.1	1	<0.1
SKIPJACK HERRING	1	0.1	--	--	1	<0.1	2	<0.1	2	0.1	1	<0.1	7	0.1
MIMIC SHINER	9	0.7	4	0.3	--	--	--	--	--	--	--	--	--	--
HORNYHEAD CHUB	--	--	--	--	--	--	--	--	--	--	--	--	2	<0.1
WHITE PERCH	--	--	--	--	1	<0.1	1	<0.1	4	0.1	5	0.2	3	0.1
SUCKERMOUTH MINNOW	--	--	--	--	--	--	2	<0.1	1	<0.1	--	--	--	--
YELLOW BASS	--	--	1	0.1	--	--	--	--	3	0.1	2	0.1	2	<0.1
BLACK BUFFALO	4	0.3	--	--	--	--	2	<0.1	3	0.1	2	0.1	2	<0.1
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIGMOUTH BUFFALO	--	--	2	0.2	1	<0.1	--	--	1	<0.1	3	0.1	2	<0.1
GRASS PICKEREL	--	--	--	--	1	<0.1	--	--	--	--	2	0.1	1	<0.1
NORTHERN PIKE	--	--	2	0.2	--	--	1	<0.1	--	--	--	--	1	<0.1
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS CARP	--	--	--	--	--	--	--	--	--	--	--	--	2	<0.1
WHITE CRAPPIE	--	--	--	--	--	--	2	<0.1	1	<0.1	2	0.1	--	--
BIGMOUTH SHINER	--	--	--	--	--	--	1	<0.1	1	<0.1	--	--	--	--
PALLID SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
REDEAR SUNFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	1	0.1	1	0.1	--	--	5	0.1	--	--	1	<0.1	--	--
SPOTTED SUCKER	--	--	--	--	2	0.1	--	--	--	--	--	--	1	<0.1
YELLOW PERCH	--	--	--	--	2	0.1	2	<0.1	--	--	--	--	--	--
ORANGETHROAT DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WALLEYE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CREEK CHUB	--	--	1	0.1	1	<0.1	--	--	--	--	--	--	--	--
BIGHEAD CARP	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOWFIN	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
SHORTNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RED SHINER	--	--	--	--	--	--	--	--	--	--	--	--	1	<0.1
RIVER REDHORSE	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
SLENDERHEAD DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WARMOUTH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALEWIFE	--	--	--	--	--	--	1	<0.1	--	--	--	--	--	--
COMMON SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHANNEL SHINER	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
HIGHFIN CARPSUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORIENTAL WEATHERFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAUGER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other Taxa[(a)]	30	2.2	40	3.0	112	3.8	148	2.6	180	6.5	126	4.4	76	1.3
TOTAL FISH	1,379	100	1,329	100	2,918	100	5,749	100	2,784	100	2,832	100	5,815	100
TOTAL SPECIES	36		36		43		50		45		45		55	

Table 1 (continued)

SPECIES	2002 #	2002 %	2003 #	2003 %	2004 #	2004 %	2005 #	2005 %	2006 #	2006 %	2007 #	2007 %	2008 #	2008 %
BLUNTNOSE MINNOW	747	11.8	4,672	41.0	1,086	21.8	2,654	25.5	3,475	44.5	3,379	37.8	1,840	25.0
GIZZARD SHAD	1,754	27.7	520	4.6	647	13.0	4,116	39.6	738	9.5	1,514	16.9	1,416	19.2
BLUEGILL	733	11.6	1,688	14.8	706	14.2	1,137	10.9	876	11.2	963	10.8	1,251	17.0
GREEN SUNFISH	761	12.0	1,296	11.4	688	13.8	373	3.6	386	5.0	505	5.6	705	9.6
EMERALD SHINER	977	15.4	385	3.4	141	2.8	314	3.0	606	7.8	543	6.1	205	2.8
LARGEMOUTH BASS	219	3.5	416	3.7	324	6.5	127	1.2	228	2.9	185	2.1	202	2.7
COMMON CARP	239	3.8	192	1.7	132	2.7	218	2.1	113	1.5	166	1.9	168	2.3
CHANNEL CATFISH	98	1.6	203	1.8	192	3.9	107	1.0	151	1.9	137	1.5	138	1.9
SPOTFIN SHINER	90	1.4	290	2.5	114	2.3	210	2.0	176	2.3	249	2.8	179	2.4
SPOTTAIL SHINER	84	1.3	252	2.2	23	0.5	47	0.5	112	1.4	260	2.9	91	1.2
BLACKSTRIPE TOPMINNOW	11	0.2	42	0.4	47	0.9	49	0.5	127	1.6	50	0.6	92	1.3
FRESHWATER DRUM	87	1.4	82	0.7	85	1.7	50	0.5	47	0.6	63	0.7	51	0.7
SMALLMOUTH BUFFALO	71	1.1	68	0.6	71	1.4	73	0.7	58	0.7	58	0.7	47	0.6
SMALLMOUTH BASS	63	1.0	96	0.8	59	1.2	21	0.2	18	0.2	81	0.9	84	1.1
ORANGESPOTTED SUNFISH	14	0.2	76	0.7	45	0.9	15	0.1	25	0.3	44	0.5	73	1.0
STRIPED SHINER	37	0.6	65	0.6	2	<0.1	90	0.9	152	2.0	188	2.1	53	0.7
BULLHEAD MINNOW	7	0.1	31	0.3	52	1.0	292	2.8	7	0.1	32	0.4	14	0.2
PUMPKINSEED	--	--	1	<0.1	--	--	3	<0.1	17	0.2	11	0.1	66	0.9
ROUND GOBY	1	<0.1	45	0.4	47	0.9	35	0.3	11	0.1	40	0.5	40	0.5
THREADFIN SHAD	9	0.1	--	--	25	0.5	--	--	46	0.6	--	--	53	0.7
SAND SHINER	41	0.7	94	0.8	11	0.2	21	0.2	22	0.3	22	0.3	21	0.3
WESTERN MOSQUITOFISH	4	0.1	5	<0.1	13	0.3	18	0.2	44	0.6	22	0.3	8	0.1
NORTHERN SUNFISH	26	0.4	36	0.3	9	0.2	13	0.1	13	0.2	21	0.2	33	0.5
LONGNOSE GAR	8	0.1	22	0.2	8	0.2	5	0.1	17	0.2	13	0.2	24	0.3
YELLOW BULLHEAD	19	0.3	10	0.1	13	0.3	9	0.1	9	0.1	16	0.2	18	0.2
GOLDFISH	4	0.1	7	0.1	--	--	14	0.1	7	0.1	40	0.5	18	0.2
BROOK SILVERSIDE	2	<0.1	14	0.1	--	--	44	0.4	6	0.1	6	0.1	5	0.1
GOLDEN SHINER	6	0.1	16	0.1	1	<0.1	4	<0.1	6	0.1	4	<0.1	23	0.3
RIVER CARPSUCKER	12	0.2	5	<0.1	2	<0.1	3	<0.1	2	<0.1	2	<0.1	5	0.1
GHOST SHINER	3	0.1	15	0.1	3	0.1	1	<0.1	5	0.1	5	0.1	3	<0.1
JOHNNY DARTER	--	--	11	0.1	1	<0.1	3	<0.1	7	0.1	16	0.2	5	0.1
QUILLBACK	5	0.1	4	<0.1	14	0.3	--	--	5	0.1	7	0.1	5	0.1
GOLDEN REDHORSE	6	0.1	6	0.1	11	0.2	1	<0.1	3	<0.1	8	0.1	25	0.3
ROCK BASS	5	0.1	3	<0.1	2	<0.1	3	<0.1	5	0.1	25	0.3	15	0.2
CENTRAL STONEROLLER	--	--	9	0.1	--	--	6	0.1	2	<0.1	4	<0.1	7	0.1
SHORTHEAD REDHORSE	4	0.1	7	0.1	1	<0.1	1	<0.1	1	<0.1	3	<0.1	4	0.1
BLACK CRAPPIE	9	0.1	6	0.1	9	0.2	--	--	2	<0.1	8	0.1	3	<0.1
WHITE SUCKER	2	<0.1	12	0.1	4	0.1	--	--	--	--	1	<0.1	--	--
FATHEAD MINNOW	--	--	5	<0.1	--	--	17	0.2	3	<0.1	4	<0.1	8	0.1
TADPOLE MADTOM	2	<0.1	--	--	--	--	8	0.1	8	0.1	2	<0.1	14	0.2
WHITE BASS	12	0.2	8	0.1	4	0.1	3	<0.1	3	<0.1	1	<0.1	4	0.1
LOGPERCH	3	0.1	--	--	--	--	7	0.1	--	--	4	<0.1	3	<0.1

Table 1 (continued)

SPECIES (cont.)	2002		2003		2004		2005		2006		2007		2008	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BLACKSIDE DARTER	--	--	2	<0.1	5	0.1	2	<0.1	--	--	4	<0.1	10	0.1
REDFIN SHINER	1	<0.1	--	--	1	<0.1	1	<0.1	2	<0.1	2	<0.1	3	<0.1
FLATHEAD CATFISH	2	<0.1	8	0.1	3	0.1	5	0.1	2	<0.1	2	<0.1	3	<0.1
SILVER REDHORSE	3	0.1	1	<0.1	1	<0.1	--	--	6	0.1	--	--	--	--
SKIPJACK HERRING	6	0.1	--	--	4	0.1	1	<0.1	--	--	1	<0.1	8	0.1
MIMIC SHINER	--	--	7	0.1	--	--	2	<0.1	--	--	1	<0.1	--	--
HORNYHEAD CHUB	1	<0.1	3	<0.1	--	--	3	<0.1	15	0.2	1	<0.1	--	--
WHITE PERCH	5	0.1	2	<0.1	--	--	--	--	--	--	1	<0.1	3	<0.1
SUCKERMOUTH MINNOW	1	<0.1	--	--	--	--	1	<0.1	--	--	--	--	5	0.1
YELLOW BASS	--	--	--	--	2	<0.1	1	<0.1	--	--	1	<0.1	2	<0.1
BLACK BUFFALO	1	<0.1	4	<0.1	1	<0.1	--	--	--	--	--	--	--	--
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIGMOUTH BUFFALO	3	0.1	2	<0.1	1	<0.1	--	--	2	<0.1	--	--	--	--
GRASS PICKEREL	1	<0.1	--	--	--	--	--	--	--	--	1	<0.1	1	<0.1
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	1	<0.1	6	0.1
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS CARP	1	<0.1	1	<0.1	--	--	2	<0.1	--	--	1	<0.1	1	<0.1
WHITE CRAPPIE	1	<0.1	1	<0.1	1	<0.1	--	--	1	<0.1	--	--	--	--
BIGMOUTH SHINER	1	<0.1	1	<0.1	--	--	--	--	--	--	2	<0.1	1	<0.1
PALLID SHINER	--	--	2	<0.1	--	--	--	--	--	--	--	--	--	--
REDEAR SUNFISH	2	<0.1	2	<0.1	--	--	--	--	2	<0.1	1	<0.1	--	--
BLACK BULLHEAD	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
SPOTTED SUCKER	--	--	--	--	1	<0.1	--	--	--	--	1	<0.1	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORANGETHROAT DARTER	--	--	1	<0.1	1	<0.1	--	--	--	--	--	--	--	--
WALLEYE	--	--	--	--	3	0.1	--	--	--	--	--	--	--	--
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	1	<0.1	--	--
BIGHEAD CARP	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOWFIN	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SHORTNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RED SHINER	1	<0.1	--	--	--	--	--	--	--	--	--	--	--	--
RIVER REDHORSE	--	--	1	<0.1	--	--	--	--	--	--	--	--	--	--
SLENDERHEAD DARTER	1	<0.1	--	--	--	--	--	--	--	--	--	--	--	--
WARMOUTH	--	--	--	--	2	<0.1	--	--	--	--	--	--	--	--
ALEWIFE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COMMON SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHANNEL SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HIGHFIN CARPSUCKER	--	--	--	--	1	<0.1	--	--	--	--	--	--	--	--
ORIENTAL WEATHERFISH	--	--	--	--	--	--	--	--	1	<0.1	--	--	--	--
SAUGER	1	<0.1	--	--	--	--	--	--	--	--	--	--	--	--
Other Taxa[(a)]	121	1.9	645	5.7	367	7.4	266	2.6	232	3.0	227	2.5	299	4.1
TOTAL FISH	6,328	100	11,398	100	4,987	100	10,396	100	7,802	100	8,950	100	7,361	100
TOTAL SPECIES	55		54		50		47		49		56		52	

Table 1 (continued)

SPECIES	2009 #	2009 %	2010 #	2010 %	2011 #	2011 %	2012 #	2012 %	2013 #	2013 %	2014 #	2014 %	Average #	Number Years
BLUNTNOSE MINNOW	2,441	35.4	1,486	21.7	790	13.2	1,365	18.9	1,119	23.2	1,479	21.7	1,554.7	20
GIZZARD SHAD	646	9.4	1,187	17.3	1,226	20.5	1,206	16.7	709	14.7	1,383	20.3	1,059.0	20
BLUEGILL	710	10.3	967	14.1	1,271	21.3	1,433	19.8	1,208	25.1	610	8.9	760.1	20
GREEN SUNFISH	708	10.3	626	9.1	949	15.9	903	12.5	371	7.7	793	11.6	586.3	20
EMERALD SHINER	160	2.3	157	2.3	102	1.7	105	1.5	29	0.6	51	0.8	331.4	20
LARGEMOUTH BASS	358	5.2	378	5.5	260	4.4	184	2.6	315	6.5	823	12.1	242.5	20
COMMON CARP	94	1.4	105	1.5	96	1.6	77	1.1	75	1.6	138	2.0	177.6	20
CHANNEL CATFISH	164	2.4	113	1.7	126	2.1	51	0.7	96	2.0	117	1.7	108.0	20
SPOTFIN SHINER	133	1.9	89	1.3	59	1.0	186	2.6	85	1.8	85	1.2	105.7	20
SPOTTAIL SHINER	98	1.4	50	0.7	24	0.4	16	0.2	3	0.1	111	1.6	97.0	20
BLACKSTRIPE TOPMINNOW	84	1.2	75	1.1	83	1.4	410	5.7	67	1.4	24	0.4	61.2	20
FRESHWATER DRUM	57	0.8	61	0.9	45	0.8	29	0.4	42	0.9	53	0.8	59.7	20
SMALLMOUTH BUFFALO	61	0.9	54	0.8	40	0.7	54	0.8	39	0.8	53	0.8	54.0	20
SMALLMOUTH BASS	133	1.9	57	0.8	44	0.7	34	0.5	15	0.3	67	1.0	45.9	20
ORANGESPOTTED SUNFISH	66	1.0	101	1.5	75	1.3	112	1.6	12	0.3	10	0.2	44.0	20
STRIPED SHINER	41	0.6	3	<0.1	17	0.3	9	0.1	11	0.2	30	0.4	37.3	17
BULLHEAD MINNOW	5	0.1	6	0.1	1	<0.1	5	0.1	1	<0.1	4	0.1	32.3	20
PUMPKINSEED	15	0.2	19	0.3	25	0.4	171	2.4	89	1.9	140	2.1	28.2	13
ROUND GOBY	57	0.8	61	0.9	13	0.2	23	0.3	32	0.7	135	2.0	27.1	14
THREADFIN SHAD	31	0.5	64	0.9	26	0.4	105	1.5	7	0.2	117	1.7	25.7	12
SAND SHINER	49	0.7	16	0.2	17	0.3	34	0.5	9	0.2	30	0.4	24.2	20
WESTERN MOSQUITOFISH	23	0.3	10	0.2	68	1.1	207	2.9	16	0.3	--	--	22.5	16
NORTHERN SUNFISH	29	0.4	33	0.5	18	0.3	30	0.4	45	0.9	47	0.7	20.9	20
LONGNOSE GAR	30	0.4	36	0.5	28	0.5	29	0.4	24	0.5	52	0.8	16.8	19
YELLOW BULLHEAD	12	0.2	10	0.2	12	0.2	8	0.1	18	0.4	19	0.3	10.2	20
GOLDFISH	15	0.2	6	0.1	1	<0.1	6	0.1	7	0.2	26	0.4	8.7	18
BROOK SILVERSIDE	6	0.1	19	0.3	13	0.2	11	0.2	3	0.1	28	0.4	8.3	16
GOLDEN SHINER	6	0.1	16	0.2	8	0.1	19	0.3	2	<0.1	25	0.4	7.7	18
RIVER CARPSUCKER	2	<0.1	5	0.1	4	0.1	3	<0.1	9	0.2	20	0.3	7.4	20
GHOST SHINER	96	1.4	3	<0.1	--	--	--	--	1	<0.1	1	<0.1	7.3	16
JOHNNY DARTER	5	0.1	17	0.3	5	0.1	4	0.1	2	<0.1	23	0.3	7.1	14
QUILLBACK	3	<0.1	11	0.2	7	0.1	7	0.1	2	<0.1	7	0.1	6.9	19
GOLDEN REDHORSE	12	0.2	17	0.3	14	0.2	2	<0.1	1	<0.1	3	<0.1	6.0	19
ROCK BASS	6	0.1	12	0.2	5	0.1	5	0.1	9	0.2	10	0.2	6.0	18
CENTRAL STONEROLLER	25	0.4	3	<0.1	1	<0.1	2	<0.1	1	<0.1	26	0.4	5.6	16
SHORTHEAD REDHORSE	1	<0.1	3	<0.1	2	<0.1	6	0.1	7	0.2	6	0.1	5.1	20
BLACK CRAPPIE	2	<0.1	6	0.1	1	<0.1	--	--	2	<0.1	26	0.4	4.8	17
WHITE SUCKER	2	<0.1	1	<0.1	2	<0.1	1	<0.1	2	<0.1	22	0.3	4.3	17
FATHEAD MINNOW	19	0.3	--	--	3	0.1	5	0.1	5	0.1	2	<0.1	3.9	14
TADPOLE MADTOM	14	0.2	11	0.2	1	<0.1	1	<0.1	1	<0.1	7	0.1	3.7	13
WHITE BASS	1	<0.1	3	<0.1	--	--	4	0.1	5	0.1	2	<0.1	3.6	18
LOGPERCH	10	0.2	6	0.1	9	0.2	2	<0.1	1	<0.1	16	0.2	3.5	15

Table 1 (continued)

SPECIES (cont.)	2009 #	2009 %	2010 #	2010 %	2011 #	2011 %	2012 #	2012 %	2013 #	2013 %	2014 #	2014 %	Average #	Number Years
BLACKSIDE DARTER	8	0.1	4	0.1	3	0.1	--	--	12	0.3	10	0.2	3.1	11
REDFIN SHINER	23	0.3	--	--	--	--	5	0.1	--	--	--	--	2.1	10
FLATHEAD CATFISH	--	--	1	<0.1	1	<0.1	1	<0.1	2	<0.1	6	0.1	2.1	16
SILVER REDHORSE	3	<0.1	5	0.1	3	0.1	5	0.1	1	<0.1	1	<0.1	1.8	14
SKIPJACK HERRING	--	--	--	--	2	<0.1	--	--	--	--	--	--	1.8	12
MIMIC SHINER	1	<0.1	3	<0.1	--	--	1	<0.1	3	0.1	4	0.1	1.8	10
HORNYHEAD CHUB	--	--	1	<0.1	--	--	--	--	1	<0.1	2	<0.1	1.5	9
WHITE PERCH	--	--	3	<0.1	--	--	--	--	--	--	--	--	1.4	10
SUCKERMOUTH MINNOW	4	0.1	--	--	4	0.1	1	<0.1	--	--	5	0.1	1.2	9
YELLOW BASS	--	--	7	0.1	--	--	--	--	--	--	2	<0.1	1.2	10
BLACK BUFFALO	--	--	--	--	1	<0.1	--	--	2	<0.1	--	--	1.1	10
ROSYFACE SHINER	--	--	--	--	--	--	--	--	9	0.2	13	0.2	1.1	2
BIGMOUTH BUFFALO	--	--	1	<0.1	--	--	1	<0.1	--	--	2	<0.1	1.1	12
GRASS PICKEREL	2	<0.1	--	--	2	<0.1	1	<0.1	1	<0.1	6	0.1	1.0	11
NORTHERN PIKE	1	<0.1	3	<0.1	2	<0.1	1	<0.1	--	--	--	--	0.9	9
BANDED KILLIFISH	--	--	--	--	--	--	2	<0.1	5	0.1	9	0.1	0.8	3
GRASS CARP	3	<0.1	--	--	1	<0.1	--	--	--	--	1	<0.1	0.7	9
WHITE CRAPPIE	2	<0.1	2	<0.1	--	--	--	--	--	--	--	--	0.7	9
BIGMOUTH SHINER	--	--	--	--	4	0.1	--	--	--	--	--	--	0.6	7
PALLID SHINER	3	<0.1	2	<0.1	--	--	2	<0.1	--	--	1	<0.1	0.5	5
REDEAR SUNFISH	--	--	--	--	--	--	--	--	1	<0.1	1	<0.1	0.5	6
BLACK BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	0.5	5
SPOTTED SUCKER	--	--	2	<0.1	--	--	--	--	--	--	1	<0.1	0.4	6
YELLOW PERCH	1	<0.1	--	--	1	<0.1	--	--	2	<0.1	--	--	0.4	5
ORANGETHROAT DARTER	--	--	--	--	1	<0.1	--	--	3	0.1	--	--	0.3	4
WALLEYE	1	<0.1	1	<0.1	1	<0.1	--	--	--	--	--	--	0.3	4
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	1	<0.1	0.2	4
BIGHEAD CARP	--	--	4	0.1	--	--	--	--	--	--	--	--	0.2	1
BOWFIN	--	--	2	<0.1	--	--	--	--	--	--	--	--	0.2	2
SHORTNOSE GAR	--	--	--	--	1	<0.1	--	--	--	--	1	<0.1	0.1	2
RED SHINER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	2
RIVER REDHORSE	--	--	--	--	--	--	--	--	--	--	--	--	0.1	2
SLENDERHEAD DARTER	--	--	--	--	1	<0.1	--	--	--	--	--	--	0.1	2
WARMOUTH	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
ALEWIFE	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
COMMON SHINER	1	<0.1	--	--	--	--	--	--	--	--	--	--	0.1	1
CHANNEL SHINER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
HIGHFIN CARPSUCKER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
ORIENTAL WEATHERFISH	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
SAUGER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1
Other Taxa[a]	408	5.9	909	13.3	453	7.6	345	4.8	276	5.7	143	2.1	270.2	--
TOTAL FISH	6,891	100	6,853	100	5,972	100	7,229	100	4,815	100	6,830	100	5,930.9	
TOTAL SPECIES	55		56		55		50		54		58		82	

(a) Other Taxa represent hybrids and non-species level identifications. **RIS Species** **State-listed RIS Species**

EXHIBIT D

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25 June 2018

Ms. Sharene Shealey
Midwest Generation, LLC
Will County Station
529 East 135th Street
Romeoville, Illinois 60446

RE: Status of MWGen Joliet Stations 316(a) & Subpart K Detailed Study Plan Work

Dear Ms. Shealey:

This letter provides a status report on the ongoing work and analyses that EA is performing on behalf of MWGen to implement the Detailed Study Plans for the Joliet Stations.

As you know, pursuant to the early screening requirements of the Illinois Subpart K regulations (35 Ill. Admin. Code 106, Subpart K), the original Conceptual Study Plan for this work prepared by EA covered all three MWGen Stations: Will County Station and the two Joliet Stations. The Conceptual Study Plan was submitted to the Illinois Environmental Protection Agency (IEPA) for review and approval on October 7, 2015. Based on a November 4, 2015 meeting discussion among representatives of EA, MWGen, and IEPA, EA proceeded to prepare three separate Detailed Study Plans, each of which addressed one of the three MWGen Stations. The Will County Detailed Study Plan and the Detailed Study Plans for Joliet 9 and Joliet 29 were submitted to the IEPA in early December 2015. IEPA approved the Joliet 9 and Joliet 29 Detailed Study Plans, collectively referred to here as the "Joliet DSP[1]" on March 3, 2016. The Illinois Department of Natural Resources ("IDNR") provided comments on the Joliet DSP on March 7, 2016. After an April 19, 2016 conference call among representatives of IDNR, MWGen, and EA to discuss the IDNR comments, EA submitted a written response to the IDNR comments on behalf of MWGen on May 13, 2016. IDNR responded to MWGen's comments on June 8, 2016, stating that it had no further concerns.

Since the May 2016 IEPA approval of the Joliet DSP, and following IDNR's concurrence in June 2016, EA has proceeded to implement the Joliet DSP field studies, modeling, and associated analyses as expeditiously as reasonably possible. As much of the required field work was dependent on concurrently acceptable weather and station operating conditions, there were some instances where planned field work could not be conducted according to the original plan. These will be detailed in the following sections. Even with these unanticipated delays, EA currently remains on schedule to complete the Joliet DSP field studies in December 2018. A detailed description of the status of the field studies is provided below, divided into the categories of study work detailed in the Joliet DSP.

[1] The Joliet 9 and 29 Detailed Study Plans are substantively identical, but separate versions were required since each station has its own NPDES Permit.

A. Fisheries and Other Biological Studies

As stated in the Joliet DSP, multiple study years are required to characterize the potential variability in aquatic communities and habitat conditions, and to decipher their trends. While fish survey data has been collected for 40 years as part of the ongoing long-term fishery monitoring program for the Upper Dresden Island Pool (UDIP), the existing data for most other components of the aquatic community were more than 20 years old as of the time the Joliet DSP was approved by the IEPA. Thus, to satisfy the requirements of the Illinois Subpart K regulations and federal 316(a) guidance, it was necessary to collect an additional two years of new data for a key biotic category (i.e., benthic macroinvertebrates) after receiving approval of the Joliet DSP. In addition, the Joliet DSP also included sampling at additional electrofishing and seining locations in the UDIP as part of the ongoing fish monitoring program. To provide better spatial distribution of sampling locations relative to the Joliet Stations' thermal discharges, two new sampling locations (403B and 403C) were added between Location 403A and the confluence of Rock Run (approximately one to two miles downstream of the Joliet Stations' discharges), one along each bank (Figure 1). EA began collecting these additional electrofishing and seining data at the new sampling locations in 2016 and this work has continued to the present as part of the annual fishery monitoring program.

However, because the conversion of the Joliet Stations to natural gas was not completed until June 2016, and their mode of operations changed to providing power only during periods of peak electrical demand (i.e., "peaker" operations), it was necessary to allow sufficient time for any potential changes in the receiving waterbody to be detected as a result of the new thermal conditions under the new Station operations. Consequently, the data EA collected during 2016 could not be considered as representative of habitat utilization by the fish community under the new station operating conditions. Therefore, the approved Joliet DSP provided for an additional two years of study during 2017 and 2018 to allow sufficient time for any potential changes in the receiving waterbody to be detected because of the new thermal conditions under the new Joliet Stations operations.

Consistent with the schedule and frequency provided in the approved Joliet DSP, EA conducted fish sampling in the UDIP in early May, early June and twice per month in July, August and September 2017. EA is following this same schedule and frequency in 2018. The May and early June 2018 fish sampling has been conducted, but there remains additional fish sampling to be conducted twice per month in July, August, and September 2018 in accordance with the approved Joliet DSP.

In addition to the ongoing long-term fishery monitoring program, the Joliet DSP added new fishery studies to be conducted during the winter months in the UDIP. The previous twenty-plus years of the fish monitoring program near the Joliet Stations were not conducted during this period. The Joliet DSP included these additional winter fish sampling events to provide information necessary to evaluate spatial trends of the fish community in response to winter thermal discharges from the two stations. If a facility operates long enough for fish to become acclimated to a thermal discharge during winter, the potential for cold shock increases if the facility rapidly reduces its thermal discharges. Because the Joliet Stations are now operating as peaker stations and were expected to do so at the time the Joliet DSP was prepared, two winter fish sampling events during each of two years of DSP work were included in the Joliet DSP. To the extent reasonably possible based on largely unpredictable station operations, these sampling events were coordinated to occur in conjunction with operating cycles of the three Joliet units. EA has completed these winter fish sampling events in a timely fashion when they were able to be scheduled concurrent with expected Joliet Station operations. For the initial planned December 2016 monitoring effort, the three Joliet units did not have sustained generation that was sufficient to conduct the thermal plume and fish surveys (Figure 2). MWGen notified the IEPA regarding the lack of generation and that no studies were accomplished in December, and the Agency did not take issue with delaying the winter work until January/February 2017. MWGen and EA planned for three potential sampling periods in January 2017, but no surveys could be conducted because none of the Joliet Units operated that month (Figure 2). Therefore, MWGen decided they would "force" the Joliet Units to operate during two periods in February 2017 (15^{th}-17^{th} and 22^{nd}-23^{rd}), taking a significant economic loss, to collect the required data. Although EA conducted reconnaissance of the Joliet Station thermal plume study area on February 15, 2017, no surveys were conducted on the subsequent two dates due to Unit 8 developing a steam leak and being taken offline. However, during the subsequent week, the first winter thermal plume and fish surveys were completed at the Joliet Stations as planned on February 23, 2017. The second winter fish survey and final thermal plume survey were completed at the Joliet Stations in December 2017, which was during the only period that the Joliet units operated until later that month (Figure 3). Although Joliet Station Units did operate during late December 2017 and early or mid-January 2018, which provided opportunities to conduct additional winter fish studies, the boat ramps were inundated by ice and precluded physical access to the river for the sampling crew to perform the required monitoring work. Thereafter, the Joliet Station Units did not operate from 18 January through February (Figure 3).

The DSP had proposed that four winter fish surveys be conducted. However, due to adverse weather conditions this past winter, as well as limited operating times by the Joliet Stations, the third winter 2018 fish survey could not be conducted as planned. Therefore, what was to be at least the fourth winter fish survey, scheduled for December 2018, will now be the third winter fish survey. If this sampling occurs and produces useable data, EA believes that the three rounds of winter fish sampling should provide adequate winter fish survey data, and it will not need to perform the fourth winter fish survey described in the Joliet DSP. MWGen informed the IEPA of this potential change to the Joliet DSP, and the IEPA advised that EA should proceed based on its best professional judgement as to whether the amount of winter fish survey data is adequate. Assuming the additional December 2018 survey does provide adequate data to assess the winter fish community, it will conclude the winter fisheries field survey work. If more data are needed, the fish survey work will need to be extended into January/February of 2019, which will add some additional months' time to the estimated completion of the Joliet DSP and preparation of the Demonstration Study Reports based on the data collected.

EA collected the May through September 2016-2017 Joliet DSP fish survey data as part of the ongoing fish monitoring program. The 2016 data, along with data collected from 1994-2015, were analyzed in EA (2017[2]) to determine/compare the composition, distribution, abundance, condition, and incidence of anomalies of fish within and among four segments of the Upper Illinois Waterway (UIW), which include the UDIP (i.e., the Upstream I-55 segment) and the Five-Mile Stretch south of the I-55 Bridge (i.e., the Downstream I-55 segment). Although the 2017 fish monitoring program report is in preparation, certain analyses have been completed and they indicate that there has been no significant change in the fish communities during the post-2015 period in the UDIP nor the Five-Mile Stretch, areas downstream of the MWGen Stations. By "no significant change", we mean that summertime electrofishing native species[3] catch rates, modified Index of Well-being (IWBmod) scores, and native species richness values during 2016 and 2017 were statistically similar to several or most previous study years in both the UDIP and the Five-Mile Stretch (Table 1). The Joliet Stations were only running a small percentage of the time during the period from mid-2016 through 2017. Furthermore, during a sizeable portion of this period, none of the MWGen Stations in the UIW were operating. The Joliet Stations were not operating during the period March through May 2016 and Will County Station was not operating through most of April and May 2016, nor from May through December 2017. EA has not identified more thermally sensitive species nor a greater abundance of the most thermally sensitive species in the summers of 2016 or 2017, which have been present during the previous summers in the Joliet DSP study area (Table 2 and Table 3). For example, summer 2016 and 2017 catch rates of the thermally sensitive White Sucker and collectively the *Moxostoma* (redhorse) species in the UDIP and the Five-Mile Stretch were within the range of values observed during the previous 21 study years:

Taxa	UDIP Catch Rates		Five-Mile Stretch Catch Rates	
	1994-2015	2015-2016	1994-2015	2015-2016
White Sucker	0-1.4	0.4-0.6	0-0.4	0-0.3
Moxostoma spp.	0.1-2.0	1.0-1.7	0.3-7.2	0.5-1.0

In summary, our preliminary determination is that there has not been any definitive improvement of the fish communities in the Joliet DSP study area during the post-2015 period. The retrospective and/or predictive sections of the Demonstration Study Reports will provide appropriate spatial (e.g., upstream and downstream of the Joliet Stations' discharges) and temporal (among months or seasons) analyses of the 2017 and 2018 fisheries data, as well as interyear comparisons.

As part of the fish survey work, EA also monitored dissolved oxygen at each of the fish survey locations. From 1994 through 2016, only four of 1,119 dissolved oxygen measurements were below the UDIP Standards of 5 ppm (May through July) or 3.5 ppm (August and September) (EA 2017). Two occurred in 2010 and one occurred in both 2015 and 2016. These measurements occurred at backwater Locations 405 (Treats Island slough) and 408 (Jackson Creek Cut-Off), and they were associated with dense mats of duckweed and algae. From 1994 through 2009, only one dissolved oxygen reading was below the General Use Standards of 5

[2] EA Engineering, Science, and Technology, Inc., PBC. 2017. 2016 Upper Illinois Waterway fisheries investigation RM 274.4-296.0. Report by EA to Midwest Generation, LLC – Joliet Stations, Joliet, IL, and Midwest Generation, LLC – Will County Station, Romeoville, IL.
[3] Native species do not include invasive or exotic species such as Asian carp, Common Carp, Round Goby, etc.

ppm (May through July) or 3.5 ppm (August and September) that apply to the Five-Mile Stretch (EA 2017). However, from 2007-2016, there were one to five measurements per year that were below these Standards (EA 2017). All the below-Standards measurements occurred at backwater Locations 414 (Moose Island slough) and 418 (the mouth of Grant Creek), and they were concomitant with dense macrophytic growth, particularly ubiquitous mats of duckweed and algae. Below-Standards dissolved oxygen measurements also occurred at these two backwater locations in 2017 when dense macrophytes and/or mats of duckweed and algae were present.

The MWGen Stations also monitor dissolved oxygen at both their intake and discharge locations as part of their NPDES permit requirements. The dissolved oxygen monitoring data we have reviewed for the post-2015 period show no adverse impact on dissolved oxygen levels associated with MWGen station operations, nor any instances where the current dissolved oxygen water quality standards have not been met. Additionally, EA performs continuous dissolved oxygen monitoring from May through September at the I-55 Bridge. For 2012-2017, there were no instances when the UDIP dissolved oxygen standards were not met. Neither the UDIP nor the Five-Mile Stretch is impaired for dissolved oxygen according to the IEPA's 305(b)/303(d) reports from 2004 to the present.

Given the importance of macroinvertebrates to the aquatic food chain, the Joliet DSP implemented two years of benthic macroinvertebrate sampling to document the condition of this biotic category and provide information to evaluate the potential effects of the thermal plumes from the Joliet Stations. The objectives of this study are to determine/compare the composition, distribution, and abundance of the benthic community among segments above, within, and below the Station's discharges. Sampling was conducted in July 2017 and will be repeated during the summer of 2018. The two years of current study results will be compared with those obtained during 1993 and 1994 (as part of the original UIW study commissioned by ComEd) to evaluate spatial and temporal trends within the benthic macroinvertebrate community in the UDIP.

B. Aquatic Habitat Surveys

The Joliet DSP provides for both existing and newly conducted habitat survey information that assesses habitat quality using the Qualitative Habitat Evaluation Index (QHEI) developed by Rankin (1989[4]). EA will use the extensive habitat surveys in various portions of the UDIP and Five-Mile Stretch between Brandon Road Lock and Dam and Dresden Island Lock and Dam that it previously conducted in 1994-1995, 2003, and 2008. Thus, this information is already available and the results were submitted and discussed in pre-filed testimony (8 September 2008) by Mr. Greg Seegert (EA) on proposed amendments to Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System (CAWS) and LDPR (IPCB Docket No. R08-9, Subdocket C). The findings of these studies generally showed that habitat was poor upstream of Brandon Road Lock and Dam and while it improved downstream of Brandon Road Lock and Dam, the QHEI scores were still typically in the "poor" and "fair" ranges of the scale.

[4] Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI). Rationale, methods, and applications. Ohio EPA, Div. Water Quality Planning and Assessment, Ecological Analysis Section, Columbus, Ohio.

As part of the new habitat survey information collected under the Joliet DSP, EA began determining QHEI scores at each electrofishing location as part of the fish survey work beginning in 2016. The new QHEI data, along with 2017 bathymetric and submergent aquatic vegetation surveys data collected in the UDIP, are being used to generate preliminary habitat maps to support a predictive thermal assessment of the effects of the Stations' thermal plumes. The September 2017 bathymetric survey, extending downstream to near the I-55 Bridge, was conducted to delineate channel, edge of channel, and shallow (less than 2 m) littoral habitat. The Joliet DSP work also included a submergent aquatic vegetation survey in July 2017 to describe the extent and dominant types of aquatic vegetation in shallow habitat. During the vegetation survey, shoreline characteristics were described (e.g., bulkhead, riprap or otherwise armored, or "natural") and substrate type determined, such as soft/mud, sand, gravel, cobble or larger. EA will also map the boundary of backwater and tributary mouth areas and identify and map any other significant structure observed that could attract fish or provide cover. The QHEI scores will also be used to characterize the type and quality of aquatic habitat, and to interpret availability and distribution of preferred habitat for the representative important species (RIS) within and outside of the thermal mixing zone and selected downstream transects of biological significance.

EA has preliminarily analyzed the new QHEI and habitat-related information collected as part of the Joliet DSP. The initial determination is that there are no significant changes in habitat quality in the UDIP. The QHEI scores are still typically in the "poor" and "fair" ranges of the scale, except for the Brandon Road Lock and Dam tailwater area that makes up approximately 5% of the UDIP area. There has been an increase in the areal extent and density of aquatic vegetation, mostly in off-channel areas of the UDIP and particularly in those areas in the Five-Mile Stretch, which provides more instream cover for aquatic life, but also have resulted in excessively vegetated shallow areas where the respiration-decomposition processes from dense macrophytic and algal growth/decay, particularly dense mats of duckweed and algae, have resulted in locally depressed dissolved oxygen levels, as previously noted. As a result, we are not seeing any discernible improvement in the fish community in these areas[5].

[5] EA (2017) stated that "[a] variety of factors, unrelated to operation of the power plants within the study area, either individually or collectively reduced at least some of the electrofishing and seining catch parameter values in all four segments during 2016. These factors include: 1) intensive electrofishing and netting studies conducted by the Asian Carp Regional Coordinating Committee's Monitoring and Response Workgroup throughout the study area; 2) several heavy rainfall events in the Chicago area, which resulted in combined sewer overflow events that depressed DO values in the upper portion of the study area and also caused significant drawdowns in the lower Lockport Pool during the study period; and 3) dense mats of duckweed/algae and dense beds of submergent and/or emergent macrophytes that reduced the effectiveness of electrofishing and/or seining at one location in Brandon Pool, at four of the nine locations within the Upstream I-55 segment [UDIP], and at all four locations within the Downstream I-55 segment [Five-Mile Stretch], particularly from late July through September." These factors were again prevalent in 2017.

C. Thermal Plume Studies and Downstream Dischargers Thermal Data Review

Thermal plume studies have also been performed as part of the Joliet DSP along with the collection and review of thermal discharge data of downstream dischargers in the UDIP. The following is a report on the status of both of these activities.

1. Thermal Plume Studies

The thermal plume studies consist of surface plume mapping and vertical profiles along predetermined transects. Previous thermal plume studies in 2002 and 2012 encompassed an area from 3,350 ft upstream of the Joliet #29 Station's discharge to 7,000 ft downstream of the discharge. The new thermal studies being performed as part of the Joliet DSP include seven additional transects further downstream and hence encompass a larger area to more completely document the downstream distribution and dissipation of thermal plume temperatures and support hydrothermal modeling of the plume for the predictive assessment.

New thermal plume studies were completed in the February 2017, July 2017, and December 2017. An earlier attempt had been made to complete the winter plume study in December 2016, but the Joliet Stations did not run for a long enough period of time to create "mature" thermal plume data (Figure 2). (Typically, a run of three days is needed.) The IEPA was notified of this issue, and it supported MWGen's proposal to postpone the winter work until January/February 2017. Because the Joliet Stations' operations did not provide an opportunity to conduct the thermal plume study in January 2017 (Figure 2), MWGen planned to put the Joliet Stations into operation for two periods in February (15^{th}-17^{th} and 22^{nd}-23^{rd}) so that the thermal plume study could be completed. The second run produced the needed winter thermal plume study.

EA has preliminarily analyzed the data collected from the new thermal plume studies. Pursuant to the Joliet DSP, it also has obtained and reviewed thermal data from the downstream dischargers Flint Hills Resources (FHR), located on the same side of the UDIP as the Joliet 29 Station), Stepan and ExxonMobil (both located on the same side of the UDIP as the Joliet 9 Station). Stepan's outfall discharge is located on a side channel by Treats Island where a stranded barge mostly blocks the area where the side channel meets the main body of the UDIP. Based on our observations of this area, the presence of the stranded barge likely contributes to reducing the flow in the area at and immediately downstream of the Stepan discharge, and combined with the shallowness of this location, likely contributes to higher localized water temperatures in this area. The temperatures recorded in the vicinity of the Stepan discharge are generally higher than those recorded further downstream at the I-55 Bridge.

Our preliminary assessment of the available thermal data indicates that when only the Will County Station is operating, the temperatures at the I-55 Bridge are generally compliant with the July 1, 2018 new numeric thermal water quality standards for the UDIP. Thus, our preliminary conclusion is that Will County Station's thermal discharge alone does not cause an exceedance of the new thermal standards in the UDIP and down to the I-55 Bridge, below which the General Use thermal standards apply. The recently collected thermal plume study data for the Joliet Stations for the February, July, and December 2017 surveys also indicated no exceedances of either the numeric UDIP or General Use limits. Additionally, there were no exceedances of either the AS 96-10 or the numeric General Use standards applicable in the Five-Mile Stretch below the I-55 Bridge, based on the continuous monitoring performed at the I-55 Bridge in 2016 or 2017, but neither of these years presented the combination of ambient temperatures, low flow, and station operating conditions that may lead to higher monitored temperatures at these locations.

It is expected that the Joliet Stations will not be able to consistently comply with the new UDIP thermal standards at the edge of their respective, allowed mixing zones. There was one occurrence post fuel conversion, in July 2016, where the Joliet 29 Station's estimated edge of mixing zone temperature exceeded 93º F. Although limited to approximately four hours, and such an exceedance is allowed under the current Secondary Contact thermal standards, as excursions up to 100º F are allowed for 5% of the hours in a rolling twelve-month period, this instance exceeded the maximum temperature allowed under the new UDIP thermal standards. Based on our preliminary review of the new thermal plume studies, as well as a review of historical unit loading and associated discharge temperatures under adverse river and weather conditions, EA believes that each of the Joliet Stations will have difficulty maintaining compliance with the new thermal standards during times of hot and dry summer conditions as well as during the fall and spring months when the standard changes to 60º F, particularly during times of unseasonably warm ambient temperatures. However, given the peaker operating mode of the Joliet Stations, these periods of exceedances will be more limited than if the Stations were operating in their pre-2016 mode of base load operations.

Further, it is possible that when both Will County Station and the Joliet Stations are operating, particularly when the Joliet Stations are running for an extended period (i.e., over at least several days) and the ambient temperatures are high and flow conditions are low, such as occurred during the summer of 2012, there is a likelihood that temperatures at both the edge of the allowed mixing zone, as well as near the I-55 Bridge, would exceed the new UDIP numeric thermal standards. Thus, under these adverse weather and river flow conditions, it is likely that the Joliet Stations will still need the adjusted thermal standards provided in AS96-10 at the I-55 Bridge as they would not be able to comply with the otherwise applicable General Use thermal standards. Under such adverse weather and river flow conditions, it is also likely that some portion of the Five-Mile Stretch may not meet all of the provisions of the General Use standards. Although no specific information currently exists to document any noncompliance with the existing thermal limitations within the Five-Mile Stretch, this potential will be reviewed, using available information, as part of MWGen's pursuit of a 316(a) variance for both Joliet Stations.

2. Downstream Thermal Dischargers Data Review

EA obtained, or received operating data from, FHR, Stepan, and ExxonMobil. Based upon review of this information, EA's preliminary conclusions are that each of these dischargers require minimal assimilative capacity in the UDIP receiving waters to maintain compliance with the applicable thermal standards. According to their respective NPDES Permits, the three dischargers have design average flows (DAF) that are very small when compared with the base flow rate of the waterway:

Discharger	Flow Rate
FHR	3.6 cfs
Stepan	1.36 cfs
Exxon Mobil	22.9 cfs

Comparing the provided temperature monitoring data for FHR, Stepan, and Exxon-Mobil to the temperatures recorded at the I-55 Bridge in the summer months, when the Will County and Joliet Stations are likely to use more of the waterway's assimilative capacity, Stepan and FHR tend to produce thermal effluent that is nearly the same temperature as the water at the I-55 Bridge. (Both of these facilities use well water as their intake source, and therefore their discharge is not influenced by upstream river temperature). For Exxon-Mobil, over the last three summers, it has had measured outfall temperatures that are higher than the temperatures measured at the I-55 Bridge. From 2012 to the present, the summer temperatures at the I-55 Bridge have held steady or decreased, while ExxonMobil's discharge temperatures have generally been higher than at the I-55 Bridge, which would support a conclusion that ExxonMobil's discharge is not being influenced by upstream heat sources nor does it have a meaningful effect on downstream temperatures. Thus, it appears to have sufficient assimilative capacity in the water (i.e., a mixing zone) to maintain compliance with the new UDIP thermal standards during the summer period. While winter temperatures for all three downstream dischargers are generally higher than the corresponding temperatures at the I-55 Bridge, this assessment should also hold true for the winter period under typical conditions.

EA still needs more time to analyze the thermal data and to conduct the modeling necessary to predict what kinds of temperatures will be found in the UDIP under "worst case" operating conditions. The above preliminary conclusions regarding the available assimilative capacity of the receiving waters to allow for consistent compliance at the edge of an allowed mixing zone for the respective thermal discharges from FHR, Stepan, and ExxonMobil also requires more time to complete our analyses. EA also has not had sufficient time to evaluate whether the UDIP narrative thermal criteria in 35 Ill. Admin. Code 302.408(c)-(f) are being met under "worst case" conditions in the waterbody, and whether those criteria are more stringent than necessary to protect a balanced, indigenous, population of aquatic life throughout the UDIP.

D. Conclusion

Ongoing work on the Joliet Stations DSP will continue in 2019. EA has begun work on the prospective analysis that will be part of the Joliet Stations' Demonstration Reports. Hydrothermal modeling runs have also been initiated in order to predict downstream temperatures under both typical and critical weather, river, and station operating conditions. This modeling data, along with all the collected field biological and thermal plume data, will be used to help develop a set of alternative thermal limits for the Joliet Stations. EA estimates it will complete the development of proposed alternative effluent limits in or about May 2019. EA is currently on schedule to complete the draft Demonstration Reports by not later than June 2019. Providing some time for MWGen to review the draft Demonstration Reports, it is estimated that the proposed thermal alternative effluent limits will be submitted to the IEPA in September 2019.

Please let me know if you need any additional information regarding the Joliet DSP work that EA is conducting.

Sincerely yours,

EA ENGINEERING, SCIENCE,
AND TECHNOLOGY, INC., PBC

Joe T. Vondruska

Joe T. Vondruska
Project Manager

Figures

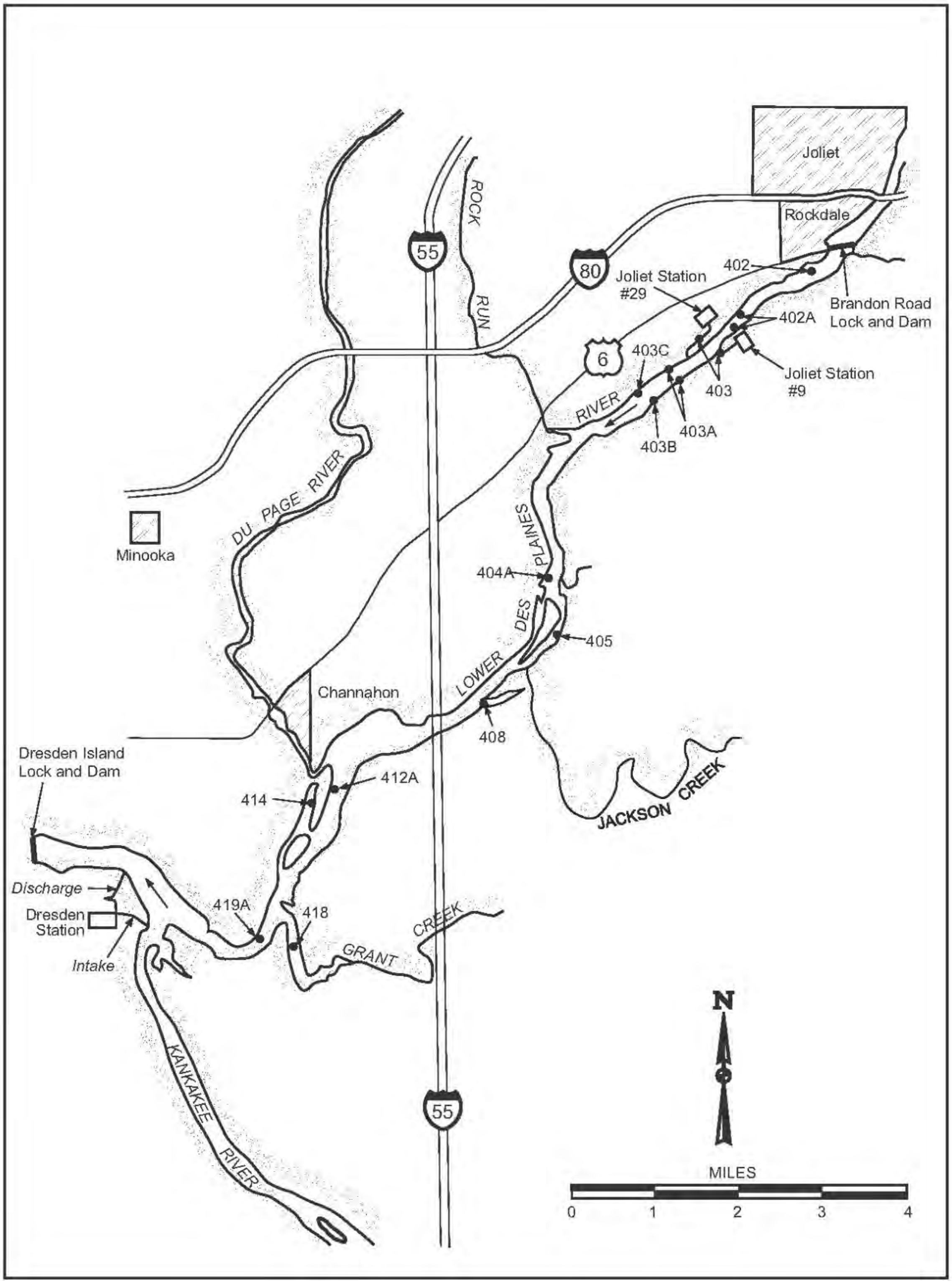

Figure 1 Fish Sampling Locations in the Upper Dresden Island and 5-mile Stretch of the lower Des Plaines River.

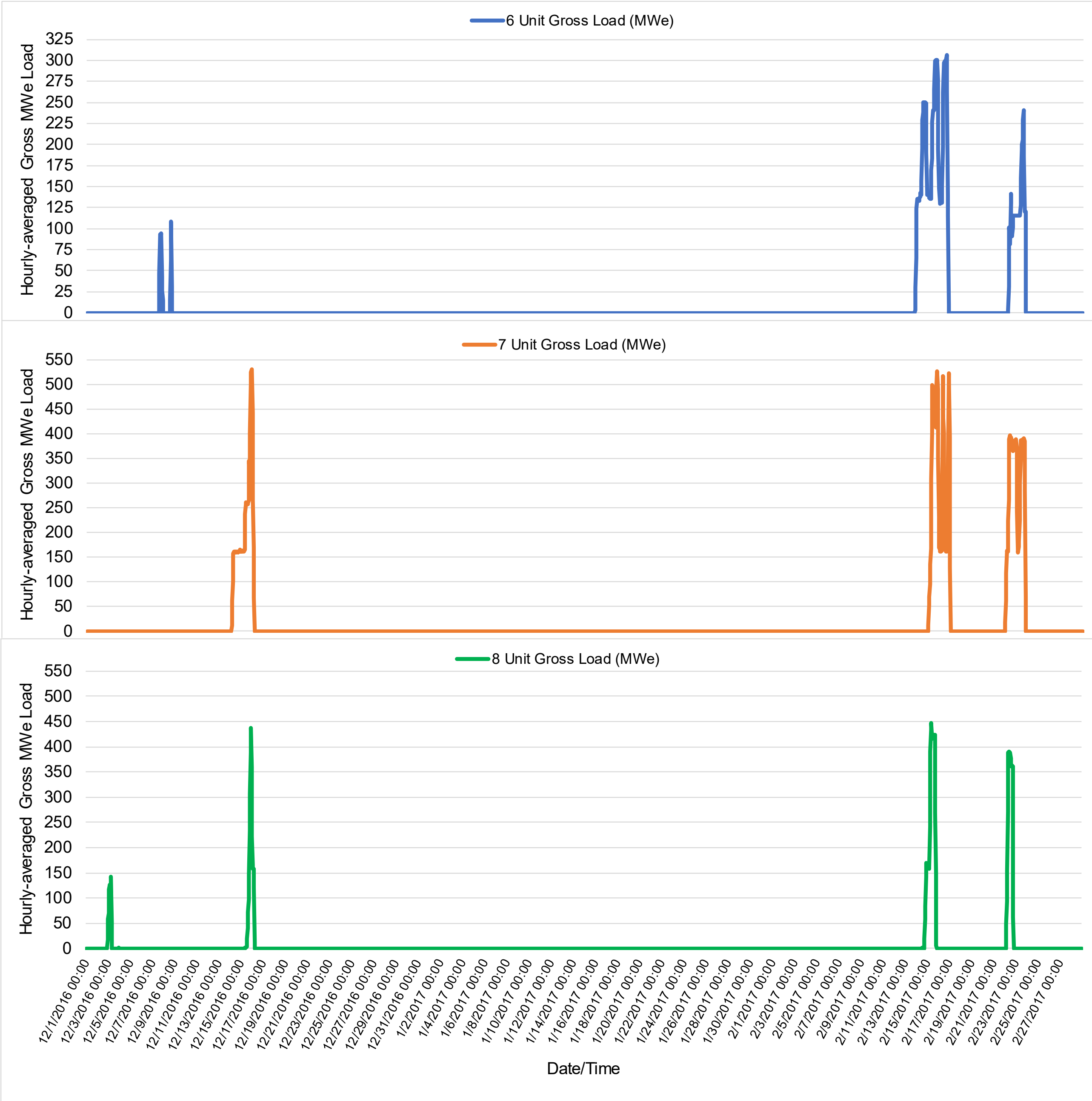

Figure 2 **Joliet Units 6, 7, and 8 Hourly-averaged Gross MWe Load, 1 December 2016 - 28 February 2017.**

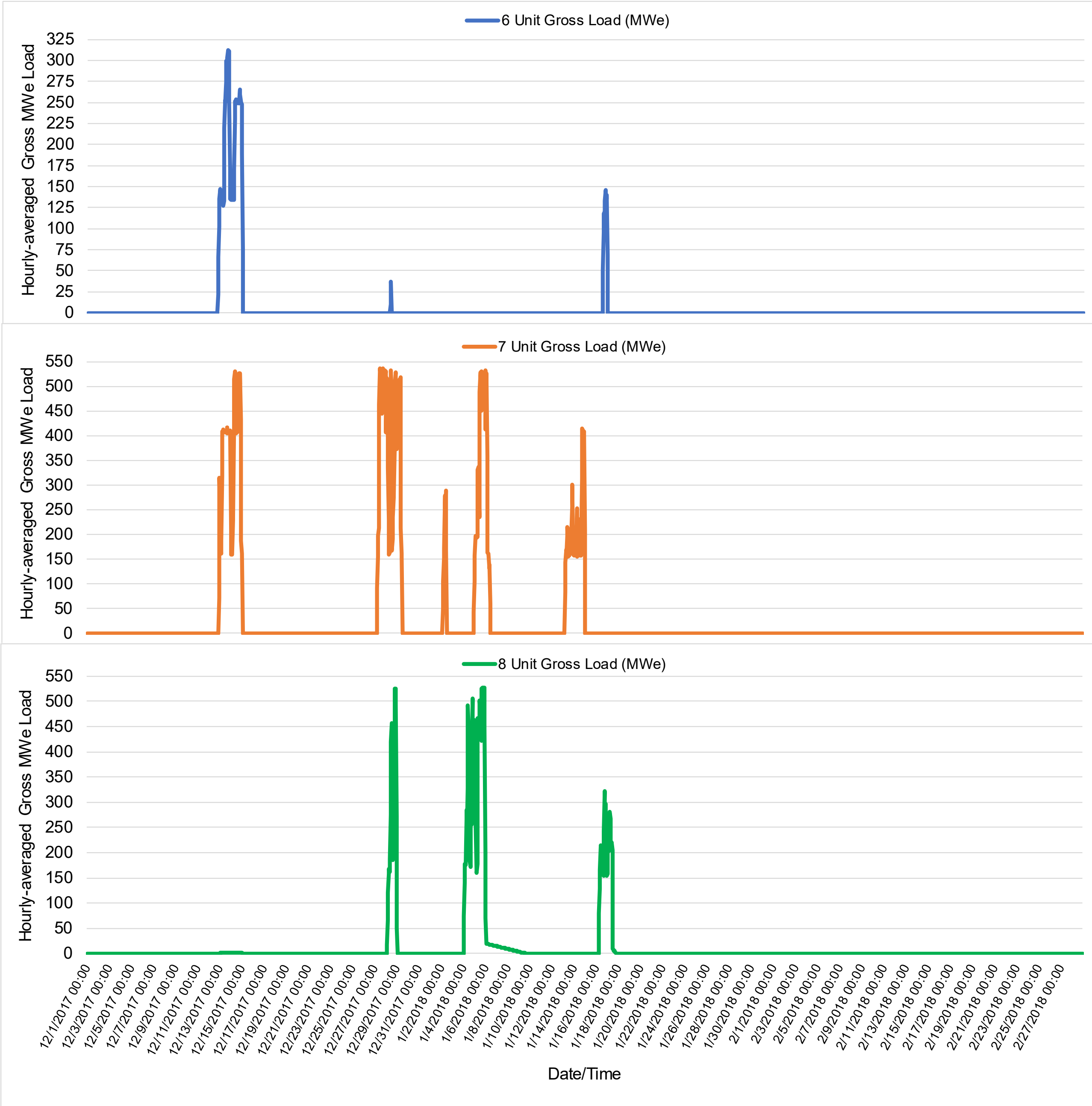

Figure 3 Joliet Units 6, 7, and 8 Hourly-averaged Gross MWe Load, 1 December 2017 - 28 February 2018.

Tables

Table 1 Interyear Comparisons of Mean Electrofishing Catch Parameters within the Upper Dresden Island Pool and the Five-Mile Stretch for the Period of 15 June through August.

Upper Dresden Island Pool[a]	2017[b]	2016[b]	2015[b]	2014[b]	2013[b]	2012[b]	2011[b]	2010[b]	2009[b]	2008[b]	2007[b]	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1995	1994	Significant Difference[c]	F Value	P Value
CPEs-all native fish	196.3	134.6	118.1	302.9	110.4	209.3	190.5	161.8	179.9	246.3	229.6	139.3	119.7	162.5	265.8	225.5	144.3	113.2	103.3	178.6	84.5	53.3	35.5	Yes	5.82	<0.01
	ABCDE	DEF	CDEF	A	EF	BCDEF	ABCDE	BCDEF	ABCDE	AB	ABCD	CDEF	EF	BCDE	ABC	BCDE	CDEF	EF	EF	BCDE	F	G	G[d]			
IWBmod	6.9	6.6	6.7	7.4	6.6	6.0	6.4	6.6	6.9	7.0	6.9	6.5	5.8	7.1	7.2	6.5	6.2	6.5	6.6	6.7	6.3	5.7	5.8	Yes	2.48	<0.01
	AB	ABCD	ABC	A	ABCDE	DE	ABCDE	ABCDE	AB	AB	AB	ABCDE	CDE	AB	AB	ABCDE	BCDE	ABCDE	ABCD	ABCD	BCDE	E	CDE			
Native Species Richness	13	10	10	15	8	9	9	9	11	12	11	9	7	10	11	10	9	9	9	10	9	7	7	Yes	6.09	<0.01
	AB	CDE	BCDE	A	EFGH	EFGH	DEFG	DEFG	BCD	BC	BCD	DEFGH	GH	BCDE	BCD	CDEFG	CDEF	DEFGH	EFGH	BCDE	EFGH	H	FGH			
Five-Mile Stretch[a]																										
CPEs-all native fish	405.6	114.1	129.9	373.9	155.1	238.0	301.4	298.3	205.1	436.8	300.4	387.4	400.8	242.3	789.3	348.4	163.4	252.5	186.2	227.3	139.1	119.8	190.0	Yes	4.76	<0.01
	ABC	G	FG	AB	EFG	DEFG	ABCDE	ABCD	ABCDEF	AB	ABCDEF	ABC	ABCDE	ABCDEF	A	ABCDE	FG	ABCDEF	CDEFG	BCDEF	FG	FG	G			
IWBmod[e]	6.7	6.4	6.2	6.8	6.4	6.2	6.8	7.4	7.2	7.9	6.7	7.7	6.8	7.4	7.9	7.5	6.7	7.4	7.2	7.1	6.7	7.2	6.0	Yes	3.96	<0.01
	BCDEF	DEF	EF	BCDEF	DEF	EF	BCDEF	ABC	ABCD	A	CDEF	AB	BCDEF	ABC	A	ABC	CDEF	ABC	ABCD	ABCDE	CDEF	ABCD	F			
Native Species Richness	13	9	9	13	8	8	10	13	12	15	11	12	11	12	13	12	10	10	11	11	10	12	9	Yes	4.74	<0.01
	ABC	FGHI	EFGHI	ABC	HI	GHI	BCDEFGHI	AB	ABCD	A	BCDEF	ABCD	BCDEF	BCDE	ABC	BCDE	BCDEFGH	CDEFGHI	BCDEFG	BCDEF	DEFGHI	BCDE	I			

(a) All data (except as noted) were log transformed for statistical analyses because they are not normally distributed. Data are from long-term monitoring Locations 402, 402A, 403A, 403, 405, and 408 in the Upper Dresden Island Pool and Locations 412A, 414, 418, and 419A in the Five-Mile Stretch.
(b) Electrofishing results from July through August of 2007-2017 may have been negatively influenced by dense aquatic vegetation and/or mats of duckweed/algae that interfered with sampling and caused atypically low DOs at certain backwater locations from 2010 through 2017, particularly within the Five-Mile Stretch.
(c) Results of one-factor parametric Analysis of Variance tests (alpha=0.05).
(d) Results of Duncan's Multiple Range Test; values with the same letters are not significantly different (alpha=0.05).
(e) Raw data are normally distributed.

TABLE 2 INTERYEAR COMPARISONS OF ELECTROFISHING CATCHES (native species only) WITHIN THE UPPER DRESDEN ISLAND POOL FOR THE PERIOD OF 15 JUNE THROUGH AUGUST.

SPECIES	1994		1995		1997		1998		1999		2000		2001	
	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%
LONGNOSE GAR	--	--	--	--	0.5	0.59	--	--	--	--	0.2	0.18	0.5	0.36
SHORTNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GAR sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOWFIN	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SKIPJACK HERRING	0.2	0.47	--	--	0.1	0.12	--	--	0.1	0.10	--	--	0.1	0.06
GIZZARD SHAD	8.5	23.94	19.3	36.15	23.2	27.46	33.3	18.65	32.5	31.46	28.5	25.18	39.0	27.00
Dorosoma sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MOONEYE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CENTRAL MUDMINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS PICKEREL	--	--	--	--	0.1	0.12	--	--	--	--	0.1	0.09	--	--
NORTHERN PIKE	--	--	0.3	0.47	--	--	--	--	--	--	--	--	0.1	0.06
CENTRAL STONEROLLER	--	--	--	--	--	--	--	--	0.1	0.10	--	--	0.2	0.12
HORNYHEAD CHUB	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.06
GOLDEN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.06
PALLID SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER	3.5	9.86	2.1	3.99	13.3	15.74	45.8	25.64	5.5	5.32	4.1	3.62	12.8	8.86
GHOST SHINER	--	--	--	--	--	--	0.1	0.06	--	--	--	--	--	--
STRIPED SHINER	--	--	--	--	--	--	0.2	0.11	--	--	--	--	0.1	0.06
BIGMOUTH SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	1.5	4.23	0.8	1.41	0.3	0.36	0.7	0.39	0.4	0.39	--	--	6.7	4.64
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTFIN SHINER	--	--	--	--	0.4	0.47	1.1	0.62	0.3	0.29	0.3	0.27	2.0	1.39
SAND SHINER	--	--	0.1	0.23	--	--	0.2	0.11	--	--	--	--	0.2	0.12
REDFIN SHINER	--	--	--	--	--	--	0.1	0.06	--	--	--	--	--	--
MIMIC SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SUCKERMOUTH MINNOW	--	--	--	--	--	--	0.2	0.11	0.1	0.10	--	--	--	--
BLUNTNOSE MINNOW	3.2	8.92	3.4	6.34	3.0	3.55	20.7	11.59	7.9	7.65	3.4	3.00	26.1	18.08
FATHEAD MINNOW	--	--	--	--	--	--	0.1	0.06	--	--	--	--	--	--
BULLHEAD MINNOW	--	--	--	--	0.9	1.07	0.3	0.17	0.2	0.19	--	--	1.8	1.27
Pimephales sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RIVER CARPSUCKER	0.7	1.88	0.6	1.17	1.0	1.18	0.1	0.06	0.7	0.68	0.4	0.35	0.3	0.18
QUILLBACK	0.5	1.41	0.8	1.41	0.8	0.95	0.2	0.11	0.2	0.19	0.5	0.44	0.1	0.06
HIGHFIN CARPSUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes sp.	--	--	--	--	0.1	0.12	0.1	0.06	--	--	--	--	--	--
WHITE SUCKER	0.3	0.94	1.4	2.58	0.2	0.24	0.2	0.11	0.2	0.19	0.1	0.09	0.1	0.06
SMALLMOUTH BUFFALO	2.5	7.04	3.3	6.10	3.0	3.55	3.5	1.96	4.7	4.55	2.1	1.86	2.3	1.63
BIGMOUTH BUFFALO	--	--	0.1	0.23	0.1	0.12	--	--	0.1	0.10	0.3	0.27	--	--
BLACK BUFFALO	--	--	--	--	--	--	0.1	0.06	0.3	0.29	0.1	0.09	--	--
SPOTTED SUCKER	--	--	--	--	0.2	0.24	--	--	--	--	--	--	--	--
SILVER REDHORSE	--	--	--	--	--	--	--	--	0.1	0.10	--	--	--	--
GOLDEN REDHORSE	0.3	0.94	0.3	0.47	--	--	0.3	0.17	0.1	0.10	--	--	--	--
SHORTHEAD REDHORSE	0.3	0.94	0.9	1.64	0.2	0.24	0.6	0.34	0.5	0.48	0.6	0.53	0.3	0.18
Moxostoma sp.	0.2	0.47	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	0.2	0.47	0.1	0.23	--	--	0.1	0.06	--	--	--	--	--	--
YELLOW BULLHEAD	--	--	0.1	0.23	0.3	0.36	0.2	0.11	0.2	0.19	0.6	0.53	0.1	0.06
CHANNEL CATFISH	2.8	7.98	1.6	3.05	4.4	5.21	3.1	1.74	2.1	2.03	2.8	2.47	2.1	1.45
TADPOLE MADTOM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLATHEAD CATFISH	--	--	--	--	--	--	0.1	0.06	--	--	0.1	0.09	--	--
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	0.2	0.47	--	--	--	--	--	--	--	--	0.1	0.09	0.1	0.06
BROOK SILVERSIDE	--	--	--	--	0.2	0.24	--	--	--	--	--	--	--	--
WHITE BASS	--	--	--	--	0.2	0.24	--	--	--	--	--	--	--	--
YELLOW BASS	--	--	0.1	0.23	--	--	--	--	0.2	0.19	--	--	--	--
Morone sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ROCK BASS	--	--	--	--	--	--	--	--	0.2	0.19	0.2	0.18	--	--
GREEN SUNFISH	3.3	9.39	7.5	14.08	11.9	14.08	32.8	18.37	20.4	19.75	27.6	24.38	16.5	11.45
PUMPKINSEED	--	--	--	--	--	--	0.4	0.22	--	--	--	--	--	--
WARMOUTH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORANGESPOTTED SUNFISH	0.2	0.47	0.5	0.94	2.2	2.60	3.4	1.90	0.8	0.77	1.0	0.88	0.1	0.06
BLUEGILL	0.7	1.88	2.9	5.40	4.0	4.73	10.0	5.60	9.1	8.81	22.1	19.52	20.3	14.04
NORTHERN SUNFISH	--	--	--	--	0.3	0.36	0.1	0.06	0.1	0.10	0.8	0.71	0.8	0.54
Lepomis HYBRID	--	--	0.3	0.47	1.0	1.18	3.8	2.13	5.2	5.03	4.9	4.33	1.8	1.27
Lepomis sp.	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.12
SMALLMOUTH BASS	0.8	2.35	0.6	1.17	1.6	1.89	2.0	1.12	0.9	0.87	0.5	0.44	1.2	0.84
LARGEMOUTH BASS	2.0	5.63	3.6	6.81	5.5	6.51	10.1	5.66	7.2	6.97	7.7	6.80	5.5	3.80
WHITE CRAPPIE	--	--	--	--	--	--	0.2	0.11	--	--	0.2	0.18	--	--
BLACK CRAPPIE	--	--	--	--	--	--	0.2	0.11	0.2	0.19	0.3	0.27	0.1	0.06
Pomoxis sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JOHNNY DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW PERCH	--	--	--	--	0.2	0.24	0.2	0.11	--	--	--	--	--	--
LOGPERCH	--	--	--	--	--	--	--	--	0.1	0.10	0.2	0.18	0.1	0.06
BLACKSIDE DARTER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.06
SLENDERHEAD DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAUGER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WALLEYE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	3.7	10.33	2.8	5.16	5.3	6.27	4.0	2.24	2.6	2.52	3.4	3.00	2.7	1.87
TOTAL FISH	35.5	100.00	53.3	100.00	84.5	100.00	178.6	100.00	103.3	100.00	113.2	100.00	144.3	100.00
TOTAL SPECIES	20		23		28		34		31		28		32	

TABLE 2 (cont.)

SPECIES	2002		2003		2004		2005		2006		2007		2008	
	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%
LONGNOSE GAR	0.3	0.15	0.1	0.03	0.3	0.21	0.1	0.07	0.3	0.18	0.5	0.22	0.8	0.34
SHORTNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GAR sp.	0.1	0.04	--	--	--	--	--	--	--	--	--	--	--	--
BOWFIN	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SKIPJACK HERRING	0.1	0.04	--	--	0.2	0.10	0.1	0.07	--	--	0.1	0.04	0.4	0.17
GIZZARD SHAD	86.5	38.36	21.6	8.12	27.6	16.97	56.6	47.28	33.5	24.06	82.6	35.97	62.8	25.52
Dorosoma sp.	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.03
MOONEYE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CENTRAL MUDMINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS PICKEREL	0.1	0.04	--	--	--	--	--	--	--	--	--	--	--	--
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	--	--	0.3	0.14
CENTRAL STONEROLLER	--	--	0.6	0.22	--	--	--	--	--	--	--	--	0.5	0.20
HORNYHEAD CHUB	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDEN SHINER	--	--	0.8	0.31	0.1	0.05	0.1	0.07	0.5	0.36	0.2	0.07	1.2	0.47
PALLID SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER	37.5	16.63	6.7	2.51	5.8	3.59	3.8	3.20	8.8	6.28	15.2	6.61	7.5	3.05
GHOST SHINER	--	--	--	--	0.1	0.05	--	--	--	--	0.3	0.15	--	--
STRIPED SHINER	--	--	0.5	0.19	--	--	0.2	0.14	1.1	0.78	2.7	1.16	0.5	0.20
BIGMOUTH SHINER	0.1	0.04	--	--	--	--	--	--	--	--	0.1	0.04	--	--
SPOTTAIL SHINER	3.1	1.37	3.5	1.32	0.8	0.46	0.7	0.56	0.3	0.18	5.6	2.43	3.3	1.32
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTFIN SHINER	1.9	0.85	5.6	2.10	1.8	1.08	1.2	0.97	1.8	1.32	3.3	1.45	6.0	2.44
SAND SHINER	0.5	0.22	0.7	0.25	0.1	0.05	0.1	0.07	--	--	--	--	0.4	0.17
REDFIN SHINER	--	--	--	--	0.1	0.05	--	--	--	--	--	--	--	--
MIMIC SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SUCKERMOUTH MINNOW	0.1	0.04	--	--	--	--	--	--	--	--	--	--	0.3	0.10
BLUNTNOSE MINNOW	8.8	3.92	63.1	23.73	13.3	8.15	11.8	9.89	31.5	22.62	43.3	18.84	55.0	22.34
FATHEAD MINNOW	--	--	0.1	0.03	--	--	--	--	--	--	--	--	0.1	0.03
BULLHEAD MINNOW	0.1	0.04	--	--	0.1	0.05	0.2	0.14	--	--	0.9	0.40	0.2	0.07
Pimephales sp.	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.03
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	0.1	0.04	--	--
RIVER CARPSUCKER	0.1	0.04	0.4	0.16	--	--	0.1	0.07	0.2	0.12	0.1	0.04	0.3	0.10
QUILLBACK	0.3	0.11	0.1	0.03	0.2	0.10	--	--	0.2	0.12	0.3	0.11	0.1	0.03
HIGHFIN CARPSUCKER	--	--	--	--	0.1	0.05	--	--	--	--	--	--	--	--
Carpiodes sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHITE SUCKER	0.1	0.04	0.7	0.25	0.2	0.10	--	--	--	--	--	--	--	--
SMALLMOUTH BUFFALO	3.3	1.44	3.3	1.25	2.6	1.59	1.6	1.32	2.8	2.03	2.4	1.05	1.8	0.74
BIGMOUTH BUFFALO	0.3	0.11	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BUFFALO	0.1	0.04	0.3	0.09	0.1	0.05	--	--	--	--	--	--	--	--
SPOTTED SUCKER	--	--	--	--	0.1	0.05	--	--	--	--	0.1	0.04	--	--
SILVER REDHORSE	0.1	0.04	--	--	0.1	0.05	--	--	0.3	0.24	--	--	--	--
GOLDEN REDHORSE	0.3	0.11	0.3	0.13	0.4	0.26	0.1	0.07	0.1	0.06	0.1	0.04	1.8	0.74
SHORTHEAD REDHORSE	0.1	0.04	0.3	0.09	--	--	--	--	0.1	0.06	0.1	0.04	0.2	0.07
Moxostoma sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	--	--	--	--	0.1	0.05	--	--	--	--	--	--	--	--
YELLOW BULLHEAD	0.4	0.18	0.6	0.22	0.5	0.31	0.3	0.28	0.2	0.12	1.1	0.47	0.6	0.24
CHANNEL CATFISH	2.8	1.22	7.3	2.76	6.3	3.90	2.7	2.23	4.2	2.99	6.2	2.69	3.1	1.25
TADPOLE MADTOM	--	--	--	--	--	--	--	--	0.1	0.06	--	--	0.2	0.07
FLATHEAD CATFISH	0.1	0.04	0.3	0.09	0.2	0.10	0.1	0.07	--	--	--	--	0.1	0.03
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	0.4	0.16	0.3	0.15	0.1	0.07	0.4	0.30	1.6	0.69	4.7	1.90
BROOK SILVERSIDE	0.1	0.04	--	--	--	--	0.1	0.07	--	--	0.2	0.07	0.3	0.10
WHITE BASS	--	--	0.1	0.03	--	--	--	--	0.1	0.06	--	--	--	--
YELLOW BASS	--	--	--	--	0.1	0.05	--	--	--	--	0.1	0.04	--	--
Morone sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ROCK BASS	0.2	0.07	0.1	0.03	--	--	0.1	0.07	0.1	0.06	0.2	0.07	0.2	0.07
GREEN SUNFISH	30.8	13.67	55.2	20.75	32.8	20.15	10.8	8.98	14.7	10.53	17.9	7.80	34.2	13.87
PUMPKINSEED	--	--	0.1	0.03	--	--	0.2	0.14	0.9	0.66	0.3	0.11	3.5	1.42
WARMOUTH	--	--	--	--	0.2	0.10	--	--	--	--	--	--	--	--
ORANGESPOTTED SUNFISH	0.5	0.22	2.3	0.88	1.6	0.97	0.3	0.21	0.7	0.48	1.8	0.80	3.3	1.32
BLUEGILL	27.3	12.12	41.6	15.64	32.7	20.10	18.8	15.74	20.0	14.36	20.3	8.86	29.8	12.12
NORTHERN SUNFISH	0.6	0.26	1.3	0.47	0.5	0.31	--	--	0.4	0.30	0.8	0.33	1.1	0.44
Lepomis HYBRID	6.0	2.66	26.0	9.78	16.4	10.10	4.0	3.34	6.8	4.91	6.5	2.83	6.3	2.54
Lepomis sp.	--	--	0.3	0.09	--	--	0.2	0.14	--	--	1.8	0.80	0.8	0.34
SMALLMOUTH BASS	1.5	0.67	2.4	0.91	1.7	1.03	0.4	0.35	0.5	0.36	3.3	1.42	2.7	1.08
LARGEMOUTH BASS	8.2	3.62	15.8	5.92	12.9	7.95	3.6	2.99	6.7	4.79	6.6	2.87	9.4	3.82
WHITE CRAPPIE	--	--	0.1	0.03	--	--	--	--	--	--	--	--	--	--
BLACK CRAPPIE	0.3	0.15	0.2	0.06	0.6	0.36	--	--	0.2	0.12	0.3	0.11	0.3	0.10
Pomoxis sp.	--	--	--	--	--	--	--	--	--	--	0.1	0.04	--	--
JOHNNY DARTER	--	--	0.1	0.03	--	--	--	--	--	--	--	--	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LOGPERCH	--	--	--	--	--	--	0.1	0.07	--	--	0.3	0.11	0.1	0.03
BLACKSIDE DARTER	--	--	--	--	--	--	--	--	--	--	0.1	0.04	0.6	0.24
SLENDERHEAD DARTER	0.1	0.04	--	--	--	--	--	--	--	--	--	--	--	--
SAUGER	0.1	0.04	--	--	--	--	--	--	--	--	--	--	--	--
WALLEYE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	3.0	1.33	3.4	1.29	2.1	1.28	1.6	1.32	2.1	1.50	2.7	1.16	1.8	0.71
TOTAL FISH	225.5	100.00	265.8	100.00	162.5	100.00	119.7	100.00	139.3	100.00	229.6	100.00	246.3	100.00
TOTAL SPECIES	36		35		35		28		29		36		38	

TABLE 2 (cont.)

SPECIES	2009		2010		2011		2012		2013		2014		2015	
	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%
LONGNOSE GAR	1.5	0.83	1.1	0.67	0.8	0.44	0.7	0.32	0.8	0.75	2.1	0.69	1.3	1.06
SHORTNOSE GAR	--	--	--	--	0.1	0.04	--	--	--	--	--	--	--	--
GAR sp.	--	--	0.1	0.05	--	--	--	--	--	--	--	--	--	--
BOWFIN	--	--	0.2	0.10	--	--	--	--	--	--	--	--	--	--
SKIPJACK HERRING	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GIZZARD SHAD	32.2	17.88	34.7	21.42	47.4	24.89	67.8	32.42	17.4	15.77	65.8	21.73	38.2	32.32
Dorosoma sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MOONEYE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CENTRAL MUDMINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS PICKEREL	0.1	0.05	--	--	0.1	0.04	--	--	0.1	0.08	0.5	0.17	0.1	0.07
NORTHERN PIKE	0.1	0.05	0.1	0.05	0.2	0.09	--	--	--	--	--	--	0.2	0.14
CENTRAL STONEROLLER	1.1	0.60	0.1	0.05	0.1	0.04	0.1	0.04	--	--	1.9	0.63	0.2	0.14
HORNYHEAD CHUB	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDEN SHINER	0.1	0.05	0.6	0.36	0.4	0.22	0.9	0.44	--	--	1.5	0.50	0.2	0.14
PALLID SHINER	--	--	0.1	0.05	--	--	0.1	0.04	--	--	--	--	--	--
EMERALD SHINER	6.5	3.61	2.3	1.44	1.3	0.66	1.8	0.88	0.8	0.75	2.3	0.74	0.7	0.56
GHOST SHINER	0.9	0.51	--	--	--	--	--	--	--	--	--	--	0.3	0.21
STRIPED SHINER	0.7	0.37	0.1	0.05	0.3	0.17	0.5	0.24	0.1	0.08	1.8	0.61	--	--
BIGMOUTH SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	2.8	1.57	1.3	0.82	0.3	0.13	0.3	0.12	0.1	0.08	6.2	2.04	2.3	1.91
ROSYFACE SHINER	--	--	--	--	--	--	--	--	0.1	0.08	0.3	0.11	--	--
SPOTFIN SHINER	2.1	1.16	1.0	0.62	1.4	0.74	2.9	1.39	0.9	0.83	5.6	1.84	0.3	0.28
SAND SHINER	0.3	0.19	--	--	--	--	0.2	0.08	--	--	1.1	0.36	--	--
REDFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.14
MIMIC SHINER	--	--	--	--	--	--	0.1	0.04	--	--	0.1	0.03	0.3	0.21
SUCKERMOUTH MINNOW	0.2	0.09	--	--	0.3	0.13	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	48.8	27.14	26.7	16.48	17.9	9.41	28.8	13.78	16.3	14.79	64.1	21.16	10.8	9.17
FATHEAD MINNOW	0.3	0.19	--	--	--	--	--	--	--	--	--	--	0.1	0.07
BULLHEAD MINNOW	0.3	0.14	--	--	--	--	--	--	--	--	--	--	--	--
Pimephales sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CREEK CHUB	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RIVER CARPSUCKER	0.1	0.05	0.3	0.15	0.3	0.13	--	--	0.2	0.15	0.8	0.25	1.0	0.85
QUILLBACK	0.1	0.05	0.2	0.10	0.2	0.09	0.1	0.04	0.1	0.08	0.1	0.03	0.3	0.28
HIGHFIN CARPSUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carpiodes sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHITE SUCKER	0.2	0.09	--	--	0.1	0.04	0.1	0.04	0.1	0.08	1.1	0.36	0.2	0.14
SMALLMOUTH BUFFALO	2.3	1.25	1.2	0.72	1.3	0.66	1.8	0.84	1.8	1.58	2.3	0.74	1.2	0.99
BIGMOUTH BUFFALO	--	--	--	--	--	--	--	--	--	--	0.2	0.06	0.2	0.14
BLACK BUFFALO	--	--	--	--	0.1	0.04	--	--	0.2	0.15	--	--	--	--
SPOTTED SUCKER	--	--	0.1	0.05	--	--	--	--	--	--	0.1	0.03	0.1	0.07
SILVER REDHORSE	0.1	0.05	0.1	0.05	0.1	0.04	0.3	0.12	--	--	0.1	0.03	0.2	0.14
GOLDEN REDHORSE	0.4	0.23	0.9	0.57	0.6	0.31	0.1	0.04	0.1	0.08	0.1	0.03	0.5	0.42
SHORTHEAD REDHORSE	0.1	0.05	0.1	0.05	0.2	0.09	0.3	0.12	0.3	0.23	0.2	0.06	0.3	0.28
Moxostoma sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW BULLHEAD	0.2	0.09	0.4	0.26	0.7	0.35	0.2	0.08	0.6	0.53	0.7	0.22	0.6	0.49
CHANNEL CATFISH	3.5	1.95	3.8	2.32	2.3	1.18	1.7	0.80	4.0	3.62	3.8	1.27	4.8	4.02
TADPOLE MADTOM	--	--	--	--	--	--	--	--	--	--	0.3	0.11	--	--
FLATHEAD CATFISH	--	--	0.1	0.05	0.1	0.04	--	--	--	--	0.4	0.14	--	--
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	0.3	0.08	0.1	0.07
BLACKSTRIPE TOPMINNOW	0.8	0.42	1.2	0.72	0.6	0.31	2.3	1.12	0.1	0.08	0.6	0.19	0.3	0.28
BROOK SILVERSIDE	0.1	0.05	0.1	0.05	0.1	0.04	0.1	0.04	0.1	0.08	1.7	0.55	--	--
WHITE BASS	--	--	0.1	0.05	--	--	0.1	0.04	--	--	--	--	--	--
YELLOW BASS	--	--	0.5	0.31	--	--	--	--	--	--	0.1	0.03	--	--
Morone sp.	--	--	--	--	--	--	--	--	--	--	1.5	0.50	--	--
ROCK BASS	--	--	0.5	0.31	0.2	0.09	0.2	0.08	0.4	0.38	0.4	0.14	0.3	0.21
GREEN SUNFISH	27.4	15.24	25.4	15.71	49.9	26.20	34.3	16.41	9.8	8.91	40.9	13.51	19.9	16.87
PUMPKINSEED	0.4	0.23	0.2	0.10	0.7	0.35	3.5	1.67	3.2	2.87	4.2	1.38	3.7	3.11
WARMOUTH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORANGESPOTTED SUNFISH	2.7	1.48	3.8	2.32	2.8	1.44	2.3	1.12	0.2	0.15	0.7	0.22	0.3	0.28
BLUEGILL	14.1	7.83	25.9	16.01	38.3	20.08	43.8	20.91	31.8	28.83	20.7	6.82	11.7	9.88
NORTHERN SUNFISH	0.6	0.32	0.6	0.36	0.3	0.13	0.9	0.44	0.5	0.45	2.8	0.91	1.7	1.41
Lepomis HYBRID	9.8	5.42	6.8	4.17	6.5	3.41	4.7	2.23	6.6	5.96	5.4	1.79	0.3	0.28
Lepomis sp.	0.9	0.51	0.1	0.05	3.0	1.57	0.5	0.24	0.3	0.30	0.8	0.28	0.1	0.07
SMALLMOUTH BASS	5.3	2.92	2.7	1.65	0.7	0.35	0.8	0.36	0.5	0.45	2.9	0.96	1.4	1.20
LARGEMOUTH BASS	10.3	5.70	16.9	10.45	10.1	5.29	6.1	2.91	10.9	9.89	50.6	16.70	11.2	9.46
WHITE CRAPPIE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK CRAPPIE	--	--	0.3	0.15	--	--	--	--	0.1	0.08	2.1	0.69	--	--
Pomoxis sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JOHNNY DARTER	--	--	--	--	--	--	--	--	--	--	0.5	0.17	--	--
YELLOW PERCH	0.1	0.05	--	--	--	--	--	--	0.1	0.08	--	--	--	--
LOGPERCH	0.3	0.14	0.4	0.26	0.3	0.13	0.1	0.04	0.1	0.08	1.0	0.33	0.3	0.21
BLACKSIDE DARTER	0.2	0.09	0.1	0.05	0.1	0.04	--	--	--	--	0.6	0.19	--	--
SLENDERHEAD DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAUGER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WALLEYE	0.1	0.05	0.1	0.05	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	2.4	1.34	1.2	0.72	1.1	0.57	1.2	0.56	1.9	1.74	2.1	0.69	2.8	2.40
TOTAL FISH	179.9	100.00	161.8	100.00	190.5	100.00	209.3	100.00	110.4	100.00	302.9	100.00	118.1	100.00
TOTAL SPECIES	39		39		37		33		32		43		37	

TABLE 2 (cont.)

SPECIES	2016 CPE	2016 %	2017 CPE	2017 %
LONGNOSE GAR	1.0	0.74	1.6	0.81
SHORTNOSE GAR	--	--	0.1	0.04
GAR sp.	--	--	0.1	0.04
BOWFIN	--	--	--	--
SKIPJACK HERRING	--	--	--	--
GIZZARD SHAD	29.2	21.67	40.0	20.37
Dorosoma sp.	--	--	--	--
MOONEYE	--	--	0.1	0.04
CENTRAL MUDMINNOW	0.1	0.06	--	--
GRASS PICKEREL	--	--	--	--
NORTHERN PIKE	0.1	0.06	--	--
CENTRAL STONEROLLER	--	--	0.2	0.08
HORNYHEAD CHUB	--	--	0.1	0.04
GOLDEN SHINER	0.3	0.25	1.0	0.51
PALLID SHINER	--	--	0.2	0.08
EMERALD SHINER	2.7	1.98	2.3	1.19
GHOST SHINER	--	--	--	--
STRIPED SHINER	0.3	0.19	1.3	0.64
BIGMOUTH SHINER	--	--	--	--
SPOTTAIL SHINER	2.1	1.55	0.4	0.21
ROSYFACE SHINER	0.6	0.43	1.1	0.55
SPOTFIN SHINER	2.3	1.73	0.3	0.13
SAND SHINER	0.3	0.25	0.1	0.04
REDFIN SHINER	--	--	--	--
MIMIC SHINER	--	--	0.2	0.08
SUCKERMOUTH MINNOW	0.1	0.06	0.4	0.21
BLUNTNOSE MINNOW	26.3	19.57	61.8	31.45
FATHEAD MINNOW	0.1	0.06	--	--
BULLHEAD MINNOW	--	--	0.1	0.04
Pimephales sp.	--	--	--	--
CREEK CHUB	--	--	--	--
RIVER CARPSUCKER	0.4	0.31	0.3	0.17
QUILLBACK	0.2	0.12	0.1	0.04
HIGHFIN CARPSUCKER	--	--	--	--
Carpiodes sp.	--	--	--	--
WHITE SUCKER	0.6	0.43	0.4	0.21
SMALLMOUTH BUFFALO	0.8	0.62	1.0	0.51
BIGMOUTH BUFFALO	--	--	--	--
BLACK BUFFALO	--	--	--	--
SPOTTED SUCKER	--	--	0.2	0.08
SILVER REDHORSE	--	--	--	--
GOLDEN REDHORSE	0.6	0.43	0.3	0.13
SHORTHEAD REDHORSE	0.4	0.31	1.4	0.72
Moxostoma sp.	--	--	--	--
BLACK BULLHEAD	--	--	--	--
YELLOW BULLHEAD	0.8	0.62	0.8	0.38
CHANNEL CATFISH	3.2	2.35	2.9	1.49
TADPOLE MADTOM	0.2	0.12	--	--
FLATHEAD CATFISH	0.1	0.06	0.1	0.04
BANDED KILLIFISH	1.0	0.74	1.5	0.76
BLACKSTRIPE TOPMINNOW	0.8	0.62	1.3	0.64
BROOK SILVERSIDE	0.1	0.06	0.4	0.21
WHITE BASS	--	--	--	--
YELLOW BASS	--	--	--	--
Morone sp.	--	--	--	--
ROCK BASS	0.2	0.12	1.5	0.76
GREEN SUNFISH	14.9	11.08	11.5	5.86
PUMPKINSEED	3.8	2.85	3.7	1.87
WARMOUTH	--	--	--	--
ORANGESPOTTED SUNFISH	1.1	0.80	0.4	0.21
BLUEGILL	17.1	12.69	26.4	13.46
NORTHERN SUNFISH	4.2	3.10	3.9	1.99
Lepomis HYBRID	2.4	1.80	2.8	1.40
Lepomis sp.	1.2	0.87	0.9	0.47
SMALLMOUTH BASS	1.2	0.87	6.1	3.10
LARGEMOUTH BASS	13.2	9.78	14.7	7.47
WHITE CRAPPIE	--	--	--	--
BLACK CRAPPIE	--	--	0.5	0.25
Pomoxis sp.	--	--	--	--
JOHNNY DARTER	--	--	0.3	0.17
YELLOW PERCH	0.1	0.06	--	--
LOGPERCH	0.2	0.12	0.9	0.47
BLACKSIDE DARTER	--	--	0.3	0.13
SLENDERHEAD DARTER	--	--	--	--
SAUGER	--	--	--	--
WALLEYE	--	--	--	--
FRESHWATER DRUM	0.6	0.43	0.8	0.42
TOTAL FISH	134.6	100.00	196.3	100.00
TOTAL SPECIES	38		44	

TABLE 3 INTERYEAR COMPARISONS OF ELECTROFISHING CATCHES (native species only) WITHIN THE FIVE-MILE STRETCH FOR THE PERIOD OF 15 JUNE THROUGH AUGUST.

SPECIES	1994		1995		1997		1998		1999		2000		2001	
	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%	CPE	%
SPOTTED GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LONGNOSE GAR	--	--	0.4	0.33	0.9	0.63	0.3	0.11	--	--	--	--	0.3	0.15
GAR sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SKIPJACK HERRING	0.5	0.26	--	--	0.1	0.09	0.3	0.11	0.4	0.20	--	--	0.6	0.38
GIZZARD SHAD	150.8	79.34	32.6	27.21	70.6	50.76	91.3	40.15	47.9	25.74	62.3	24.65	37.3	22.80
Dorosoma sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS PICKEREL	--	--	--	--	--	--	0.1	0.06	--	--	--	--	--	--
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CENTRAL STONEROLLER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDEN SHINER	--	--	0.2	0.17	--	--	--	--	0.1	0.07	0.3	0.10	0.4	0.23
PALLID SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER	3.3	1.71	--	--	6.4	4.58	5.3	2.31	2.1	1.15	0.9	0.35	11.5	7.04
GHOST SHINER	0.3	0.13	--	--	--	--	0.6	0.28	--	--	--	--	--	--
STRIPED SHINER	--	--	--	--	--	--	0.1	0.06	--	--	--	--	--	--
SPOTTAIL SHINER	0.8	0.39	2.4	2.00	0.6	0.45	2.4	1.05	0.5	0.27	8.4	3.32	1.9	1.15
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTFIN SHINER	0.3	0.13	--	--	0.6	0.45	0.4	0.17	1.8	0.94	0.5	0.20	3.3	1.99
SAND SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
REDFIN SHINER	--	--	--	--	--	--	0.1	0.06	--	--	--	--	--	--
MIMIC SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SUCKERMOUTH MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	1.8	0.92	8.8	7.35	4.9	3.50	19.4	8.53	16.6	8.89	22.5	8.91	25.4	15.53
FATHEAD MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BULLHEAD MINNOW	3.0	1.58	1.4	1.17	2.1	1.53	12.5	5.50	9.9	5.32	11.0	4.36	17.5	10.71
RIVER CARPSUCKER	0.8	0.39	2.0	1.67	1.5	1.08	0.8	0.33	0.8	0.40	1.0	0.40	0.4	0.23
QUILLBACK	1.0	0.53	1.8	1.50	1.0	0.72	0.3	0.11	0.6	0.34	0.4	0.15	1.0	0.61
WHITE SUCKER	--	--	0.4	0.33	--	--	0.1	0.06	--	--	--	--	--	--
SMALLMOUTH BUFFALO	1.5	0.79	2.8	2.34	2.6	1.89	1.8	0.77	4.0	2.16	3.1	1.24	3.5	2.14
BIGMOUTH BUFFALO	--	--	--	--	0.9	0.63	0.3	0.11	0.3	0.13	0.3	0.10	0.1	0.08
BLACK BUFFALO	--	--	0.4	0.33	--	--	--	--	--	--	0.3	0.10	--	--
Ictiobus sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTED SUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SILVER REDHORSE	0.3	0.13	0.4	0.33	--	--	--	--	--	--	--	--	0.1	0.08
BLACK REDHORSE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDEN REDHORSE	0.8	0.39	3.4	2.84	1.4	0.99	2.5	1.10	0.4	0.20	--	--	0.3	0.15
SHORTHEAD REDHORSE	1.3	0.66	3.4	2.84	0.8	0.54	0.6	0.28	0.5	0.27	0.3	0.10	0.1	0.08
ICTIOBINAE sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW BULLHEAD	0.5	0.26	--	--	0.3	0.18	0.3	0.11	0.5	0.27	1.0	0.40	0.4	0.23
CHANNEL CATFISH	0.3	0.13	1.2	1.00	1.8	1.26	0.6	0.28	1.0	0.54	1.4	0.54	1.4	0.84
Ameiurus sp.	--	--	--	--	--	--	--	--	0.1	0.07	--	--	--	--
TADPOLE MADTOM	--	--	--	--	--	--	0.1	0.06	--	--	0.1	0.05	--	--
FLATHEAD CATFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	--	--	0.1	0.09	0.1	0.06	--	--	0.3	0.10	0.1	0.08
BROOK SILVERSIDE	--	--	--	--	0.1	0.09	0.1	0.06	0.3	0.13	--	--	0.4	0.23
WHITE BASS	--	--	--	--	--	--	0.1	0.06	0.1	0.07	0.1	0.05	--	--
YELLOW BASS	--	--	0.4	0.33	0.1	0.09	0.1	0.06	--	--	--	--	--	--
Morone sp.	0.5	0.26	--	--	--	--	--	--	0.1	0.07	--	--	--	--
ROCK BASS	--	--	--	--	0.1	0.09	--	--	--	--	--	--	--	--
GREEN SUNFISH	3.0	1.58	2.0	1.67	3.5	2.52	7.1	3.14	8.2	4.38	18.4	7.28	5.1	3.14
PUMPKINSEED	--	--	0.2	0.17	--	--	0.8	0.33	0.1	0.07	--	--	--	--
WARMOUTH	--	--	--	--	--	--	--	--	--	--	0.1	0.05	--	--
ORANGESPOTTED SUNFISH	4.5	2.37	14.4	12.02	15.6	11.23	31.5	13.86	20.6	11.05	16.6	6.58	5.8	3.52
BLUEGILL	1.8	0.92	8.2	6.84	12.1	8.72	30.0	13.20	49.2	26.42	82.6	32.72	35.8	21.88
NORTHERN SUNFISH	0.3	0.13	--	--	--	--	--	--	--	--	0.1	0.05	0.1	0.08
Lepomis HYBRID	--	--	--	--	0.1	0.09	0.4	0.17	1.1	0.61	1.5	0.59	0.9	0.54
Lepomis sp.	0.8	0.39	20.0	16.69	--	--	--	--	--	--	0.3	0.10	--	--
SMALLMOUTH BASS	1.0	0.53	3.6	3.01	1.1	0.81	2.1	0.94	0.8	0.40	1.5	0.59	0.6	0.38
LARGEMOUTH BASS	1.0	0.53	4.4	3.67	4.5	3.23	10.3	4.51	13.3	7.14	13.4	5.30	6.4	3.90
WHITE CRAPPIE	--	--	--	--	--	--	0.4	0.17	0.3	0.13	0.4	0.15	--	--
BLACK CRAPPIE	--	--	0.2	0.17	0.3	0.18	0.4	0.17	0.4	0.20	1.0	0.40	0.1	0.08
JOHNNY DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LOGPERCH	--	--	0.8	0.67	1.3	0.90	0.5	0.22	1.0	0.54	0.1	0.05	0.5	0.31
BLACKSIDE DARTER	--	--	--	--	--	--	--	--	0.1	0.07	--	--	--	--
SLENDERHEAD DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	10.5	5.53	4.0	3.34	3.8	2.70	3.5	1.54	3.3	1.75	2.6	1.04	2.4	1.45
TOTAL FISH	190.0	100.00	119.8	100.00	139.1	100.00	227.3	100.00	186.2	100.00	252.5	100.00	163.4	100.00
TOTAL SPECIES	24		25		28		36		29		29		29	

TABLE 3 (cont.)

SPECIES	2002 CPE	2002 %	2003 CPE	2003 %	2004 CPE	2004 %	2005 CPE	2005 %	2006 CPE	2006 %	2007 CPE	2007 %	2008 CPE	2008 %
SPOTTED GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LONGNOSE GAR	0.9	0.25	0.3	0.03	--	--	0.5	0.12	0.1	0.03	1.0	0.33	0.8	0.17
GAR sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SKIPJACK HERRING	0.3	0.07	--	--	0.3	0.10	0.1	0.03	--	--	--	--	--	--
GIZZARD SHAD	80.9	23.21	78.6	9.96	38.6	15.94	217.3	54.21	115.4	29.78	76.6	25.51	56.5	12.94
Dorosoma sp.	--	--	194.4	24.63	--	--	--	--	--	--	--	--	--	--
GRASS PICKEREL	--	--	--	--	--	--	0.4	0.09	--	--	--	--	0.1	0.03
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CENTRAL STONEROLLER	--	--	--	--	--	--	--	--	--	--	0.1	0.04	0.1	0.03
GOLDEN SHINER	0.5	0.14	0.8	0.10	0.3	0.10	1.5	0.37	--	--	0.1	0.04	1.3	0.29
PALLID SHINER	--	--	1.0	0.13	0.3	0.10	--	--	0.3	0.07	--	--	--	--
EMERALD SHINER	26.9	7.71	1.5	0.19	5.0	2.06	2.3	0.56	20.5	5.29	1.9	0.62	4.3	0.97
GHOST SHINER	--	--	0.3	0.03	--	--	--	--	1.2	0.30	0.4	0.12	0.4	0.09
STRIPED SHINER	--	--	--	--	--	--	0.3	0.06	0.8	0.20	--	--	0.6	0.14
SPOTTAIL SHINER	2.4	0.68	6.1	0.78	0.5	0.21	1.8	0.44	2.2	0.56	3.8	1.25	11.3	2.58
ROSYFACE SHINER	--	--	1.9	0.24	--	--	--	--	--	--	--	--	--	--
SPOTFIN SHINER	2.1	0.61	4.5	0.57	1.4	0.57	2.9	0.72	4.1	1.06	3.3	1.08	3.6	0.83
SAND SHINER	0.1	0.04	--	--	--	--	--	--	--	--	0.4	0.12	--	--
REDFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MIMIC SHINER	--	--	4.8	0.60	--	--	--	--	--	--	--	--	0.3	0.06
Notropis sp.	--	--	0.1	0.02	--	--	--	--	0.1	0.03	--	--	0.1	0.03
SUCKERMOUTH MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	26.6	7.64	151.5	19.20	19.5	8.05	32.3	8.05	43.2	11.15	108.8	36.20	67.6	15.48
FATHEAD MINNOW	--	--	1.1	0.14	--	--	0.1	0.03	--	--	--	--	0.4	0.09
BULLHEAD MINNOW	3.1	0.90	8.5	1.08	2.6	1.08	5.1	1.28	11.8	3.04	4.4	1.46	15.4	3.52
RIVER CARPSUCKER	0.5	0.14	0.4	0.05	1.5	0.62	1.0	0.25	0.6	0.17	1.0	0.33	0.9	0.20
QUILLBACK	0.4	0.11	0.3	0.03	0.3	0.10	1.3	0.31	0.5	0.13	0.3	0.08	0.4	0.09
WHITE SUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SMALLMOUTH BUFFALO	4.4	1.26	2.3	0.29	2.8	1.14	1.6	0.41	1.7	0.43	2.3	0.75	1.9	0.43
BIGMOUTH BUFFALO	0.4	0.11	0.1	0.02	--	--	0.1	0.03	--	--	--	--	0.3	0.06
BLACK BUFFALO	--	--	0.6	0.08	--	--	0.3	0.06	--	--	--	--	0.1	0.03
Ictiobus sp.	--	--	--	--	--	--	--	--	--	--	0.3	0.08	--	--
SPOTTED SUCKER	0.1	0.04	--	--	--	--	--	--	--	--	--	--	--	--
SILVER REDHORSE	--	--	--	--	0.3	0.10	0.4	0.09	0.1	0.03	0.1	0.04	--	--
BLACK REDHORSE	0.1	0.04	--	--	--	--	--	--	0.1	0.03	--	--	--	--
GOLDEN REDHORSE	1.1	0.32	4.3	0.54	0.5	0.21	0.3	0.06	3.5	0.89	0.9	0.29	5.4	1.23
SHORTHEAD REDHORSE	0.1	0.04	0.3	0.03	--	--	--	--	0.1	0.03	--	--	--	--
ICTIOBINAE sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	--	--	0.1	0.02	--	--	--	--	--	--	--	--	--	--
YELLOW BULLHEAD	0.5	0.14	0.8	0.10	0.3	0.10	--	--	0.3	0.07	--	--	0.4	0.09
CHANNEL CATFISH	3.9	1.11	5.1	0.65	2.9	1.19	1.6	0.41	1.8	0.46	1.4	0.46	2.1	0.49
Ameiurus sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TADPOLE MADTOM	--	--	0.1	0.02	--	--	--	--	0.3	0.07	--	--	0.9	0.20
FLATHEAD CATFISH	--	--	--	--	0.1	0.05	--	--	--	--	--	--	--	--
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	0.1	0.04	0.3	0.03	0.5	0.21	0.1	0.03	0.3	0.07	0.8	0.25	0.3	0.06
BROOK SILVERSIDE	0.9	0.25	1.4	0.17	0.5	0.21	0.9	0.22	1.3	0.33	1.5	0.50	5.6	1.29
WHITE BASS	0.1	0.04	0.8	0.10	0.1	0.05	--	--	--	--	--	--	--	--
YELLOW BASS	0.1	0.04	0.1	0.02	0.1	0.05	--	--	--	--	--	--	0.6	0.14
Morone sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ROCK BASS	--	--	0.1	0.02	0.1	0.05	0.4	0.09	0.4	0.10	0.1	0.04	0.8	0.17
GREEN SUNFISH	29.1	8.36	56.6	7.17	36.8	15.17	18.1	4.52	21.4	5.53	18.6	6.20	28.3	6.47
PUMPKINSEED	0.4	0.11	0.9	0.11	0.3	0.10	0.1	0.03	--	--	--	--	0.1	0.03
WARMOUTH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORANGESPOTTED SUNFISH	27.8	7.97	89.9	11.39	10.1	4.18	5.5	1.37	18.2	4.70	4.9	1.62	26.1	5.98
BLUEGILL	115.3	33.08	138.4	17.53	85.3	35.19	87.0	21.71	108.7	28.06	49.1	16.35	153.3	35.09
NORTHERN SUNFISH	--	--	0.1	0.02	--	--	0.4	0.09	0.5	0.13	0.4	0.12	4.1	0.94
Lepomis HYBRID	1.4	0.39	2.5	0.32	2.1	0.88	2.0	0.50	3.1	0.79	1.8	0.58	2.4	0.54
Lepomis sp.	--	--	1.0	0.13	0.1	0.05	0.3	0.06	1.8	0.46	0.5	0.17	10.1	2.32
SMALLMOUTH BASS	1.8	0.50	4.3	0.54	2.8	1.14	0.5	0.12	0.8	0.20	0.9	0.29	3.9	0.89
LARGEMOUTH BASS	12.1	3.48	18.9	2.39	21.0	8.67	11.5	2.87	19.4	5.00	12.5	4.16	20.3	4.64
WHITE CRAPPIE	0.3	0.07	0.4	0.05	0.1	0.05	--	--	--	--	0.1	0.04	--	--
BLACK CRAPPIE	0.4	0.11	0.5	0.06	0.5	0.21	0.1	0.03	0.3	0.07	0.1	0.04	0.3	0.06
JOHNNY DARTER	--	--	--	--	--	--	--	--	--	--	--	--	0.3	0.06
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LOGPERCH	0.9	0.25	0.4	0.05	1.0	0.41	1.1	0.28	1.2	0.30	1.3	0.42	4.5	1.03
BLACKSIDE DARTER	--	--	0.6	0.08	0.1	0.05	--	--	--	--	--	--	0.1	0.03
SLENDERHEAD DARTER	0.1	0.04	0.1	0.02	--	--	0.1	0.03	--	--	--	--	0.1	0.03
FRESHWATER DRUM	2.5	0.72	2.6	0.33	3.9	1.60	1.8	0.44	1.7	0.43	1.1	0.37	0.9	0.20
TOTAL FISH	348.4	100.00	789.3	100.00	242.3	100.00	400.8	100.00	387.4	100.00	300.4	100.00	436.8	100.00
TOTAL SPECIES	35		42		33		34		32		30		40	

TABLE 3 (cont.)

SPECIES	2009 CPE	2009 %	2010 CPE	2010 %	2011 CPE	2011 %	2012 CPE	2012 %	2013 CPE	2013 %	2014 CPE	2014 %	2015 CPE	2015 %
SPOTTED GAR	--	--	--	--	--	--	--	--	0.1	0.08	--	--	--	--
LONGNOSE GAR	0.4	0.18	1.1	0.38	1.0	0.33	0.3	0.11	0.1	0.08	1.8	0.47	0.1	0.10
GAR sp.	--	--	--	--	--	--	--	--	--	--	0.1	0.03	--	--
SKIPJACK HERRING	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GIZZARD SHAD	14.4	7.01	67.9	22.76	121.3	40.23	55.3	23.21	19.1	12.33	96.4	25.78	19.0	14.63
Dorosoma sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GRASS PICKEREL	0.9	0.43	--	--	0.5	0.17	--	--	--	--	--	--	0.3	0.19
NORTHERN PIKE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CENTRAL STONEROLLER	0.5	0.24	--	--	--	--	--	--	--	--	--	--	--	--
GOLDEN SHINER	0.1	0.06	0.9	0.29	0.5	0.17	2.1	0.89	0.3	0.16	14.3	3.81	0.4	0.29
PALLID SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER	0.8	0.37	0.5	0.17	--	--	--	--	0.1	0.08	0.1	0.03	--	--
GHOST SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
STRIPED SHINER	0.3	0.12	0.1	0.04	0.4	0.12	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	2.0	0.98	4.3	1.42	1.6	0.54	0.8	0.32	0.1	0.08	2.1	0.57	3.3	2.50
ROSYFACE SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTFIN SHINER	2.9	1.40	2.0	0.67	1.1	0.37	0.1	0.05	0.3	0.16	1.1	0.30	0.1	0.10
SAND SHINER	--	--	--	--	--	--	0.3	0.11	--	--	--	--	--	--
REDFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MIMIC SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SUCKERMOUTH MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	44.0	21.45	36.4	12.20	8.8	2.90	13.5	5.67	8.9	5.72	51.8	13.84	14.4	11.07
FATHEAD MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BULLHEAD MINNOW	0.3	0.12	1.9	0.63	1.4	0.46	2.3	0.95	0.5	0.32	0.3	0.07	--	--
RIVER CARPSUCKER	0.4	0.18	0.3	0.08	--	--	--	--	0.3	0.16	--	--	--	--
QUILLBACK	0.5	0.24	0.1	0.04	0.5	0.17	0.1	0.05	0.1	0.08	0.3	0.07	0.1	0.10
WHITE SUCKER	--	--	--	--	--	--	--	--	--	--	0.4	0.10	--	--
SMALLMOUTH BUFFALO	0.6	0.30	1.1	0.38	0.9	0.29	0.8	0.32	0.9	0.56	1.3	0.33	0.5	0.38
BIGMOUTH BUFFALO	--	--	--	--	0.3	0.08	0.3	0.11	--	--	--	--	--	--
BLACK BUFFALO	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTED SUCKER	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.10
SILVER REDHORSE	--	--	0.1	0.04	--	--	--	--	--	--	--	--	--	--
BLACK REDHORSE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDEN REDHORSE	1.6	0.79	2.9	0.96	1.1	0.37	0.5	0.21	0.5	0.32	0.6	0.17	0.5	0.38
SHORTHEAD REDHORSE	0.8	0.37	0.1	0.04	0.1	0.04	--	--	--	--	--	--	--	--
ICTIOBINAE sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW BULLHEAD	0.5	0.24	0.4	0.13	0.4	0.12	0.9	0.37	0.5	0.32	0.8	0.20	0.1	0.10
CHANNEL CATFISH	1.1	0.55	1.0	0.34	0.9	0.29	0.8	0.32	1.4	0.89	0.6	0.17	1.3	0.96
Ameiurus sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TADPOLE MADTOM	0.1	0.06	0.6	0.21	0.5	0.17	--	--	--	--	--	--	--	--
FLATHEAD CATFISH	--	--	--	--	--	--	--	--	0.1	0.08	--	--	--	--
BANDED KILLIFISH	--	--	--	--	--	--	--	--	--	--	--	--	0.3	0.19
BLACKSTRIPE TOPMINNOW	0.6	0.30	2.0	0.67	1.0	0.33	0.4	0.16	--	--	1.6	0.43	1.1	0.87
BROOK SILVERSIDE	3.1	1.52	2.8	0.92	8.5	2.82	0.8	0.32	0.3	0.16	17.5	4.68	9.1	7.03
WHITE BASS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW BASS	--	--	--	--	--	--	--	--	0.3	0.16	--	--	--	--
Morone sp.	--	--	0.1	0.04	--	--	--	--	--	--	1.3	0.33	--	--
ROCK BASS	1.5	0.73	2.8	0.92	2.3	0.75	0.5	0.21	--	--	1.1	0.30	0.3	0.19
GREEN SUNFISH	19.5	9.51	22.0	7.38	20.9	6.93	11.3	4.73	17.3	11.12	12.3	3.28	6.6	5.10
PUMPKINSEED	--	--	--	--	0.1	0.04	0.3	0.11	1.1	0.73	19.6	5.25	9.3	7.12
WARMOUTH	0.1	0.06	--	--	--	--	--	--	--	--	0.1	0.03	0.1	0.10
ORANGESPOTTED SUNFISH	14.4	7.01	43.0	14.42	7.0	2.32	15.6	6.57	0.6	0.40	6.8	1.81	7.4	5.68
BLUEGILL	50.1	24.44	48.8	16.35	84.0	27.87	109.3	45.90	78.9	50.85	52.1	13.94	23.1	17.81
NORTHERN SUNFISH	1.1	0.55	0.6	0.21	0.4	0.12	0.3	0.11	1.1	0.73	2.6	0.70	1.3	0.96
Lepomis HYBRID	4.6	2.25	0.9	0.29	1.1	0.37	1.4	0.58	1.1	0.73	0.8	0.20	0.1	0.10
Lepomis sp.	6.0	2.93	1.3	0.42	5.3	1.74	13.5	5.67	1.4	0.89	1.6	0.43	0.4	0.29
SMALLMOUTH BASS	2.1	1.04	1.5	0.50	1.9	0.62	--	--	0.5	0.32	0.6	0.17	0.6	0.48
LARGEMOUTH BASS	21.3	10.36	43.1	14.46	23.0	7.63	6.6	2.78	17.9	11.52	74.6	19.96	26.9	20.69
WHITE CRAPPIE	--	--	--	--	--	--	--	--	--	--	--	--	0.4	0.29
BLACK CRAPPIE	0.3	0.12	0.3	0.08	0.1	0.04	--	--	--	--	--	--	0.4	0.29
JOHNNY DARTER	--	--	--	--	--	--	--	--	--	--	0.1	0.03	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	0.3	0.07	--	--
LOGPERCH	5.4	2.62	6.5	2.18	4.1	1.37	0.1	0.05	0.8	0.48	8.3	2.21	2.4	1.83
BLACKSIDE DARTER	0.3	0.12	0.1	0.04	--	--	--	--	--	--	0.1	0.03	--	--
SLENDERHEAD DARTER	0.3	0.12	--	--	--	--	--	--	--	--	0.1	0.03	--	--
FRESHWATER DRUM	2.5	1.22	1.0	0.34	0.6	0.21	0.4	0.16	0.8	0.48	0.6	0.17	0.1	0.10
TOTAL FISH	205.1	100.00	298.3	100.00	301.4	100.00	238.0	100.00	155.1	100.00	373.9	100.00	129.9	100.00
TOTAL SPECIES	34		32		30		25		27		32		29	

TABLE 3 (cont.)

SPECIES	2016 CPE	2016 %	2017 CPE	2017 %
SPOTTED GAR	--	--	--	--
LONGNOSE GAR	0.9	0.77	0.5	0.11
GAR sp.	--	--	--	--
SKIPJACK HERRING	--	--	--	--
GIZZARD SHAD	30.5	26.73	231.1	56.97
Dorosoma sp.	--	--	--	--
GRASS PICKEREL	0.1	0.11	--	--
NORTHERN PIKE	0.1	0.11	--	--
CENTRAL STONEROLLER	--	--	0.2	0.04
GOLDEN SHINER	2.1	1.86	13.2	3.25
PALLID SHINER	--	--	--	--
EMERALD SHINER	--	--	--	--
GHOST SHINER	--	--	--	--
STRIPED SHINER	--	--	0.2	0.04
SPOTTAIL SHINER	1.3	1.10	0.2	0.04
ROSYFACE SHINER	--	--	--	--
SPOTFIN SHINER	0.1	0.11	1.1	0.27
SAND SHINER	--	--	--	--
REDFIN SHINER	--	--	--	--
MIMIC SHINER	--	--	--	--
Notropis sp.	--	--	--	--
SUCKERMOUTH MINNOW	--	--	0.5	0.11
BLUNTNOSE MINNOW	2.4	2.08	34.2	8.42
FATHEAD MINNOW	--	--	--	--
BULLHEAD MINNOW	0.3	0.22	1.2	0.31
RIVER CARPSUCKER	0.1	0.11	0.2	0.04
QUILLBACK	--	--	0.2	0.04
WHITE SUCKER	--	--	0.3	0.08
SMALLMOUTH BUFFALO	0.8	0.66	0.9	0.23
BIGMOUTH BUFFALO	--	--	--	--
BLACK BUFFALO	--	--	--	--
Ictiobus sp.	--	--	--	--
SPOTTED SUCKER	0.1	0.11	--	--
SILVER REDHORSE	--	--	--	--
BLACK REDHORSE	--	--	--	--
GOLDEN REDHORSE	0.5	0.44	0.2	0.04
SHORTHEAD REDHORSE	--	--	0.8	0.19
ICTIOBINAE sp.	--	--	0.2	0.04
BLACK BULLHEAD	0.1	0.11	--	--
YELLOW BULLHEAD	1.5	1.31	0.3	0.08
CHANNEL CATFISH	0.4	0.33	0.6	0.15
Ameiurus sp.	--	--	--	--
TADPOLE MADTOM	0.1	0.11	--	--
FLATHEAD CATFISH	--	--	0.2	0.04
BANDED KILLIFISH	0.4	0.33	1.4	0.34
BLACKSTRIPE TOPMINNOW	0.8	0.66	0.9	0.23
BROOK SILVERSIDE	0.6	0.55	5.9	1.45
WHITE BASS	--	--	--	--
YELLOW BASS	--	--	--	--
Morone sp.	--	--	--	--
ROCK BASS	0.3	0.22	0.9	0.23
GREEN SUNFISH	2.9	2.52	7.0	1.72
PUMPKINSEED	7.9	6.90	13.2	3.25
WARMOUTH	--	--	--	--
ORANGESPOTTED SUNFISH	1.5	1.31	0.9	0.23
BLUEGILL	37.5	32.86	51.6	12.71
NORTHERN SUNFISH	0.9	0.77	1.9	0.46
Lepomis HYBRID	0.3	0.22	0.2	0.04
Lepomis sp.	6.3	5.48	20.8	5.13
SMALLMOUTH BASS	1.1	0.99	2.8	0.69
LARGEMOUTH BASS	10.8	9.42	9.2	2.26
WHITE CRAPPIE	--	--	--	--
BLACK CRAPPIE	0.1	0.11	--	--
JOHNNY DARTER	--	--	0.2	0.04
YELLOW PERCH	0.1	0.11	--	--
LOGPERCH	1.0	0.88	2.3	0.57
BLACKSIDE DARTER	--	--	--	--
SLENDERHEAD DARTER	--	--	--	--
FRESHWATER DRUM	0.5	0.44	0.6	0.15
TOTAL FISH	114.1	100.00	405.6	100.00
TOTAL SPECIES	32		33	

EXHIBIT E

United States Environmental Protection Agency
Office of Water Mail Code 4305T
EPA-820-F-13-012 March 2013

Discharger-specific Variances on a Broader Scale: Developing Credible Rationales for Variances that Apply to Multiple Dischargers

Frequently Asked Questions

DISCLAIMER

These Frequently Asked Questions (FAQs) do not impose legally binding requirements on the EPA, states, tribes or the regulated community, nor do they confer legal rights or impose legal obligations upon any member of the public. The Clean Water Act (CWA) provisions and the EPA regulations described in this document contain legally binding requirements. These FAQs do not constitute a regulation, nor do they change or substitute for any CWA provision or the EPA regulations.

The general description provided here may not apply to a particular situation based upon the circumstances. Interested parties are free to raise questions and objections about the substance of these FAQs and the appropriateness of their application to a particular situation. The EPA retains the discretion to adopt approaches on a case-by-case basis that differ from those described in these FAQs where appropriate. These FAQs are a living document and may be revised periodically without public notice. The EPA welcomes public input on these FAQs at any time.

1. Why is the EPA issuing these FAQs?

The EPA is issuing these FAQs to help address questions that arise when states and tribes[1] seek to streamline the adoption and approval of water quality standards (WQS) variances for pollutants that have an impact on multiple permittees (or dischargers). This occurs when groups of permittees are experiencing the same challenges in meeting their water quality based effluent limits (WQBELs) for the same pollutant, regardless of whether or not the permittees are located on the same waterbody. States and tribes that want to find ways to both improve the efficiency of their WQS adoption and approval process, and provide permittees with as much certainty as possible regarding their ultimate discharge requirements, may find these FAQs particularly helpful. While the EPA realizes there may be further questions about the implementation of multiple discharger variances, these FAQs

[1] "Tribal" and "tribes" refers to tribes authorized for treatment in a manner similar to a state (TAS) under section 518 of the Clean Water Act (CWA) for purposes of CWA section 303(c) water quality standards (WQS).

are designed to help states and tribes evaluate the appropriateness of using a multiple discharger variance approach.

The federal water quality standards regulations at 40 CFR 131 and the federal permitting regulations at 40 CFR 122 provide for a number of tools for states and tribes that offer regulatory flexibility when implementing water quality management programs. These tools include site-specific criteria, revisions to designated uses, dilution allowances, permit compliance schedules, and WQS variances. Which regulatory tool is appropriate depends upon the circumstances.

2. What is a water quality standards variance?

A water quality standards variance is a time limited designated use and criterion (i.e., interim requirements) that is targeted to a specific pollutant(s), source(s), and/or waterbody segment(s) that reflects the highest attainable condition[2] during the specified time period. As such, a variance requires a public process and EPA review and approval under CWA 303(c). While the designated use and criterion reflect what is ultimately attainable, the variance reflects the highest attainable condition for a specific timeframe and is therefore less stringent.[3] However, a state or tribe may adopt such interim requirements only if it is able to demonstrate that it is not feasible to attain the currently applicable designated use and criterion during the period of the variance due to one of the factors listed at 40 CFR 131.10(g).[4] Where the currently applicable designated use and criterion are not being met, WQS variances that reflect a less stringent, time limited designated use and criterion allow states, tribes and stakeholders additional time to implement adaptive management approaches to improve water quality, but still retain the currently applicable designated use as a long term goal for the waterbody. States have adopted, and EPA has approved, water quality standards variances that apply to individual dischargers, variances that apply to multiple dischargers, and variances that apply to entire waterbodies or segments.

The interim requirements specified in the variance apply only for CWA section 402 permitting purposes and in issuing certifications under section 401 of the Act for the pollutant(s), permittee(s) and /or waterbody or water body segment(s) covered by the variance. Specifically, the variance serves as the basis for the WQBEL in National Pollutant Discharge Elimination System (NPDES) permits. However, the interim requirements *do not replace* the designated use and criteria for the water body as a whole, therefore, any implementation of CWA section 303(d) to list impaired waters must continue to be based on the designated uses and criteria for the waterbody rather than the interim requirements.

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[2] The highest attainable condition is the condition that is both feasible to attain and is closest to the protection afforded by the designated use and criteria.

[3] While variances are described as “time limited” and designated uses are implied to be “permanent,” 40 CFR 131.20 requires that states and tribes hold public hearings for the purpose of reviewing the applicable water quality standards, including designated uses, and modifying them as appropriate.

[4] See Section 5.3 of the *Water Quality Standards Handbook EPA 823 B 94 005a, August 1994; Advanced Notice of Proposed Rule Making, Water Quality Standards Regulation, July 7, 1998 63 FR 36759.*

3. When might a state or tribe want to adopt a WQS variance?

Many states and tribes have found that WQS variances are useful to consider when there is a new or more stringent effluent limit[5] as long as the state or tribe can also provide a demonstration that attaining the designated use and criterion is not feasible for the term of the variance, but the designated use and criterion may be attainable in the longer term. Example situations of when a variance may be appropriate include when:

- Attaining the designated use and criterion is not feasible under the current conditions (e.g., water quality-based controls required to meet the numeric nutrient criterion would result in substantial and widespread social and economic impact) but could be feasible should circumstances related to the attainability determination change (e.g., development of less expensive pollution control technology or a change in local economic conditions); or
- The state or tribe does not know whether the designated use and criterion may ultimately be attainable, but feasible progress toward attaining the designated use and criterion can still be made by implementing known controls and tracking environmental improvements (e.g., complex use attainability challenges involving legacy pollutants).

Properly applied, a WQS variance can lead to improved water quality over the duration of the variance and, in some cases, full attainment of designated uses due to advances in treatment technologies, control practices, or other changes in circumstances, thereby furthering the objectives of the CWA.

4. What is the legal basis for a WQS variance?

The CWA specifies an interim goal that, "wherever attainable," water quality provide for the protection and propagation of fish, shellfish, and wildlife and provide for recreation in and on the water. In implementing the CWA, the regulation at 40 CFR 131.10 establishes how a state or tribe may demonstrate that uses specified in CWA section 101(a)(2) or subcategories of such uses are not feasible to attain. In 1977, an EPA Office of General Counsel legal opinion considered the practice of temporarily downgrading the WQS as it applies to a specific permittee rather than permanently downgrading an entire water body or waterbody segment(s) and determined that such a practice is acceptable as long as it is adopted consistent with the substantive requirements for permanently downgrading a designated use. In other words, a state or tribe may change the standard in a more targeted way than a designated use change, so long as the state or tribe is able to show that achieving the standard is "unattainable" for the term of the variance. The state practice described in the Office of General Counsel legal opinion became known as adopting a "variance" to a water quality standard.

The EPA's regulation at 40 CFR 131.13 provides that variance policies are general policies affecting the application and implementation of WQS and that states and tribes may include variance policies in their state and tribal standards, at their discretion.[6] The EPA interprets its

[5] For example, when dischargers are faced with new or revised criteria, and/or when a reasonable potential analysis shows the need for a water quality based effluent limit.

[6] Section 40 CFR 131.13 further provides that such policies are subject to EPA review and approval.

regulation to authorize the use of a WQS variance where a state or tribe meets the same procedural and substantive requirements as removing a designated use. Therefore, variances can be granted based on any one of the six factors listed at 40 CFR 131.10(g).

5. What are the factors a state or tribe can use to justify the need for a water quality standards variance?

As provided in §131.10(g), states and tribes "may remove a designated use which is *not* an existing use, as defined in 40 CFR 131.3, or establish sub-categories of a use if the state or tribe can demonstrate that attaining the designated use is not feasible because:

(1) Naturally occurring pollutant concentrations prevent the attainment of the use; or

(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or

(3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or

(5) Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or

(6) Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact."

6. What is a Multiple Discharger Variance?

If a state or tribe believes that the designated use and criterion are unattainable as they apply to multiple permittees because they are all experiencing challenges in meeting their WQBELs for the same pollutant(s) for the same reason, regardless of whether or not they are located on the same waterbody, a state or tribe may streamline its WQS variance process. To do so, the state or tribe would adopt one variance that applies to all of these permittees (i.e., a multiple discharger variance) so long as the variance is consistent with the CWA and implementing regulation at 40 CFR 131.10 (for example, all the dischargers in the group cannot meet the required WQBEL to protect aquatic life for a period of time due to substantial and widespread economic and social impact).

The EPA recognized the utility of a multiple discharger variance, and its distinction from an individual discharger WQS variance in the "Water Quality Guidance for the Great Lakes System: Supplementary Information Document" (SID; EPA–820–B–95–001; March 1995, p.

238). The EPA also spoke to the use of multiple discharger variances in the "Water Quality Standards for the State of Florida's Lakes and Flowing Waters; Final Rule." 75 Fed. Reg. 75762, 75790 (December 6, 2010). It is important to note that multiple discharger variances may not be appropriate or practical for all situations, and may be highly dependent on the parameters considered and the number of affected permittees.

7. What should a state or tribe keep in mind when justifying the need for a multiple discharger variance?

In developing an analysis to justify the need for a multiple discharger variance, states and tribes should consider the following three principles. The variance and the justification:

(1) Must meet the same 40 CFR 131 regulatory requirements as an individual discharger WQS variance, and should consider any EPA guidance. Specifically, the state or tribe must fully demonstrate that a factor listed in 40 CFR 131.10(g) precludes attainment of a use specified in CWA 101(a)(2) for the entire variance period. When using 40 CFR 131.10(g)(6), this means that the documentation provided to support the variance must address both the substantial AND widespread components of the economic and social impacts of attaining the designated use and criterion.

(2) Should ensure that any overall demonstration is conducted in a manner that accounts for as much individual permittee information as possible. A permittee that could not qualify for an individual WQS variance should not qualify for a multiple discharger variance. The demonstration should:

- Apply only to permittees experiencing the same challenges in meeting WQBELs for the same pollutant(s), criteria and designated uses.
- Group permittees based on specific characteristics or technical and economic scenarios that the permittees share (e.g., type of discharger (public or private), industrial classification, permittee size and/or effluent quality, treatment train (existing or needed), pollutant treatability, available revenue, whether or not the permittee can achieve a level of effluent quality comparable to the other permittees in the group, and/or waterbody or watershed characteristics) and conduct a separate analysis for each group.[7] The more homogeneous a group is in terms of factors affecting attainability of the designated use and criterion, the more credible the multiple discharger variance will be.
- Collect sufficient information for each individual permittee, including engineering analyses and financial information, to adequately support the specification of permittee groups for each individual permittee to be covered by the variance (e.g. estimated costs that each permittee may experience, permittee specific revenue).

[7] The EPA recommends that the state or tribe develop a separate variance for each group (even when going through the same rulemaking procedure) so that if questions arise for one group, it does not jeopardize approval for the others.

(3) Should consider an individual variance for a particular permittee if it does not fit with any of the group characteristics (e.g., private vs. public dischargers, large vs. small permittee, or permittees with a parent company vs. those without).

8. What should a state or tribe keep in mind when adopting a multiple discharger variance pursuant to state/tribal law?

Any multiple discharger variance should:

(1) Include a justifiable expiration date, consistent with the analysis provided, for each permittee or group of permittees covered by the variance. After the expiration date, each permittee in the group will be subject to the applicable water quality standards, or obtain EPA approval on a variance renewal. If the variance will expire during the permit term, the permitting authority must either include an appropriate WQBEL that will apply at the expiration of the variance or include a reopener clause such that the WQBEL may be revised in order for that permit to derive from and comply with WQS the entire permit term.

(2) Provide that any renewal of a multiple discharger variance includes a new demonstration that the designated use and criterion are not feasible to attain during the term of the renewed variance, and documentation of the feasible progress that has been made by each permittee covered by the renewal. In addition, individual permittees will be reevaluated to determine if they continue to qualify under their group designation. Permittees that no longer qualify will cease to be covered by the multiple discharger variance.

It is important to note that even though the duration of a variance may be longer than 3 years, a variance is a water quality standard that must be reviewed every 3 years, consistent with 40 CFR 131.20 (a).

9. What must a state or tribe keep in mind when determining the appropriate interim requirements for a multiple discharger variance?

As with any WQS variance, the interim requirements will need to reflect the highest attainable condition during the term of the variance. The highest attainable condition may be expressed as the highest attainable interim use and criterion[8] or highest attainable effluent

[8] Section 131.6(a) requires that each state's water quality standards submitted to EPA for review must include "use designations consistent with the provisions of sections 101(a)(2) and 303(c)(2) of the Act." CWA section 101(a)(2) establishes as a national goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water," wherever attainable. Section 303(c)(2)(A) requires state water quality standards to "protect the public health or welfare, enhance the quality of water and serve the purposes of this [Act]." EPA's regulations at 40 CFR part 131 interpret and implement these CWA provisions as creating a "rebuttable presumption" that requires state water quality standards to provide for all of the uses specified in Section 101(a)(2) of the Act, unless those uses are shown by a use attainability analysis to be unattainable. Section 131.10(g) and 131.10(j) authorizes a state to remove protection for a use specified in 101(a)(2) (or subcategory of such a use) if the state can demonstrate that one of the attainability factors is met. Once the presumption is rebutted, the state must still adopt, under 131.6(a), "use designations consistent with the provisions of sections 101(a)(2) and 303(c)(2) of the Act." In order to comply with this provision, states will

condition for a permittee(s) during the term of the variance. For example, this could be accomplished by specifying in the variance a numeric value that reflects the highest water quality that a discharger could achieve (beyond their technology-based effluent limits) during the term of the variance.[9] In general, interim requirements should be established on a permittee specific basis (particularly when demonstrating that the applicable designated use is unattainable based on 40 CFR 131.10(g)(6)), but there may be instances where establishing requirements for a group of permittees may be appropriate (e.g., with "legacy pollutants", or when hydrologic conditions have been modified). EPA notes that some states have included additional interim requirements, such as requirements to research advances in wastewater treatment or improved management practices, to conduct wastewater treatability studies, to define demonstrated performance of wastewater treatment or other control methods.

need to adopt designated uses that continue to serve the 101(a)(2) goal by protecting for the highest attainable use unless the state has shown that no use specified in 101(a)(2) or no subcategory of such uses are attainable.

[9] This is a reasonable alternative to adopting an interim designated use and criterion because the resulting instream concentration reflects the highest attainable interim use and interim criterion.

EXHIBIT F

Fact Sheet: Colorado Temporary Modifications

Updated December 2010 to Describe Latest Revisions to
Colorado's General Policy (Regulation #31, Section 31.7(3))

What is a Temporary Modification?

- Site-specific WQS revision subject to EPA review and triennial review.
- Recognizes significant uncertainty and provides time to resolve a WQS issue.
- A protective numeric criterion is adopted/retained. Often this is a CWA 304(a) criterion. Referred to as the "underlying standard."
- A temporary (less stringent) narrative or numeric standard is also adopted; normally the temporary standard is based on maintaining and protecting existing water quality.
- An expiration date is adopted based on the time needed to execute the plan for resolving the WQS issue. Barring action by the Commission to adopt a different numeric standard, the underlying standard becomes effective upon expiration of the temporary modification (inspiring stakeholders to develop a defensible alternative).

How Do Temporary Modifications Affect WQS-Based Decisions?

- CWA 303(d) listing decisions are based on the protective underlying standard and representative water quality data. Temporary modifications are <u>not</u> a basis for de-listing.
- TMDL may be a low priority until the WQS uncertainty is resolved; however, TMDL might be high priority if there is interest in using TMDL Program expertise and resources.
- NPDES compliance schedules (to achieve WQBELs based on the underlying standards) are held in abeyance until the uncertainty is resolved. However, permits may require actions intended to eliminate the WQS uncertainty (e.g., field study requirements), and include requirements to protect the temporary standard.

Types of Temporary Modifications

- *Type A - Significant uncertainty regarding WQS necessary to protect current and/or future uses*. Covers situations where there are compelling reasons to doubt that the current WQS is appropriate, including water effect ratio and copper toxicity issues, recalculation issues, and cases where UAAs are needed. The justification may or may not describe a valid attainability question – e.g., the justification may focus on evidence that the criterion needs to be modified, but contain little or no evidence that WQBELs are infeasible. Temporarily postpones need to issue a compliance schedule to achieve WQBELs based on significantly uncertain WQS. See examples below.
- *Type B - Significant uncertainty regarding the extent to which existing quality is the result of natural or irreversible human-induced conditions.* Covers situations where the underlying standard may be infeasible to achieve, but additional studies are needed to derive a defensible numeric standard. The justification must reference an attainability issue related to natural and/or anthropogenic sources. Provides time to develop a site-specific criteria study and/or UAA; however, the focus is usually on reviewing the criterion. Retaining the present designated use serves as a reminder that conditions may be correctable and may increase priority for funding to attain the classified use. See examples below.
- *Type C* - Significant uncertainty regarding the timing of implementing attainable source controls or treatment (this is a new type adopted in 2010 but Region 8 submitted comments during the rulemaking process that it would recommend EPA disapproval).

Conditions for Granting a Temporary Modification

1) Significant uncertainty (see types of temporary modifications above); and
2) Non-attainment of underlying standard demonstrated or predicted; and
3) An existing permitted discharge has a demonstrated or predicted WQBEL compliance problem; and
4) Adequate supporting information is submitted, including a justification for the interim narrative or numeric value, raw data describing effluent and ambient quality, a plan for eliminating the need for the temporary modification, and a justification for the proposed expiration date; and
5) Expiration date based on how soon resolving the issues is deemed feasible.

Annual Review Process

An annual rulemaking hearing is held to review temporary modifications that expire within two years. As a result of the hearing, the Commission may, for example:

- Delete the temporary modification and allow the underlying standard to go into effect, or
- Delete the temporary modification and adopt a revised underlying standard.

Site-Specific Examples

- *Total Ammonia – McElmo Creek, La Plata River Segment 7a, Aquatic life Warm Class 1, Regulation #34.* Current type A temporary modification. Uncertainty regarding whether discharger (e.g., Vista Verde Village Mobile Home Park, a 0.015 mgd aerated lagoon facility) can comply with WQBELs (economic impact issue). Colorado does not yet have a fully developed discharger-specific variance program. Uncertainty regarding whether table value standard is appropriate for the expected aquatic community (recalculation issue). The portion of McElmo Creek receiving the mobile home park discharge has low flows; additional data are needed to characterize expected aquatic life and explore possible recalculation. State staff are evaluating options with EPA participation. Underlying standard = table values (EPA 1999 Update). Temporary standard = Previous (less stringent) table values for un-ionized ammonia. Expires 12/31/2012.

- *Dissolved Copper – Monument Creek, Fountain Creek Segment 6, Aquatic Life Warm Class 2, Regulation #32*. Current type A temporary modification. Uncertainty regarding whether hardness-dependent table value standard is appropriate given ameliorating effects of site water characteristics including influence of the Tri-Lakes WWTF. Studies to date show that there is a WER. Uncertainty regarding how far downstream an adjusted numeric standard should apply. Uncertainty regarding how a site-specific standard should be derived from biotic ligand model instantaneous results. Uncertainty regarding whether a “translator” adjustment is appropriate for purposes of calculating WQBELs, and if so, what translator adjustment is appropriate. EPA has supported use of the biotic ligand model, including tasking Hydroqual with developing the fixed monitoring benchmark (FMB) approach. Underlying standard = hardness-dependent table values. Temporary standard = “current condition.” Expires 12/31/2012.

- *Total Recoverable Iron – Dry, Sage, and Grassy Creeks, Yampa River Segments 13d and 13e, Aquatic Life Warm Class 2, Regulation #33*. Current type B temporary modification. Uncertainty regarding whether elevated iron concentrations are due to natural or irreversible man-induced sources. Seneca Coal Company discharges at multiple locations along these creeks. As part of the annual review process, a rulemaking action currently is underway to consider adoption of site-specific standards based on pre-mining water quality data. Underlying standard = 1,000 µg/L as a 50th percentile. Temporary standard = "existing quality." Expires 5/31/2011.

- *Dissolved Selenium – Toll Gate Creek, Upper South Platte River Segment 16h, Aquatic Life Warm Class 2, Regulation #38*. Type B temporary modification (now deleted). There was uncertainty regarding whether elevated selenium concentrations are due to natural or irreversible man-induced sources. The City of Aurora discharges to this segment. The USGS was contracted to do the study. In 2009, site-specific selenium criteria were adopted based on evidence that the existing ambient concentrations are due to natural groundwater flow associated with bedrock, and the temporary modification was deleted.

- *Temperature – San Miguel River Segment 4b, Aquatic Life Cold Class 2, Regulation #35*. Current type B temporary modification. Uncertainty regarding appropriate ambient temperature standard for this section of the San Miguel River, which supports a mixed aquatic community in a transition zone between cold and warm water habitats. Uncertainty regarding the extent to which Tri-State Generation and Transmission's cooling water discharge is affecting stream temperature and aquatic life. Uncertainty regarding effects of upstream water diversions on aquatic life and temperature, and whether effects are reversible. Uncertainty regarding thermal requirements of expected community (e.g., mottled sculpin, a cold water species). Uncertainty regarding the appropriate aquatic life use sub-category. As part of the annual review process, a rulemaking action currently is underway to consider adoption of site-specific WQS revisions based on a UAA and site-specific criteria study. Underlying standard = None. Temporary standard = 26.3°C as a maximum weekly average during June-Sept. Expires 5/31/2011.

- *Dissolved Zinc – Eagle River Segments 5a, 5b, and 5c, Aquatic Life Cold Class 1, Regulation #33*. Type A and Type B combo temporary modification (now deleted). There was uncertainty regarding whether the much improved (but still somewhat elevated) zinc levels downstream of the Eagle Mine CERCLA site were natural or man-induced rreversible. There was uncertainty regarding whether the table value standard is appropriate for the expected aquatic community (recalculation issue). There was uncertainty regarding whether the aquatic community within the CERCLA site is significantly different compared to upstream control sites. These sources of uncertainty were studied under the temporary modification while the remedial action was underway (remedial actions were <u>not</u> postponed to allow time for resolution of the WQS issues). In 2008, based on all three lines of evidence, site-specific zinc criteria were adopted (requiring a small additional improvement in zinc levels) and the temporary modification was removed.

EXHIBIT G

COLORADO WATER QUALITY CONTROL COMMISSION
STATE OF COLORADO

WRITTEN TESTIMONY OF TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION, INC.

IN THE MATTER OF WATER QUALITY CLASSIFICATIONS AND STANDARDS AND DESIGNATIONS FOR THE GUNNISON AND LOWER DOLORES RIVER BASIN, REGULATION 35 (5 C.C.R. 1002-35)

Tri-State Generation and Transmission Association, Inc. (Tri-State) submits the following Written Testimony to support its revised proposal regarding the San Miguel River, Segment 4. This testimony specifically addresses the Tri-State proposal to move the segment boundary between Segment 4 and Segment 5 upstream approximately 3 miles from Naturita Creek to the Power Plant Bridge.

BACKGROUND

Tri-State owns and operates the Nucla Generating Station (Nucla Station) located approximately 3 miles upstream from the end of Segment 4 on the San Miguel River near Nucla, Colorado. The Nucla Station is located approximately 4 miles southeast of Nucla, Colorado and 3 miles northeast of Naturita, Colorado (see Tri-State Exhibit 1). It is a steam electrical power generation plant with a total power generation capacity of 110 megawatts (mw) of electricity and provides power to the western power grid. The Nucla Station is operated at its maximum capability due to Colorado electricity demand.

Pursuant to its water rights the Nucla Station takes approximately 1.4 million gallons per day (MGD) or 3 cubic feet per second (cfs) of water from the San Miguel River when the facility is operating at full capacity. The majority of this water is used in the circulating water systems which remove waste heat from the turbine condensers. The remaining water is divided between the boiler makeup, ash and coal wetting, and potable water.

In the circulating water system, cold water from the cooling towers circulates through the tubes in the turbine condensers. Exhaust steam from the turbines passes over the outside of the condenser tubes and is condensed back into high purity condensate to be reused in the boiler water cycle. The warm water leaving the turbine condensers is circulated back to the cooling towers where the heat is given off to the atmosphere in the evaporative cooling process. This cooling process concentrates dissolved solids in the cooling water. The concentration effects are kept under control by releasing water from the system (cooling tower blowdown) and replacing it with less concentrated makeup water. Water is cycled up to seven times before it is discharged to the waste water management system.

The waste water management system includes two cooling towers and a baffled pond. The baffles create a flow system in the pond to increase the settling and holding time prior to discharge to the San Miguel River. When the water discharge permit for the Nucla Station was renewed in 1993, the Colorado Water Quality Control Division (Division) included a temperature discharge limit of 30 °C. The Nucla Station discharge has always met this temperature limit, and generally discharges below the limit.

The Nucla Station pond system was re-constructed in 1997 at a cost of $1,200,000 to ensure compliance with permit limitations. This project was carefully designed to improve the waste water management system. The system was designed to meet the temperature discharge limit of 30 °C as required by the Division.

In 1999, the Division proposed a 20 °C temperature limit for the Nucla Station. In discussions it was discovered that the Division had been applying the temperature standards inconsistently across the state. Tri-State committed to work with the Division to review and understand the temperature standard and how it should be applied in permits. In addition, Tri-State initiated a study on the San Miguel River to determine if the cold water aquatic life use classification in the lower portion of Segment 4 was appropriate.

In 2001, Tri-State presented temperature data to the Water Quality Control Commission (Commission) with a proposal to change the use classification of the lower portion of Segment 4 to warm water aquatic life use. Tri-State presented temperature data to the Commission showing that the 20 °C classification was not appropriate. The Division did not support the proposed change noting that Tri-State did not provide aquatic life evidence and that pursuant to Division's calculations the temperature of the lower portion of Segment 4 did not often exceed 20° C during the hottest portion of the day. Tri-State worked with the Division to conduct the aquatic life and temperature study on the river that is presented to the Commission at this June, 2006 hearing.

Tri-State engineers did an evaluation to look at options for additional cooling of the discharge water. In order to meet a temperature discharge standard of 20 °C year round an additional cooling tower or chiller would be needed at a capital project cost of up to $1,200,000 and additional annual operational and energy costs. Tri-State understands that water quality standards are critical to protect the species in Colorado waters and supports these standards. However, there is a significant economic investment that would be required to protect aquatic life to a degree that is more stringent than necessary. In this case, Tri-State questions whether such expenditure is necessary and reasonable to protect the aquatic life found in the lower portion of Segment 4.

COLORADO COOPERATIVE DITCH DIVERSION

The Colorado Cooperative Ditch Company and its shareholders (collectively referred to as "CC Ditch Company") own and operate a diversion structure on the San Miguel River approximately 8 miles upstream from the Power Plant Bridge with water rights of 145 cfs. The CC Ditch Company constructed the diversion structure around 1900 and began transporting water for various uses, including irrigation, livestock watering, and potable water, with an initial capacity of 27 cfs of water from the San Miguel River. Through the 1960s, the CC Ditch Company increased capacity of the ditch system to approximately 110 cfs. The CC Ditch Company increased operations since the 1960s to the current average management of 120 cfs. The removal of significant quantities of water from the San Miguel River at the CC Ditch can significantly reduce or even eliminate the flow below the structure. The low flow remaining in the San Miguel River below this diversion can be substantially impacted by ambient air temperatures and solar radiation. In addition to the impact on temperature, the CC Ditch intake structure prevents cold water species, which may be washed down during periods of high flow, from migrating back upstream to the cold water portion of the stream.

TEMPERATURE DATA

Over the past five years, Tri-State and its consultants have placed a number of temperature data loggers in the San Miguel River. The temperature data logger that has been in place for the most years and therefore has the most temperature measurements is located upstream from the Nucla Station discharge and adjacent to the Nucla Station intake structure. The intake structure is essentially a dam that creates a deep pool that is shaded by the roof of the structure. The temperature is measured by data loggers that are 3-5 feet below the San Miguel River surface. Due to this configuration, Tri-State believes that the water temperature at the intake pool is often cooler than the temperatures in the river at natural depths. However, given the length of record for this data logger, it was used for the temperature data and use classification analysis for the lower portion of Segment 4 of the San Miguel River – and is considered conservative.

Using the intake pool temperature data, maximum weekly average temperatures (MWAT is the 7-day average of daily averages from measurements taken every 15 minutes) on a rolling basis were calculated. These temperatures are presented in Table 1 from two perspectives: (1) year round twenty-four hours a day, and (2) summers only for consistency with the Colorado definition for cold water biota (Regulation 31.5(8)). The data are presented to show the number of times the MWAT is greater than 20 °C, the total number of MWAT averaging times, and the percentage of time the MWAT is greater than 20 °C. Table 2 presents the hottest period of the day during the summer to respond to the Division comments in the 2001 Commission hearing.

Table 1. Percentage of Maximum Weekly Average Temperatures Greater than 20 ºC for the San Miguel River Measured at the Intake Pool.

Period	Number of MWATs > 20 ºC	Total Number of MWAT periods	Percentage > 20 ºC
Year round (October 2000 – October 2005)	183	1289	14%
Summer (June 15 – Sept. 15 in the years 2001 – 2005)	160	408	39%

Table 2. Percentage of Measurements in the Hottest Period of the Day Greater than 20 ºC for the San Miguel River Measured at the Intake Pool.

Period	Percentage > 20 ºC				
	2001	2002	2003	2004	2005
Summer Hottest Period of the Day* (June 15 – Sept. 15 in the years 2001 – 2005)	76%	92%	88%	70%	76%

* Hottest Period of the Day is defined as one hour prior to and one hour following the maximum temperature of each day.

This methodology of calculating rolling MWATs and using the data for use classification is consistent with the Division’s methodology in assessing the attainment of the cold water aquatic life standard in the Lower Gunnison Segment 2 (Tri-State Exhibit 3). When evaluating year round data, the Lower Gunnison Segment 2 recorded approximately 19% of the MWATs as greater than 20 ºC. Based on this information, the Division is recommending in the Regulation 35 hearing that Segment 2 of the Lower Gunnison River be reclassified as warm water aquatic life. In comparison, the year round data of the lower portion of Segment 4 on the San Miguel River exceeded 20 ºC 14% of the time. However, the summer data exceeded 20 ºC 39% of the time and the summer hottest period of the day temperatures exceeded 20 ºC between 70-92% over a five year period of record.

CONCLUSIONS

In summary, Tri-State believes cold water aquatic life is not the appropriate designated use for the portion of Segment 4 of the San Miguel River downstream of the Power Plant Bridge. The aquatic study conducted by Chadwick Ecological Consultants (Tri-State Exhibit 2) concluded that no cold water species were present below Big Bucktail Creek and that the study area was dominated by warm water biota. In addition, Tri-State believes the CC Ditch Company diversion creates a hydrological modification that precludes attainment of the cold water aquatic life use and impacts the temperature in the San Miguel River below the diversion. Finally, the temperature data show that both annually and during the summer the river temperature frequently exceeds 20 ºC.

In conclusion, changing the stream segment boundary upstream 3 miles to the Power Plant Bridge will correctly reflect the aquatic life use in this portion of the San Miguel River.

This change will not affect stream temperature and will not change Tri-State's operations or discharge at the Nucla Station.

EXHIBIT H

WATERSHED-BASED NPDES PERMITTING:

RETHINKING PERMITTING AS USUAL

WHAT IS WATERSHED-BASED NPDES PERMITTING?

Watershed-based NPDES permitting is an approach to developing NPDES permits for multiple point sources located within a defined geographic area (i.e., watershed boundaries). Through this approach, NPDES permitting authorities consider watershed goals and the impact of multiple pollutant sources and stressors, including nonpoint source contributions. This approach can encompass a wide variety of activities, from synchronizing permit issuance within a watershed to developing water-quality based effluent limits for a group of point sources, aimed at achieving new efficiencies and environmental results.

WHAT ARE POSSIBLE WATERSHED-BASED PERMITTING APPROACHES?

Every watershed is different and requires customized solutions to protect and restore water quality. One size-fits all approaches go against this basic premise of watershed management. Watershed-based NPDES permitting recognizes the need for watershed-specific solutions and does not prescribe one approach. Instead, it provides several possible approaches to serve as examples and generate ideas. Examples of possible approaches include the following:

- **Watershed-Based Individual Permit–Multiple Permittees.** This is a single NPDES permit that would cover multiple sources in the same watershed, or implement a Total Maximum Daily Load (TMDL) or watershed plan. Would allow several point sources within a watershed to apply for and obtain coverage under the same permit.
- **Watershed General Permits.** This approach relies on general permitting and would be similar to many existing general permits except that the watershed boundary defines eligibility for coverage or applicability of certain conditions (e.g., monitoring).
- **Integrated Municipal Permits.** This approach bundles all point source requirements for a municipality into a single NPDES permit. It may or may not reflect watershed boundaries.

WHY WATERSHED-BASED NPDES PERMITTING?

Recent studies of the nation's waters reveal that nearly half of the water bodies assessed are not meeting water quality standards, and that point source discharges are a contributing factor in many of these impaired waters. Where conditions are right for this approach, watershed-based NPDES permitting may successfully address these remaining water quality problems and produce further water quality improvements. In addition to environmental results, other possible benefits of watershed-based permitting approaches may include:

- Integration of other watershed protection programs under the Clean Water Act and the Safe Drinking Water Act
- Targeted and maximized use of resources to achieve environmental results
- Increased and coordinated public involvement in the permitting process
- Cooperation and collaboration among point source dischargers and other key stakeholders within the watershed
- Opportunities for water quality trading and other market-based strategies for meeting water quality standards.

WHERE IS WATERSHED-BASED NPDES PERMITTING HAPPENING?

OREGON: WASHINGTON COUNTY'S SPECIAL SERVICE DISTRICT EVALUATING BENEFITS AND ISSUES OF WATERSHED-BASED PERMITTING

In the Tualatin River watershed, both TMDLs and endangered species issues are primary concerns. Clean Water Services is responsible for wastewater and surface water management in urban Washington County, which translates into numerous permits and requirements under the NPDES program. Under a multi-year pilot project, Clean Water Services is evaluating the technical, stakeholder, regulatory and legal issues surrounding the development of a watershed-based NPDES permitting approach that will result in a permit that covers multiple point sources. Two outcomes of the pilot project are an interim permit that will allow development of a watershed-based permitting framework and a 5-year project work plan to coordinate requirements under the Clean Water Act, the Endangered Species Act, and the Safe Drinking Water Act.

Photo: Courtesy, Clean Water Services.

COLORADO: SELENIUM STAKEHOLDERS COLLECT DATA FOR STANDARDS IN THE SOUTH PLATTE RIVER

During the triennial review process in 2000, the Colorado Department of Public Health and Environment (CDPHE) proposed lowering the chronic selenium standard. This lowered standard would make compliance with NPDES water-quality based effluent limits challenging for point sources given current technological limitations for selenium removal and nonpoint source contributors. Conoco Inc. convened a stakeholder group of point sources that discharge to the South Platte River and its tributaries to discuss potential impacts of changing the selenium standards within this watershed. Based on data presented by the Selenium Stakeholder group during the Triennial Review hearings, the state granted a three-year Temporary Modification for a portion of this watershed to allow for additional monitoring to better understand the sources of selenium and determine site-specific selenium criteria. This study, now in its third year of implementation, has facilitated the collection of a large amount of quality data which can be used to develop and implement TMDLs in the future at a significant cost savings to the group.

Photo: Anthony R. Congram, ConocoPhillips.

CONNECTICUT: MULTIPLE POTWS IN LONG ISLAND SOUND REDUCING NITROGEN UNDER ONE PERMIT

Photo: Mark Parker, CT DEP.

In the summer, excessive nitrogen loading causes low dissolved oxygen (DO) in bottom waters of western Long Island Sound. The States of Connecticut and New York have established a 2014 goal to reduce nitrogen loads and have formalized a nitrogen reduction program through a TMDL. To help achieve this goal, the Connecticut Department of Environmental Protection (CTDEP) developed and issued an NPDES permit addressing nitrogen discharges to 79 publicly-owned treatment works (POTWs) that discharge at least 20 pounds of total nitrogen (TN) per day to Long Island Sound. Existing individual permits held by the POTWs continue to regulate other pollutants and protect against localized impacts. Reductions in TN close to the low DO impact zone in the Long Island Sound are more "valuable" than TN reductions from more distant sources in the Sound; this disparity in credit value promotes trading through the Nitrogen Credit Exchange program. The ultimate measure of success in this watershed-based permitting approach is meeting, or exceeding, the nitrogen reduction schedule in the TMDL; as of 2002, the nitrogen reductions are several years ahead of projections.

NORTH CAROLINA: POINT SOURCES FORM THE NEUSE RIVER COMPLIANCE ASSOCIATION

Nutrient impacts led to TMDLs and the Neuse River Basin Nutrient Sensitive Waters Management Strategy. To meet the Strategy's 30 percent total nitrogen reduction goal, public and private entities in the basin that hold individual NPDES permits formed the Neuse River Compliance Association. The North Carolina Department of Environment and Natural Resources (NCDENR) issued an individual watershed-based permit with multiple permittees, called a group compliance permit, to the members of the Association. Dischargers participating in the Association keep their existing individual permits, but are subject to the TN limits in the group compliance permit. The TN limit in this permit is the sum of all TN loads for each of the Association members, established and allocated through the TMDL. If Association membership changes, the Association's TN allocation changes accordingly. The Association serves as the point of contact between the members and NCDENR and conducts activities for the group such as reporting. The group compliance permit does not contain any monitoring requirements; members of the Association adhere to the monitoring requirements contained in their existing individual permits.

Photo: Courtesy, NCDENR-DWQ.

HOW IS EPA PROMOTING THIS APPROACH?

Watershed-based NPDES permitting is gaining momentum and EPA is committed to accelerating this approach through a variety of actions focused on education and technical assistance, as stated in the January 2003 Watershed-Based NPDES Permitting Policy Statement. EPA has conducted activities such as compiling research and background information on watershed-based NPDES permitting, identifying and analyzing existing examples of this approach, and creating case study fact sheets. In addition, EPA has committed to developing guidance on implementation and technical issues surrounding watershed-based NPDES permitting. Where there is an interest in using this approach, EPA can help to initiate efforts by acting as a facilitator or identifying funding opportunities.

WHAT RESOURCES ARE AVAILABLE?

To date, EPA has generated several resources to educate stakeholders on the watershed-based NPDES permitting approach. EPA's web site is the primary resource for obtaining information on this approach, including:

- **Watershed-Based Permitting Under the NPDES Program: A Summary of Related Background Information.** A compilation and summary of past research, policies, memos and case studies.
- **Potential Partners in Promoting Watershed-Based Permitting: An Analysis of Watershed Organizations.** An analysis of 29 watershed organizations to identify the various roles that they can play in this permitting approach based on existing organizational goals and activities.
- **Watershed-Based NPDES Permitting Policy Statement.** Policy signed by Assistant Administrator for Water, G. Tracy Mehan III on January 7, 2003, that demonstrates the Agency's significant level of support for this approach.
- **Committing EPA's Water Program to Advancing the Watershed Approach.** Memo from EPA's Assistant Administrator for Water, G. Tracy Mehan III on December 3, 2002 that addresses steps the Office of Water will take to demonstrate renewed commitment to the watershed approach, including accelerating efforts to issue permits on a watershed-basis.
- **Watershed-Based NPDES Permitting Case Studies.** Series of fact sheets that present an overview of existing watershed-based NPDES permitting activities around the country.

Resources that EPA will make available in the near future include an implementation guidance manual, a technical guidance manual, and training opportunities.

WHAT IS THE PROCESS?

The process used to generate NPDES permits under a watershed approach will vary from watershed to watershed. There are basic steps that stakeholders involved in the process can use as a starting point. Stakeholders should tailor this process to fit the needs of the watershed.

Step One:	Select a watershed and determine boundaries.
Step Two:	Identify stakeholders and facilitate their participation.
Step Three:	Assess water quality conditions of the watershed. Collect and analyze data for permit development.
Step Four:	Develop watershed-based permit conditions and documentation.
Step Five:	Issue watershed-based permit(s).
Step Six:	Measure and report progress.

WHERE DO STAKEHOLDERS FIT IN?

A wide variety of stakeholders can affect, and are affected by, watershed management decisions. As in any watershed effort, it is imperative to identify and involve stakeholders in watershed-based NPDES permitting early on in the process. Every step in the watershed-based NPDES permitting process contains an opportunity for stakeholders to participate! Stakeholders such as the NPDES permitting authority and point sources may initiate and facilitate the overall process. Other stakeholders, such as local watershed organizations and residents, may contribute data and information or provide input on the technical process. Every watershed-based permitting approach is different; therefore, the type of stakeholder involvement will vary.

WHERE CAN I FIND MORE INFORMATION?

For more information on watershed-based NPDES permitting, visit EPA's web site at www.epa.gov/npdes/watersheds.

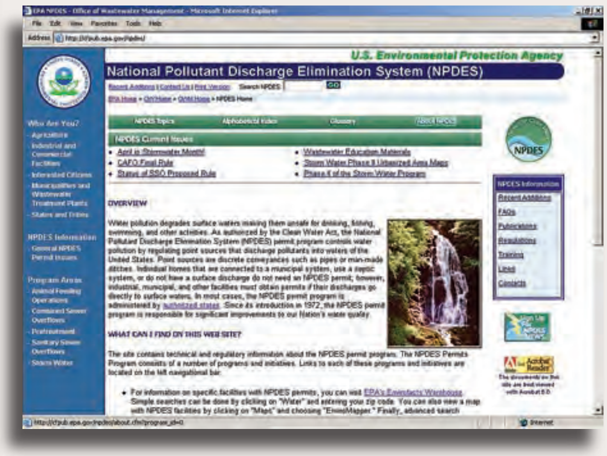

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EXHIBIT I

Sand Creek Watershed, Colorado

Watershed-Based Selenium Standard

Permitting Authority:
Colorado Department of Public Health and Environment

Permittee Points of Contact:
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Pollutants of Concern in the Watershed:
Selenium

Watershed Approach:
Stakeholder collaboration to develop a watershed-based selenium standard

Permit Type:
Individual permits to publicly-owned treatment works and industrial facilities

Permits Issued: Various dates

Overview

Suncor Energy (U.S.A.), Inc., formerly Conoco Denver Refinery, convened the Selenium Stakeholder Group to discuss the scientific merit and feasibility of implementing Colorado's proposed more stringent selenium standard for point sources discharging to the South Platte River and its tributaries, specifically Sand Creek. Members of the group predicted that applying the lower standard would result in Sand Creek being inappropriately placed on Colorado's Clean Water Act (CWA) section 303(d) list of impaired waters because ambient background selenium concentrations would exceed the more stringent standard.

The dischargers worked with state and federal agencies to develop a proposal in which the dischargers would collect the biological, chemical, and physical data necessary to justify a less stringent selenium standard for western plains stream ecosystems. The goal of the program is to develop a science-based water quality standard for selenium that is protective of, and appropriate for, western plains stream ecosystems. Pending the results of the study, the Colorado Department of Public Health and Environment (CDPHE) granted a temporary modification of the selenium standard for Sand Creek and Segment 15 of the South Platte River. The approach allows for adaptive implementation in which stakeholders work cooperatively and proactively to solve problems outside the regulatory arena.

This case study focuses on NPDES dischargers in the Sand Creek watershed working together using a watershed approach to develop a site-specific water quality criterion.

Watershed: *Sand Creek, South Platte River, Colorado*

Key Water Quality Concerns: *Selenium concentrations*

Stakeholder Involvement Techniques:

- *Municipality, 2 refineries, & wastewater district voluntary collaboration on research.*
- *Shared stakeholder goal—avoid lower selenium standard.*
- *Economic and environmental concerns that movitate stakholders to work together.*

Case Study Issues of Interest

Type of Point Sources	POTW Discharges	✔
	Industrial Process/Nonprocess Wastewater Discharges	✔
	Concentrated Animal Feeding Operations	
	Municipal Separate Storm Sewer System Discharges	
	Construction Site Stormwater Discharges	
	Industrial Facility Stormwater Discharges	
	Combined Sewer Overflows	
Highlighted Approach(es)	Statewide Watershed Approach	
	Implementation of Water Quality Standards	✔
	Implementation of Total Maximum Daily Loads or Other Watershed Pollutant Reduction Goals	✔
	Permit Coordination/Synchronization	
	Integrated Municipal Requirements	
	Point Source – Point Source Water Quality Trading	
	Point Source – Nonpoint Source Water Quality Trading	
	Discharger Association	
	Coordinated Watershed Monitoring	✔

Watershed Approach Background

In 2000 through its triennial review process, the CDPHE's Water Quality Control Commission (Commission) proposed lowering the selenium standard for protection of aquatic life (chronic effects) from 12 μg/L (micrograms per liter) total selenium to 4.6 μg/L dissolved selenium on the basis of the U.S. Environmental Protection Agency's (EPA) then-current dissolved selenium criterion. Dischargers in the Sand Creek watershed believed that the standard change was unwarranted on the basis of preliminary site-specific biological data and literature review. It appeared that the standard was based on lake ecosystems on the east and west coasts and was not appropriate for a western plains stream ecosystem. A change in the selenium standard could make compliance with National Pollutant Discharge Elimination System (NPDES) water quality-based effluent limits (WQBELs) extremely challenging considering current technological limitations for selenium removal from process wastewater discharges.

Colorado's Three-step Triennial Review Process for Water Quality Standards

1. **October Year 1: Issues Scoping Hearing.** Provides an opportunity for early identification of potential issues to be addressed in the next major rulemaking hearing and for identification of any issues that might need to be addressed in rulemaking before that time.
2. **November Year 2: Issues Formulation Hearing.** Results in identifying specific issues to be addressed in the next major rulemaking hearing.
3. **June Year 3: Rulemaking Hearing.** Revisions to the water quality classifications and standards are formally adopted.

The Selenium Stakeholder Group, consisting of two refineries, a municipality, and a wastewater district, formed around the dischargers' shared concerns over the economic impacts of compliance with the more stringent standards, which they believe are not appropriate for Sand Creek and the South Platte River. The Selenium Stakeholder Group worked with EPA, CDPHE, the U.S. Fish and Wildlife Service (USFWS), and the Colorado Division of Wildlife (CDOW) to design a monitoring program to collect data that would allow the stakeholders and agencies to evaluate the suitability of Colorado's selenium standards and, if necessary, develop a more appropriate standard. The study that the Selenium Stakeholder Group began was one of the first studies in Colorado to involve collecting and analyzing water column, sediment, and biological data to determine the ecological impacts of selenium. The work of the Selenium Stakeholder Group is still underway.

Watershed Approach Strategy

The goal of the Selenium Stakeholder Group is to facilitate a collaborative approach to developing and adopting a water quality standard that is protective of western plains stream ecosystems through data collection and analysis. To meet this goal, the group has focused on building relationships among stakeholders and designing and implementing a scientifically sound selenium study.

Stakeholder Collaboration

The members of the Selenium Stakeholder Group represent dischargers in the watershed that would be impacted by a lower selenium standard. The group comprises two industrial dischargers, an upstream publicly owned treatment works (POTW) on Sand Creek operated by the city of Aurora, and a downstream wastewater reclamation district on the South Platte River, which is the wastewater treatment authority for most of metro Denver. The municipal stormwater dischargers in the watershed were invited to participate but generally were not interested, largely because they did not feel that they would be affected by a revision to the selenium standard. Two local organizations concerned with water quality issues, the South Platte Coalition for Urban River Evaluation and the Sand Creek Regional Greenway Partnership, were engaged in the process but are not members of the stakeholder group.

Each member of the Selenium Stakeholder Group has different motivating factors for participating. For the upstream municipality on Sand Creek, concerns over elevated upstream selenium concentrations and potential impacts on NPDES permit limits motivated its participation in the group. The industrial dischargers, although competitors, were motivated to cooperate under the watershed approach through a shared concern about future WQBELs based on a total maximum daily load (TMDL) for a stream in which background selenium concentrations exceed the proposed lower selenium standard. Permit renewals for these facilities were imminent at the time of the 2000 temporary modification. The downstream wastewater reclamation district on the South Platte River initially joined the group because it tends to be an active participant in local water quality issues. The reclamation district is motivated to continue participation because it cannot control selenium concentrations entering the POTW and because of the economic and technical limitations of treating huge municipal flows to meet the wasteload allocations in the 1998 selenium TMDL for Segment 15 of the South Platte River, which are based on the more stringent standard.

The Selenium Stakeholder Group worked closely with CDPHE and the other agencies in a collaborative process to develop the proposal for a temporary modification of the selenium standard and to design the selenium study. Because of this collaboration, the proposal for the temporary modification was uncontested.

Study Design and Results

The Selenium Stakeholder Group presented preliminary data demonstrating that suspected nonpoint sources of selenium in the upper Sand Creek watershed would cause a violation of the lower selenium standard and require Colorado to place Sand Creek on its section 303(d) list. On the basis of these data and the proposal developed jointly by the Selenium Stakeholder Group and participating agencies, in November 2000 the Commission granted a temporary modification of the selenium standard for Sand Creek and Segment 15 of the South Platte River, which was already subject to a TMDL for selenium. During the temporary modification, the 12 μg/L chronic total selenium standard would be retained, and no acute standard would be adopted for Sand Creek. For Segment 15 of the South Platte River, the Commission adopted temporary modifications for chronic selenium of 5.2 μg/L and acute selenium of 18.4 μg/L. The temporary modifications would expire in June 2004, pending the results of a study to be conducted by the Selenium Stakeholder Group.

The dischargers agreed to develop and implement a study during the temporary modification period to collect more information to better understand the sources of selenium in the Sand Creek watershed and to determine appropriate site-specific selenium standards. The specific terms of the study plan were negotiated among the Selenium Stakeholder Group, EPA, CDPHE's Water Quality Control Division (Division), CDOW, and the USFWS and were included in the agreement. The dischargers hired third-party consultants to design the study with input from the dischargers and agencies. The third-party consultants also performed all data analyses under the study.

The stakeholder group implemented the first phase of the study in March 2001. During this phase, the group collected monthly water column and outfall data and quarterly sediment sampling data. They also conducted semiannual fish population and watershed habitat assessments. The study results indicated that the current selenium standard was not resulting in any significant negative impacts on fish populations.

The stakeholder group completed the first phase of the study as required and presented its findings at CDPHE's 2004 triennial review hearings. On the basis of the more complete data set provided by the Selenium Stakeholder Group and because of uncertainty regarding the sources of selenium in the watershed, the Commission agreed to retain the temporary modification for Sand Creek until 2010; however, Colorado placed Sand Creek on its 303(d) list in 2002 because of exceedance of the underlying 4.6 ug/L selenium standard. The Commission removed the temporary modification for Segment 15 of the South Platte River in 2004 because ambient conditions in the river met the underlying water quality standards.

During the extension of the temporary modification, the stakeholders, principally Suncor Energy and the city of Aurora, contracting with the U.S. Geological Survey for additional services, are continuing with the second phase of the study. In this phase, stakeholders are focusing on identifying the sources of selenium in the watershed, primarily using ground water analyses.

Highlights of the Selenium Stakeholder Group's Approach

Outreach

The process promoted a broad watershed approach to issues of mutual concern and provided an effective catalyst to bring dischargers and regulators around the same table.

Coordination

Coordination among dischargers and between dischargers and regulatory agencies is a key element of this watershed approach. The relationship established among neighboring dischargers and between dischargers and regulators through this approach expanded to other issues. In one case, a wasteload reallocation (water quality-based trade) between two refineries was uncontested during the permit renewal process. In another example, a municipality improved its communication, which enabled an exchange of technical expertise with state and federal agencies.

This approach provided a medium for adaptive implementation. Working cooperatively and proactively allowed a group of stakeholders to solve problems outside the regulatory realm, furthering efforts toward sustainability.

Data Collection

The study plan facilitated collection of a large amount of quality data that can be used to develop an appropriate selenium standard and for implementing better science-driven TMDLs if they are needed in the future. The study plan also facilitated sharing important ecological data about a western plains ecosystem with state and federal agencies.

Factors Considered During Development

In the early stages of the watershed approach, the Selenium Stakeholder Group was challenged with determining how to divide among its members the administrative costs to operate the group and the costs of the study itself. The total cost of the project to date has exceeded $0.5 million, incorporating costs for consultants, sampling, and legal assistance. The stakeholder group determined individual contribution levels on the basis of discharge rates. Because the refineries had more flexibility in allocating budgets to the project than did the POTWs, stakeholders agreed that the industrial dischargers would contribute a larger share of the dollars, whereas the POTWs would make primarily in-kind contributions. A primary consultant to the effort coordinated all billing, dividing the charges and invoices among the individual stakeholders according to the agreement.

The dischargers were motivated to fund the program for economic and environmental reasons. The industrial dischargers found that it would be more economical to fund the project than it would be to implement controls to meet a lower selenium standard, which likely would be exceeded anyway because of natural background selenium concentrations in Sand Creek. In addition, all the dischargers supported the decision, from an environmental standpoint, to conduct the study with the aim of developing a water quality standard appropriate to the ecosystem. Suncor Energy also saw the study as a good opportunity to build relationships with neighboring dischargers.

Watershed Approach Effectiveness

To date, indicators of success for this watershed approach include collecting new selenium data that were unavailable to regulators before implementing the study and achieving temporary modifications to the selenium standard in Sand Creek and Segment 15 of the South Platte River. Ultimately, stakeholders and others will consider the program a success when the stakeholders agree on and the Commission endorses a water quality standard that is protective of western plains streams. Another measure of future success will be whether the results of the watershed approach align with or influence EPA's process for developing a national selenium criterion.

The members of the Selenium Stakeholder Group identified the following benefits as a result of their participation in the watershed approach:

- State regulatory agencies now recognize the dischargers as proactive supporters of environmental progress because they were willing to generate and provide new data for use in objectively determining an appropriate selenium standard. The working relationship between the dischargers and the agencies has fostered trust among the groups and has provided all stakeholders with better insight on the opportunities and challenges presented by various regulatory options for controlling selenium.

- All the dischargers benefited from the cost-sharing approach. By providing in-kind contributions to match the financial contributions from the refineries, the POTWs were able to participate in a data collection effort that otherwise would not have been supported by their annual budgets. The cost-sharing approach allowed each discharger to be proactive in implementing a solution that none could have achieved on its own.

- The upstream municipality, the city of Aurora, benefited from its positive interaction with the regulatory agencies. Because of this watershed approach, the city has established a good working relationship with EPA and CDPHE, which has allowed it better access to technical expertise. The relationship has allowed the agencies and dischargers to proceed in a streamlined and collaborative effort in which they exchange ideas throughout the process and agree on the best ways to move forward. These relationships have extended to other areas in which the city interacts with the state and federal agencies.

A report developed by one of the refineries and the participating consultants during the first phase of the selenium study identifies a number of additional environmental, economic, and social benefits of the watershed approach. They include the following:

- Beneficial Monitoring Data—The collaborative, watershed-based data collection effort resulted in collecting valuable and previously unavailable data to inform the selenium standard development process. Regulators can also use these data to inform watershed modeling and TMDL implementation. This could help the state prioritize TMDLs to achieve the greatest environmental benefit.

- Avoiding Unnecessary TMDLs—By proactively addressing the selenium standard before TMDL development, the Selenium Stakeholder Group expects to achieve economic benefits for the dischargers and regulators through collecting data that will allow Colorado to remove stream segments, including Sand Creek, from its 303(d) list, thereby avoiding development of unnecessary TMDLs.

- Early Awareness of Economic Sustainability Challenges—The selenium stakeholders' early participation in the watershed approach made it clear to dischargers that selenium discharge reductions would be required. This allowed the dischargers to identify economically sustainable selenium reductions through project scoping and pilot study work well in advance of NPDES-imposed compliance schedules.

- Relationship Building for the Future—In addition to improved relationships with regulators and agency personnel, the dischargers have benefited from relationship building within the Selenium Stakeholders Group. Early collaboration with neighboring dischargers has laid the groundwork that would be necessary to establish wasteload allocations under any future TMDLs. Improved relationships facilitated a water quality trade during a Colorado Discharge Permit System permit renewal for the two refineries. Although competitors, the refineries were able to build on the relationship they developed through the stakeholder process, working with the wastewater reclamation district to achieve uncontested wasteload reallocations for iron, manganese, and zinc among the dischargers.

Lessons Learned & Next Steps

The Selenium Stakeholder Group has faced several challenges that were not foreseen in the early stages of the watershed approach. First, communication with the agencies was complicated by frequent agency staff turnover. The dischargers found that new agency personnel had different priorities and goals for the watershed approach; this created challenges to the group in maintaining momentum. Second, over the course of the study, it was sometimes difficult for some of the stakeholders to meet their in-kind obligations. Dischargers establishing similar agreements should carefully consider their respective abilities to perform in-kind functions relative to the feasibility of making financial contributions toward hiring outside consultants to conduct activities on their behalf. Finally, in collaborating with the agencies on the study design, the dischargers were challenged to cooperate with the agencies in meeting agency needs for scientific integrity, while ensuring that the activities requested by the agencies would truly add value to study results.

The source identification phase of the selenium study is still underway; therefore, it is too early to draw conclusions. Early indications are that much of the selenium load in the affected streams is naturally occurring. The dischargers hope that these results will lead to the development of a water quality standard that considers the natural background selenium concentrations. If this result is achieved, streams that Colorado placed on the 303(d) list on the basis of the current selenium standard can be delisted, avoiding unnecessary TMDL development. Stakeholders will present the results of the source analysis at CDPHE's 2009 triennial review hearings.

Resources

Colorado Department of Public Health and Environment. 2004. *Water Quality Control Commission Public Participation Handbook.* www.cdphe.state.co.us/op/wqcc/GeneralInfo/PublicParticipation/pubpart.html

Colorado Department of Public Health and Environment, Water Quality Control Commission. 2006. *Regulation No. 38—Classification and Numeric Standards South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin* (amended).

Congram, A.R. 2001. *Recent Waste Load Trades Supporting Segments 15 and 16a.* Letter to Lynn Kimble (Colorado Department of Public Health and Environment, Water Quality Control Division) Documenting Trades.

Congram A., S. Reeves, B. Linenfelsar, and S. Canton. No date. *The Selenium Stakeholders—Case Study for a TMDL Alternative.*

Foster, T.S. 2004. *Prehearing Statement of Selenium Stakeholder Group.* Presented to the Colorado Department of Public Health and Environment's Water Quality Control Commission on behalf of the Selenium Stakeholder Group.

Selenium Stakeholder Group. 2001. *Selenium Stakeholder Site Specific Selenium Study Plan—South Platte Segments 15 and 16a (Sand Creek).* Draft.

Note: All Web references current as of July 6, 2007.

EXHIBIT J

Division Exhibit 4

Water Quality Control Division's Comments on and Discussion of the Proposed Changes to Regulation 35, Classifications and Numeric Standards

April 4, 2006

Water Quality Control Division's Comments on and Discussion of the Proposed Changes to Regulation 35, Segment 4 of the San Miguel River, for Classification and Numeric Standards, as Related to Temperature and Aquatic Life

Tri-State Generation and Transmission Association, Inc. (hereinafter "Tri-State") has proposed a revised classification and numeric standard for segments 4 and 5 of the San Miguel River. In the following testimony, the Water Quality Control Division (hereinafter "Division") presents its position on Tri-State's proposal and presents and develops an alternative proposal for a standard. The Division originally proposed in the Notice to extend the current temporary modification. Background information on the current standard and existing water quality is also provided.

Much of the information and data in this exhibit are presented by Tri-State and their consultant, Chadwick Ecological Consultants (hereinafter "CEC") in their Aquatic Biological Studies Report (CEC, 2006) and in previous reports and information received from Tri-State (Arcadis Report, 2001). The Division appreciates the information provided by Tri-State and their efforts in studying the San Miguel.

Attachment 1 is a list of documents that were used in this process by the Division. Hard copies of the documents are available upon request. Attachment 2 are computer files on a compact disk of data upon which the Division's analysis and proposals are based. The compact disk is available from the Commission office, or a copy can be requested from the Division.

I. CURRENT WATER QUALITY STANDARDS AND CONDITIONS IN THE SAN MIGUEL RIVER, SEGMENTS 4 AND 5

Recent History of Classifications and standards

Currently, the San Miguel River, segments 4 and 5 are classified for Aquatic Life as Cold Water Class 1, and Warm Water Class 1, respectively with the associated 20°C and 30°C temperature standards. Cold Water Class 1 classification is defined as "…waters that (1) currently are capable of sustaining a wide variety of cold-water biota, including sensitive species, or (2) could sustain such biota but for correctible water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species" [Reg.31.13 (1)(c)(i)]. "Cold-water biota" is defined as "aquatic life, including trout, normally found in waters where summer temperature does not often exceed 20°C" [Reg.31.5 (8)]. Table 1 of the basic standards includes a temperature standard of "Max 20°C" for Class 1 – Cold Water Aquatic Life.

Warm Water Class 1 classification is defined as "…waters that (1) currently are capable of sustaining a wide variety of warm-water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species" [Reg.31.13 (1)(c)(ii)]. "Warm-water biota" is defined as "aquatic life, normally found in waters where the summer temperature frequently exceeds 20°C. Table 1 of the basic standards includes a temperature standard of "Max 30°C" for Class 1 – Warm Water Aquatic Life.

The segment boundary between segments 4 and 5 is currently located at the confluence with Naturita Creek. Segments are generally defined according to the points at which the use, water quality, or other stream characteristics change significantly enough to require a different classification and/or water quality standards [Reg.31.6 (4)(c) and 35.11(iii)(3)]. In many cases, such transition points are identified from available data. In other cases, delineation of segments are based upon best professional judgments on the points where changes in uses, water quality, or other stream characteristics would likely occur. According to [Reg.31.6 (2)(b)], the procedures for upgrading/downgrading an assigned beneficial use classification, states that at a minimum, the state shall maintain those water use classifications currently designated, unless it can be demonstrated that the existing classification is not presently being attained and cannot be attained within a twenty (20) year time period.

A temporary modification to the temperature standard was established in 2001 for Segment 4 from the Power Plant Bridge, downstream of Brooks Bridge, to Naturita Creek (Reg. 35, effective February 20, 2002). This temporary modification of 28°C is for the months of July, August, and September. The temporary modification is set to expire on December 31, 2006 [Reg.35.21 (h)]. The purpose of the temporary modification was to allow time for Tri-State to participate in a workgroup that addressed the statewide implementation of the narrative and numeric temperature standards that affect discharge limitations through the basic standards triennial review process.

In preparation for the June 2006 rulemaking, several discussions have been held among the Division, Tri-State, Colorado Division of Wildlife (hereinafter "CDOW"), U.S. Environmental Protection Agency (hereinafter, "EPA") and CEC. The proposed resegmentation of the San Miguel River was discussed among the parties and unresolved issues needed to be addressed before consideration of resegmentation could proceed. The Division indicated that more data on the aquatic biological community was needed, as limited fish and no invertebrate data was available to support resegmentation. The above parties met to develop a study plan for the acquisition of more data. CEC conducted biological and temperature sampling to address the issues brought up in discussions.

II. DISCUSSION OF TRI-STATE'S PROPOSED RESEGMENTATION/RECLASSIFICATION

Proposal by Tri-State

In the notice for this rulemaking, Tri-State has proposed two alternatives dealing with segmentation, classification and standards changes associated with Segments 4 and 5 of the San Miguel River. Tri-State's preferred alternative is alternative 1.

Alternative 1 involves changing the segmentation boundary for Segments 4 and 5 as follows:

Segment 4: Mainstem of the San Miguel River from a point immediately above the confluence of the South Fork of the San Miguel to a point immediately below the confluence of Big Bucktail Creek.

Segment 5: Mainstream of San Miguel River from a point immediately below the confluence of Big Bucktail Creek to its confluence with the Dolores River.

Alternative 1 would delete the current temporary modification.

Alternative 2 involves a seasonal classification and standards change to Segment 4. The following qualifier would be added to the Aquatic Life Cold 1 classification: Aquatic Life Warm 1, June through October from Big Bucktail Creek to Naturita Creek. Instream temperature standards shall be implemented as Maximum Weekly Average Temperatures at the end of the chronic regulatory mixing zone.

Alternative 2 would delete the current temporary modification.

Issues and Concerns

The Division has two significant concerns related to the protection of the aquatic life use classification of the San Miguel River: the analysis of biological data relating to a change to Warm Water Aquatic Life Class1 for the lower portion of Segment 4, and the analysis of temperature data by Tri-State. Our concerns are based on our review of the conclusions found in the Aquatic Biological Studies Report, previous data submitted to the Division by Tri-State in the course of discussions, and on scientific literature on the thermal tolerances of macroinvertebrates and instream water temperature models.

1.Issues with analysis of biological data. The Division believes that the analysis of biological data does not conclusively point to a clear-cut segment boundary, or that the biological data conclusively shows a warm-water biological community in the region that the Tri-State proposal would reclassify.

Analysis of the biological data does not show a compelling argument for reclassifying the aquatic life beneficial use to a Warm Water Class 1. The Division's analysis focused on the analysis of biological data as a means of demonstrating the spatial distribution of species that maybe regarded as typical of warm-water or coldwater communities. One difficulty in reviewing the data is that the stream reach in question may constitute a zone of transition where distinct boundaries are not readily observable. In applying a "weight of evidence" approach to this problem, however, the aim is to determine whether or not a compelling case can be made for change. Finding that a change is plausible is not sufficient to discard the existing classification, which remains a reasonable approach.

Aquatic communities are usually partitioned into three categories – fish, benthos, and periphyton – each of which is sampled differently. In the San Miguel River, previous collections of fish and benthos provide the basis for the present analysis. The recent study commissioned by Tri-State included samples of fish and benthos at each of four locations in the vicinity of the power plant. CDOW sampled fish populations in the same general region in 1977 and 1999. In addition, CDOW has been stocking coldwater species in the San Miguel for over 50 years.

Analysis of Benthos

Benthic organisms are useful integrators of habitat conditions at a particular spot in a stream because their movements (with the exception of drift) are much more restricted than those of fish and their life spans are much longer than periphyton organisms. Thus, they are more likely to indicate the suitability of a particular spot for warmwater or coldwater organisms.

The data provided by Tri-State can be used to categorize the benthic community at each of four locations relevant to the re-segmentation proposal. Under the present classification scheme, three locations are within the coldwater segment 4 and one is within the warmwater segment 5. In order to justify relocating the segment boundary upstream, one or two of the upstream sites should have biological communities consistent with a warmwater designation.

One strategy for evaluating the thermal preference of the community is to assess the thermal preferences of the individual species. Fortunately, the Idaho Department of Environmental Quality has compiled thermal tolerances, based on literature review and field investigations, covering most of the species found in the San Miguel River. A species may be categorized as having a narrow tolerance range for temperature (stenothermal warm or cold) or a broad range under summer conditions (eurythermal cool, warm or hot).

Species collected in the four samples taken by Tri-State were placed in one of the five categories insofar as it was possible. The majority of species at all sites are considered "eurythermal warm summer" in their temperature preference. For the few species tolerant of colder temperatures (stenothermal cold and eurythermal cool summer), their spatial distribution did not show a clear pattern. These data alone seem not to support or refute the existing segmentation.

A broader perspective on the benthic organisms can be obtained by placing the Tri-State's sites within the context of comparable samples taken upstream and downstream on the San Miguel River. The Division has taken five samples (3 obtained in 1994, and 2 obtained in 2004) downstream near the confluence with the Dolores River, a location that should be typical of the warm-water conditions in Segment 5. In addition, eight samples (6 obtained in 1994, and 2 obtained in 2004) have been taken at upstream sites from Norwood Hill to above Telluride. The sites can serve as end members representing warmwater and coldwater conditions in the San Miguel basin. To allow data comparability between Tri-State data and Division data, counts were re-sampled statistically to yield results from a Division protocol specifying a 300-organism sub-sample. (The Division protocol utilizes the kick sample technique, while the CEC study utilized a surber sampler technique.)

A comparison of sites on the basis of the thermal tolerances of the resident organisms reveals an interesting and useful pattern. The percentage of taxa with a tolerance for colder conditions (stenothermal cold or eurythermal cool) decreases from high to low elevation. The Tri-State sites conform to the pattern, but are so similar to one another that it is not possible to select a boundary that would divide warmwater and coldwater sites.

Discriminant analysis was used to classify the end members (samples from warm-water and cold-water locations) based on a selection of standard metrics (e.g., total taxa, EPT (ephemeroptera, plecoptera, tricoptera) taxa, etc.) that aggregate species composition and abundance according to taxonomic or ecological criteria. The list of criteria was screened to reduce correlation among the classification variables. The resulting discriminant function classified all 12 sites correctly. The four sites from the Tri-State study were then added to the set and the analysis was performed for several scenarios designed to test the performance of the classification variables. The premise is that the fewest misclassifications will occur when the initial classification of the four Tri-State sites is most accurate with respect to the end members. A misclassification occurs when initial classification is at odds with the statistical analysis.

The current segmentation of the San Miguel River creates the expectation that one site (SMR-4) should be warm water class 1 (Segment 5) and that the other three sites should have coldwater biota. For the proposed change in segment boundaries to be justified, a better classification (as per the discriminant analysis) should result if sites SMR-2 and SMR-3 are classified as warmwater. Five scenarios are tested to allow consideration of all logical assignments of Tri-State sites to warmwater or coldwater. The optimal scenario, with SMR-4 classified as warmwater and the other three as coldwater sites, is consistent with the existing segmentation. It is the only scenario involving the Tri-State samples where there are no misclassifications.

In summary, analysis of available benthos data from Tri-State and the Division does not support a change in segment boundaries. While it would be easy to argue that a transition zone exists, there is not compelling reason to reject the existing boundary and even less justification to move it.

Analysis of Fish

The most recent information, provided by Tri-State, characterizes the fish community at each of four sites on the basis of electro-shock survey. There are clear differences among the sites in terms of abundance and species composition. Coldwater species are found only at SMR-1, and two eurythermal species are found at all sites. If a decision were required on the basis of those data alone, it would be difficult to make the argument that the reach below Piñon should be classified for coldwater aquatic life.

As it happens, additional information is available from older DOW sampling in 1999 and 1977. Although sampling sites differ from those in the recent study, the distribution of sites along the river is adequate for obtaining a general picture of species composition and its longitudinal changes. The data suggest that coldwater taxa have been found much further downstream than was the case in the recent study.

The difficulty in reaching simple conclusions is illustrated by additional comparisons focusing on collections over time at comparable sites. The sites were not replicated exactly, but are close enough to serve present purposes. All three studies included collections near Piñon Bridge. It is apparent that species composition and abundance can be quite variable. The same is true further downstream for collections made above Uravan. When taken in aggregate, the fish data do not make a convincing case for altering the existing segmentation of the San Miguel.

<u>2.Issues with analysis of temperature data.</u> Tri-State has provided the Division with a large data set of temperature measurements from the San Miguel River in the vicinity of their effluent discharge. (Attachment 2) The records document trends over time (daily and seasonal, annual for a few sites) at each site, and longitudinal trends on each date. The data can help assess the impact of the heated water discharge, and the relative importance of other factors in determining the spatial changes in temperature. Use of the data for determining the proper classification of the stream segment is more difficult because existing standards lack clarity from the perspective of implementation.

Data loggers installed at 12 locations have recorded water temperature at 15-minute intervals for varying periods of record. At most stations, the period of record is relatively brief, beginning in July or August 2005. Tri-State has attempted to extend the usefulness of each record by establishing predictive relationships (regression equations) that use a station with a long record to "simulate" data for stations with only a short record. Tri-State had verbal approval to apply a modeling approach, of which linear regression is undoubtedly the simplest forum. The potential pitfalls of this approach are numerous and deserve comment.

Preliminary screening of the data provided by Tri-State revealed some problems that could influence calculation of daily means at individual sites, or bias predictions based on regression lines. One of the more conspicuous problems appears in the record for the Piñon Bridge site. The amplitude of temperature variation greatly exceeds what would be expected for the stream, and the maximum and minimum values are inconsistent with values reported for adjacent sites. It is possible that the probe was out of the water on those dates. The problem is significant because daily averages from those dates provide the basis for calculating temperatures at four sites downstream in 2004.

Questions about reliability also arise in the very extensive data set for the Intake Pool. Reduced amplitude of variation and unusually low temperatures were recorded in 2002 and 2004. In addition, very high temperatures were recorded in July 2001. The data are of particular concern because they were used to predict temperatures at *all* other stations in 2001 and 2002.

With such a long data record, it is not surprising that there are occasional days with apparently anomalous values, but it does raise questions about the extent to which the data can be extrapolated in the manner shown in Tri-State's report. Concern about the data record is not the only reason to re-evaluate conclusions drawn in the Tri-State report. Graphs of simulated temperature in 2001, 2002, and 2003 are based entirely on measurements made in the Intake Pool.

Close inspection of diel variation in August 2005, when nearly all sites had coincident measurements, reveals interesting patterns. Average temperatures are below 20^{o}C at all sites. It is also apparent that temperature changes between adjacent sites are difficult to explain. Warming might be expected between each site during the day, but the observations do not support this expectation. For example, three reaches (Brooks to PP Bridge, Intake Pool to 1000 ft downstream, and Naturita up to Naturita down) show substantial cooling during the early afternoon. It is hard to imagine a mechanism that could produce such a response if sites are truly representative of stream conditions. One possible explanation would be incomplete mixing. All three reaches have in common the addition of flow between sites (i.e., Bucktail Creek, plant effluent, and Naturita Creek). If mixing is not complete between those sites, questions should be raised about regression equations and temperature predictions offered by Tri-State.

Tri-State has relied heavily on simulated temperature values for the assessment of conditions in the river. A more complete review of measured temperature data is desirable. The most complete record is from the Intake Pool, for which July and August data are available for five years. Average values for July show that the 20^{o}C threshold is exceeded in only one of the five years; the same is true of the August data. It remains true, however, that the 20^{o}C threshold is exceeded for part of each day. The variation across years appears to be large relative compared to the spatial variation observed within one year.

Conclusions for the analysis of temperature data are the following:

- Too much reliance has been placed on "simulated" temperature data. There are errors in the records for key sites that have been used to simulate temperatures at other sites. The modeling approach applied by Tri-State is too simplistic to yield useful results.
- Measured temperature data show that variation across years at one site may be more important than spatial variation at one time. Broad spatial coverage relevant to the months of concern is available only in August 2005. The range of daily average temperatures observed in August 2005 is relatively small – 18.0 above Bucktail to 19.1 above Naturita – whereas the range of the average August temperatures in the Intake Pool is 17 to 20 over five successive years.
- Some sites may not represent mixed conditions. Tri-State should demonstrate that the following sites represent fully mixed conditions: below Bucktail, 1000 ft downstream, 3000 ft downstream, and below Naturita. The USGS defines mixing distance by a rule-of-thumb approach; the downstream site should be at least 30x channel width below the outfall.

- Temperature data provide weak support for the position that the reach in question has been misclassified. The average temperatures are typically below the nominal threshold of 20^{o}C during the months of interest (July and August), and there is relatively little longitudinal change in temperature.

III. DIVISION'S ALTERNATIVE PROPOSAL

Introduction

In the lower part of the San Miguel River, there is a transition zone from warm-water to cold-water conditions. The transition is defined abruptly in a regulatory context as the boundary between segments 4 and 5. The transition for biological communities will be much more gradual, constituting a zone of transition rather than a line of demarcation, and it may be affected locally by variations in stream flow and temperature. While it is reasonable to expect the biota within each segment to conform approximately to the appropriate aquatic life classification, it is unrealistic to expect biological data to confirm or reject the precise boundary between the regulatory segments.

Interpretation of data is made more difficult by frequent and substantial alterations to water flows during the irrigation season. In the absence of diversions, the cold-water leaving Norwood Canyon would likely remain cold for quite a distance downstream. When diversions reduce flows to just a few cfs, there is a realistic expectation that the water will warm much more quickly than would be true at higher flows. Exposure to warmer water can affect the composition of the aquatic communities, but the duration of exposure is highly variable and dependent on flow alterations.

The Division maintains that conditions throughout Segment 4 would be fully supportive of cold-water biota if stream flows were sustained, but they are not. That the lower part of Segment 4 is not fully supportive of a cold-water classification is not at all surprising in view of the "significant alterations to water flows". It would be a mistake, however, to reject the cold-water classification, as Tri-State proposes. Instead, the Division proposes to change the designation to Class 2, in acknowledgment of the significance of flow alterations. Technical issues are presented below to justify a Class 2 designation.

The Division also recognizes that ambient temperature conditions push the boundary of what is normally considered cold-water conditions, creating a legitimate basis for a site-specific standard. Because the temperature regime is influenced by flow alterations, it remains appropriate to retain the cold-water classification, and to incorporate flow into the site-specific standard. The technical basis for that argument is presented below.

Proposal

Based on the Division's review of the San Miguel River Aquatic Community Study (CEC) and our discussion of the issues, the Division is proposing a site-specific seasonal temperature standard for the summer months as the desired approach. Along with the site-specific temperature standard, the Division also proposes a reclassification of the lower part of Segment 4 of the San Miguel to Cold Water Class 2 for aquatic life. The site-specific temperature standards would apply only to the lower portion of the segment. In the Division's proposal, Segment 4 would be divided into two parts at the CC ditch, into 4a and 4b. The new 4b segment would be reclassified as Cold Water Class 2. The other beneficial uses and numeric standards would remain the same as the original Segment 4.

Rationale for Development of a Site-Specific Temperature Standard

The Division does not support such the proposal offered by Tri-State because the biological evidence is not compelling evidence for resegmentation/reclassification. On the other hand, it is evident from field measurements that the lower portion of segment 4 is not easily classified as either warm- or cold-water. The case for a transition zone has already been advance on the basis of biological data. In the summer, temperatures may exceed 20^{o}C for some part (but never all) of each day.

Development of a site-specific temperature standard offers an option that would maintain a cold-water classification, but acknowledge that temperatures higher than 20^{o}C can be expected during the summer months, while still supporting classified uses. Formulation of a site-specific standard is hampered to some extent by uncertainties about the final form of statewide temperature standards now under development. For present purposes, however, it is reasonable to assume that the MWAT (maximum weekly average temperature) concept, or some variation thereof, may become the preferred averaging statistic. Currently, the 303(d) listing methodology uses the MWAT as the ambient statistic to define temperature.

Most of Segment 4 is a relatively high gradient stream that descends through a canyon. When the gradient is high, energy dissipation is the primary mechanism adding heat to the water, and this mechanism is independent of stream discharge (Meier et al. 2003). In the last few miles, beyond the confluence with Cottonwood Creek, the gradient lessens substantially. The change in slope has affects temperature predictions because there is a shift in the processes important for altering temperature. When the gradient is low, heat exchange processes (e.g., solar radiation, long-wave radiation, and exchange with the stream bed) drive the changes in temperature.

A useful basis for understanding the role of heat exchange processes is the "constant discharge heat transport model" presented by Theurer et al. (1984). It predicts change in temperature with a function that incorporates discharge explicitly. The details of the equation are less important than the form of the function and the underlying assumption that temperature is driven toward an "equilibrium" value. The assumption is particularly appropriate in this setting where the San Miguel delivers cold-water from the canyon, where temperatures are controlled largely by dissipation of kinetic energy, to the valley, where heat exchange processes dominate. The role for discharge is especially relevant because stream flows may be altered significantly on a time scale that is short relative to changes in air temperature, which drive the equilibrium temperature for the stream.

In the summer, stream flows may be strongly affected by water management practices and diversions to the CC Ditch are large enough to cause significant reductions in stream flow. At the Brooks Bridge gage, flows less than 10 cfs have been measured in 5 of the last 11 years. Reduction of flow is sufficiently frequent and pronounced to consider the merits of reclassifying the lower part of the segment (below the CC Ditch) as Cold 2. The potential for significant and abrupt change in flow must be considered in the formulation of a site-specific temperature standard whether or not the segment is reclassified.

The logical point of departure for a site-specific standard is a characterization of ambient temperatures in the reach. A very comprehensive data set has been obtained by Tri-State, whose sampling program has included as many as 11 data loggers distributed from Norwood to Uravan. Of the sites monitored, the most complete record is available at the Intake Pool. Loggers deployed in the pool have measured temperatures at 15-minute intervals for more than five years. Attention is focused on the summer months (chiefly July and August) because that is the part of the year when ambient temperatures are highest, making it a logical time for concerns about the potential effect of heated water discharge. It is also the time when stream flows are likely to be reduced by diversions; significant reductions also can occur in September.

MWATs were calculated from summer data at the Intake Pool, after some preliminary screening to remove days where amplitudes or daily extremes were obvious outliers. Data from July and August of five years (2001-2005) were used to construct box-and-whisker plots, which provide an efficient display of the distributions of 7-d averages (Figure 1). Although there are differences across years in the shapes of the distributions, the maxima in 4 of 5 years are very similar (21-22^{o}C). The Jul-Aug MWAT for all years was 21.7^{o}C, recorded in 2001. A very similar value was recorded in the summer of 2002. Characteristics of the days included in the 2001 and 2002 MWATs are shown in Tables 1 and 2. For the most part, there is much more variation in the daily range of temperature than there is in the daily minimum. This observation becomes important in development of the site-specific standard.

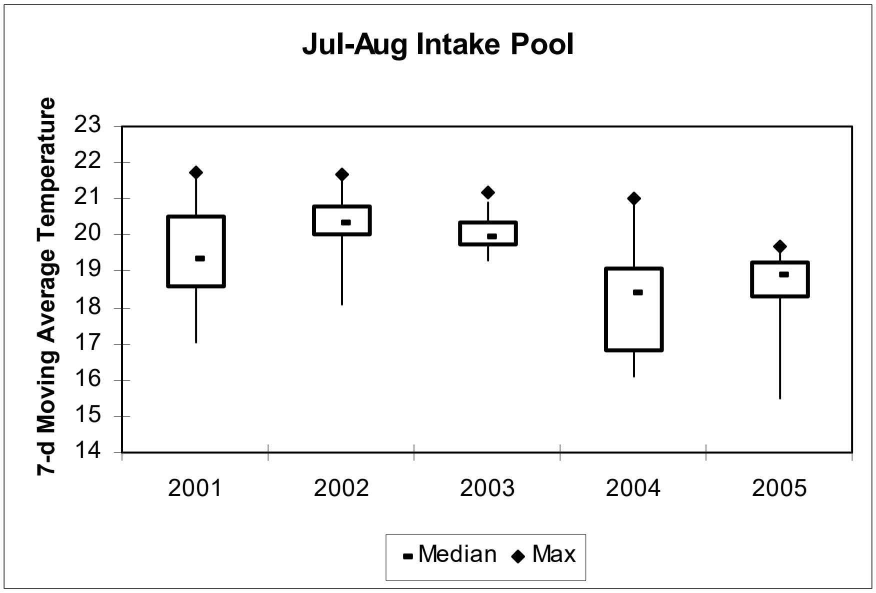

Figure 1. Box-and-whisker plots of 7-d moving average temperature in the intake pool for July and August of five consecutive years. The tips of the "whiskers" mark the 5% and 95% values; the box encompasses the central 50% of the values; the median and the maximum are shown with symbols as indicated.

Table 1. Daily characteristics of temperature for dates included in the MWAT for 2001. Temperatures are in ^{o}C and flows are in cfs.

Date	Minimum	Range	Average	Flow
7/25/2001	17.2	8.5	20.9	58
7/26/2001	18.8	7.2	22.0	54
7/27/2001	17.5	8.9	21.7	51
7/28/2001	16.9	11.6	22.2	35
7/29/2001	17.1	11.8	22.4	28
7/30/2001	17.2	9.9	21.5	23
7/31/2001	18.3	7.0	21.5	41
Average	17.6	9.3	21.7	41.4

Table 2. Daily characteristics of temperature for dates included in the MWAT for 2002. Temperatures are in ^{o}C and flows are in cfs.

Date	Minimum	Range	Average	Flow
7/7/2002	17.2	8.3	21.6	4.0
7/8/2002	18.2	8.0	22.1	3.5
7/9/2002	19.3	6.7	22.0	3.9
7/10/2002	18.5	7.5	21.6	5.0
7/11/2002	17.9	8.4	21.4	5.1
7/12/2002	17.6	9.7	21.5	4.5
7/13/2002	17.6	10.5	21.6	7.0
Average	18.0	8.4	21.7	4.7

MWATs are determined without consideration of variations in flow that occur within each 7-d interval. This shortcoming cannot be ignored in the San Miguel where diversions can have a radical impact on flow, and where flow may exert a strong influence on daily patterns of temperature variation. As mentioned previously, the change in gradient near the lower end of Segment 4 shifts the balance of physical processes controlling stream temperature. The increased role for heat exchange processes leads to the expectation that the daily range of temperature variation will show an inverse relationship to flow, because flow is an indicator of the thermal mass. Increasing the daily range should alter daily average temperature. (Unless the minimum is decreased by an amount equal to the increase in the maximum.) If either extreme were insensitive to flow, as was suggested previously for the daily minimum, any change in the amplitude would affect the average temperature.

Daily minimum temperatures for all August days in the period of record (2001-2005) at the Intake Pool were plotted as a function of flow at the Brooks Bridge gage (Figure 2). Attention was restricted to August because that time of year is least likely to show the effects of seasonal changes in air temperature. No association is apparent between flow and daily minimum temperature. Data examined from other sites support this conclusion. In addition, minimum temperature changes relatively little between nearby sites (Figure 3). Slope and intercept are both small enough to suggest very little change over a distance of several miles. The correspondence is similarly close between minima observed at the Brooks Bridge and Intake Pool sites.

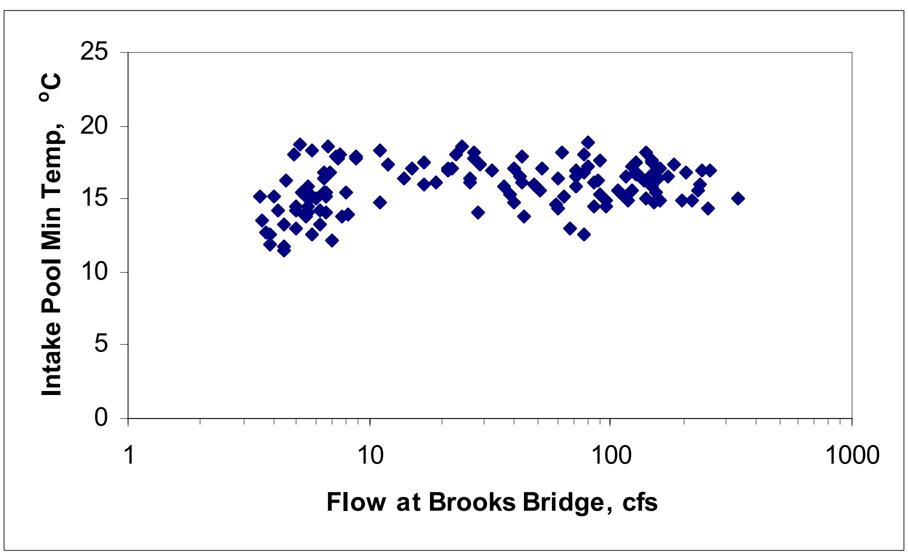

Figure 2. Daily minimum temperatures at the Intake Pool in the month of August, 2001-2005, as a function of stream flow.

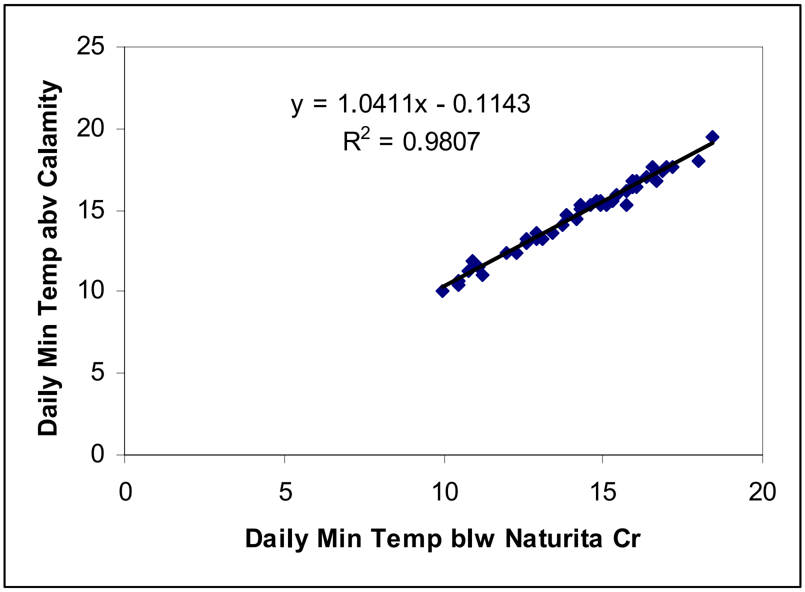

Figure 3. Correspondence between daily minimum temperatures recorded in the San Miguel River below Naturita Creek and above Calamity Draw in Aug-Sep 2005.

Given the expectation that daily minima are relatively stable and unaffected by flow, at least for short periods of time, it becomes important to examine the relationship between flow and the daily range of temperature variation. If the minimum and the range are known, the daily average, or adjustments thereto, can be computed using a sine curve to mimic the daily pattern of temperature.

The relationship between flow and the range of temperature at the Intake Pool is complex, but some key conclusions emerge (Figure 4). Most importantly, the greatest daily variation in temperature occurs at lowest flow; variability decreases as flow increases. At high flow, the small daily range of temperature reflects the resistance of a large volume to temperature change. The range of temperature variation may be low at any flow; this is neither surprising nor entirely relevant to present purposes. The chief concern from the standpoint of the site-specific temperature standard is to properly address the influence of low flows on the MWAT. At low flow, under proper conditions, the daily range of temperature can be very large.

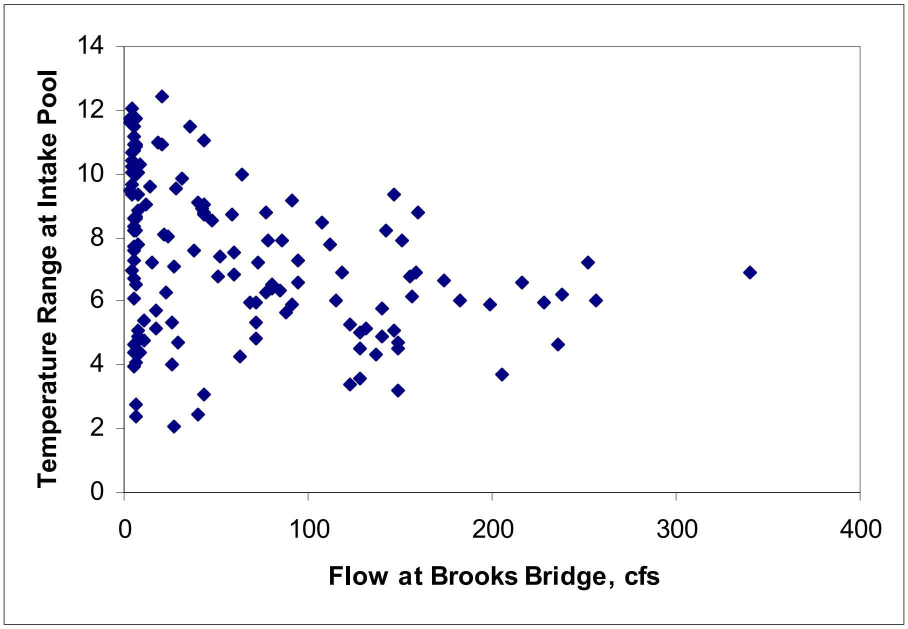

Figure 4. Relationship between the daily range of temperature at the Intake Pool and the daily average stream flow at Brooks Bridge. Data are taken from August in each of the five years available. The daily range of temperatures is twice the amplitude.

The mechanism of adjustment proposed to account for the effect of flow on temperature is to reconstruct the MWAT using a larger amplitude, one that is representative of what could occur if a string of low flow days occurred during optimal conditions for heat gain (i.e., clear skies and high air temperatures). Assuming that the daily pattern of variation is represented adequately by a sine function, and using the average of the observed minima as a "baseline", the adjusted MWAT is simply the sum of the minimum and amplitude (i.e., half of the daily range of values). The adjustment increases the MWAT to 24.0 from 21.7^{o}C, as derived from measured temperature.

The remaining step is to decide where and when the adjusted MWAT should be applied within Segment 4. Significant alterations to flow occur at the CC Ditch headgate and affect the remainder of the Segment. The consequences of the flow reduction are sufficiently frequent and large to justify re-classifying this portion of the Segment as Class 2 for aquatic life. The adjusted MWAT should be applied to the reclassified Segment. Also, it may be appropriate to apply the adjusted MWAT only when flow (as measured at Brooks Bridge) falls below a threshold; a case the data suggest a threshold in the vicinity of 60-100 cfs (cf. Figure 4). The site-specific standard would be applied only in those months with high ambient temperatures – Jul-Sep. The adjusted MWAT would be the standard when flows were below the stated threshold; otherwise, the unadjusted MWAT value would be applied.

<u>Rationale for Reclassification of the Lower Part of Segment 4</u>

Support for Re-Classifying the Lower Part of Segment 4 of the San Miguel as Cold-Water Class 2 for Aquatic Life

Class 1 waters are supposed to be "capable of sustaining a wide variety of … biota, including sensitive species." Some streams are not deserving of that classification for reasons that may include impairment of physical habitat, uncorrectable water quality degradation, or significant alterations to water flows or levels. Segment 4 of the San Miguel is presently classified as Cold-water Class 1, but recent investigations cast doubt on the validity of that classification for the lower part of the segment. Diversions at the CC Ditch below Norwood reduce flows to an extent that warrants consideration for re-classification to Class 2.

The CC Ditch typically carries about 120 cfs, but has the right to take as much as 145 cfs. Operation has been relatively consistent since the 1960s. (A brief synopsis of the operating history was provided in a March 14 e-mail from Chantelle Johnson of Tri-State.) When flow in the river is low, the diversion can remove almost all flow. Evidence for the importance of the diversion can be seen in the historical record of flows at the USGS gage downstream at Brooks Bridge (Figure 5). Reduction of flow constricts the habitat available to the aquatic organisms. It also slows the velocity of the stream, and this slower velocity has water quality implications including such constituents as temperature, pH, dissolved oxygen, and sediment.

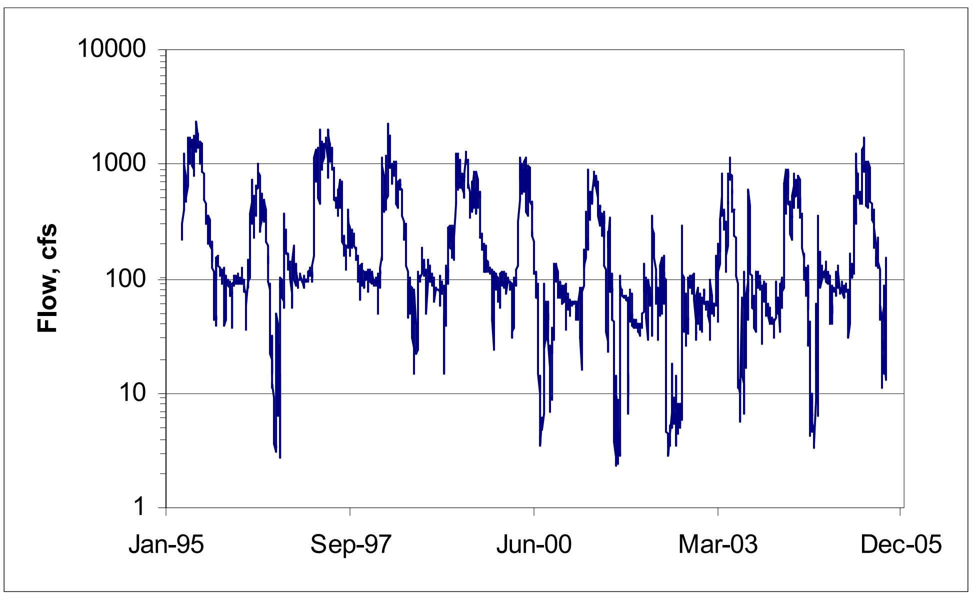

Figure 5. Daily average flows (cfs) at the Brooks Bridge gage for the period of record (1995-2005). Note that flows are plotted on a log scale to accentuate the occurrence of lowest flows.

The case for Class 2 can be made compelling on the basis of flows. Two lines of evidence are presented: effect on habitat dimensions and effect on water velocity. Flow reductions diminish the habitat available for aquatic organisms. In most streams, minimum habitat dimensions are encountered during baseflow conditions, which usually occur in late summer, or in winter at higher elevations. The historical record at the Brooks Bridge site is not long enough to show unaltered baseflow conditions, but a value of 80-100 cfs is reasonable based on comparison with the gage upstream at Placerville (Figure 6). Summer flows often are much less than the expected baseflow at Brooks

Bridge. The change is particularly important in a channel like that of the San Miguel where dimensions are shaped at high flows (bankfull or more) and no re-shaping occurs as flow declines. The channel is shaped to accommodate flows much higher than the 3 cfs minimum it now experiences, with the result that a very small amount of water is spread thinly over a relatively large channel.

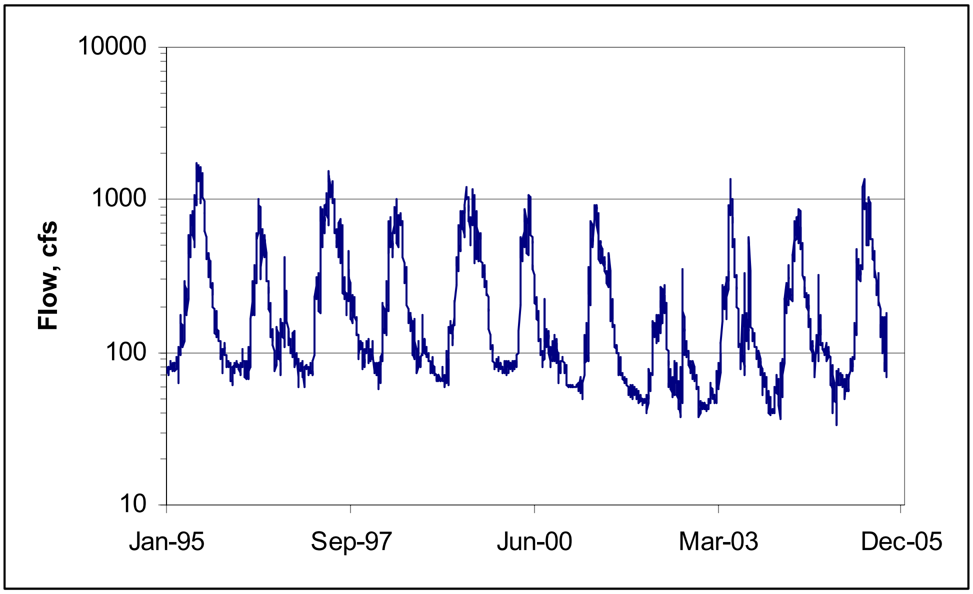

Figure 6. Daily average flows (cfs) at the Placerville gage for the period 1995-2005. Note that flows are plotted on a log scale to accentuate the occurrence of lowest flows.

In comparison to baseflow conditions, the altered flows are shallower and cover less area of substrate. Channel geometry equations can be used to show how much the width and depth of flow are reduced when flows are only 3 cfs instead of 80-100 cfs. The connections between flow and channel width (Figure 7), and between flow and average depth (Figure 8), are captured in channel geometry equations, which are applied here to compare width and depth under specific flow conditions (Table 3). A caveat should be inserted here: the table includes extrapolations beyond the range of measured values. Nevertheless, it is clear that when flows are very low, habitat area is only half of that expected at unaltered baseflow and there is not enough to cover the cobbles (diameter: 2.5-10”) that are the dominant substrate type in this reach. These are significant alterations in comparison to expected baseflow conditions, but not yet the full measure of change. The Tri-State intake removes another 3 cfs, which may be virtually all remaining flow under the lowest flow conditions recorded at the Brooks Bridge gage.

Table 3. Calculated width, depth and velocity in the San Miguel at the Brooks Bridge as a function of stream flow. Calculations are based on channel geometry equations as explained in the text.

Flow, cfs	**Top Width, ft**	**Average Depth, in**	**Average Velocity, ft/s**
100	62.4	14.7	1.31
50	55.5	11.9	0.91
20	47.6	9.0	0.56

10	42.4	7.3	0.39
5	37.7	5.9	0.27
3	34.6	5.1	0.21

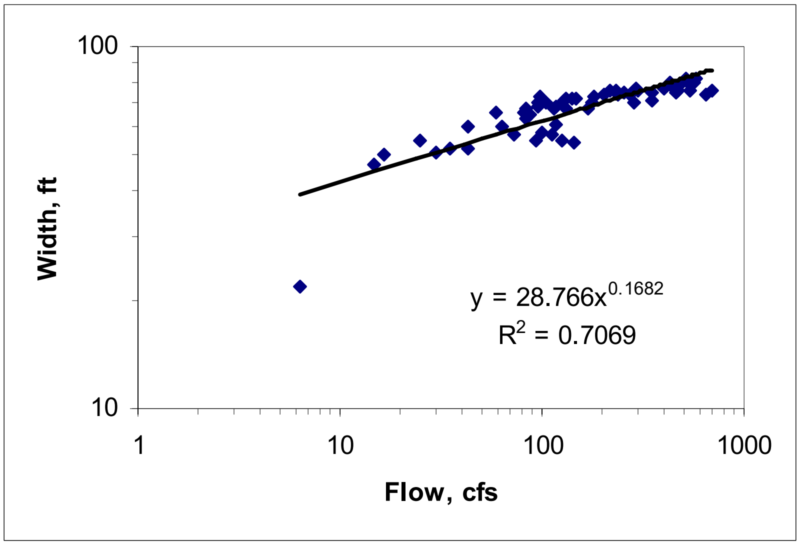

Figure 7. Relationship between channel width and flow in the San Miguel River at the Brooks Bridge gage. The data were obtained from by the USGS as part of routine gage calibrations. Data are fit to a power function, consistent with channel geometry equations.

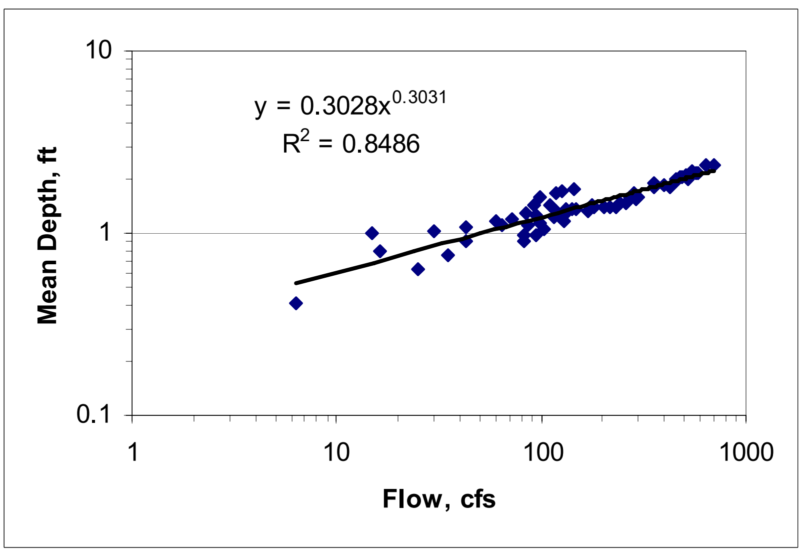

Figure 8. Relationship between mean depth and flow in the San Miguel River at the Brooks Bridge gage. The data were obtained from by the USGS as part of routine gage calibrations. The data are fit to a power function, consistent with channel geometry equations.

While the alterations to available habitat are important, it is not the full extent of alteration to stream conditions. Stream velocity is decreased by a factor of 6 from that expected under unaltered baseflow conditions (Figure 5 and Table 1). There are several consequences of the much-reduced velocity: the capacity to carry sediment is decreased, the capacity to deposit sediment is increased, the opportunity to warm the water is increased (smaller thermal mass moving slowly), and there is greater opportunity for biological processes (photosynthesis) to regulate dissolved oxygen and pH.

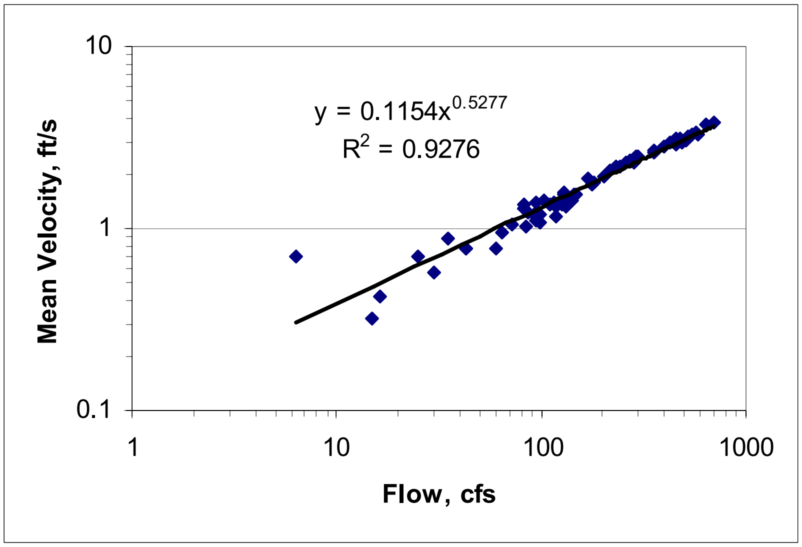

Figure 9. Relationship between mean velocity and flow in the San Miguel River at the Brooks Bridge gage. The data were obtained from by the USGS as part of routine gage calibrations. The data are fit to a power function, consistent with channel geometry equations.

The loss of flow that is the direct result of diversions at the CC ditch, as well as at several locations downstream, including the Tri-State intake, causes significant impairment to habitat for aquatic organisms in the San Miguel River. The expected effects are sufficiently important to call into question the suitability of the present Class 1 designation. On the basis of the evidence presented above, the Division believes a Class 2 designation would be more appropriate.

Division Exhibit 4

Water Quality Control Division's
Alternative Basis and Purpose Statement

April 4th, 2006

Division's Alternative
Statement of Basis Specific Statutory Authority and Purpose

The provisions of 25-8-202(1)(a) and (b); 25-8-204; and 25-8-402 C.R.S. provide the specific statutory authority for the amendments to this regulation adopted by the Commission. The Commission also adopted in compliance with 24-4-103(4) C.R.S., the following statement of basis and purpose.

<u>Basis and Purpose</u>

The Colorado Water Quality Control Commission established Aquatic Life classifications and temperature standards for the San Miguel River of the Gunnison and Lower Dolores River Basins. In the 2001 Classification and Standards Rulemaking Hearing for the Gunnison and Lower Dolores River Basins, the Commission decided to grant the temporary modification to the temperature standard for Segment 4 of the San Miguel River from the Power Plant Bridge, downstream of Brooks Bridge, to Naturita Creek. The temporary modification of 28°C was granted for the months of July, August and September, and is set to expire on December 31st, 2006. In the Statement of Basis, Specific Statutory Authority and Purpose, the Commission adopted this temporary modification "to allow time for Tri-State to participate in a workgroup addressed the statewide implementation of the narrative and numeric temperature standards that affect discharge limitations through the basic standards triennial review process."

Since the 2001 rulemaking, Tri-State and CEC performed additional studies on the San Miguel River, segments 4 and 5 to include biological information and temperature information. Based on the results of these studies and consideration of appropriate scientific literature, the Division recommended that a seasonal temperature standard of 24°C be applied for the months of July-September. The Division also recommended that Segment 4 be divided into two segments at the CC ditch, 4a and 4b, and that segment 4b be reclassified as Cold Water Class 2 for Aquatic Life.

Division Exhibit 4, Attachment 1

References:

Meier, W., C. Bonjour, A. Wuest, and P. Reichert. 2003. Modeling the effect of water diversion on the temperature of mountain streams. Journal of Environmental Engineering 129: 755-764.

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Chadwick Ecological Consultants, Inc. 2006. San Miguel River Segments 4 and 5 Boundary Aquatic Biological Studies. Prepared for Tri-State Generation and Transmission Association.

Arcadis, Geraghty and Miller. 2001. Written Testimony of Craig E. Divine, M.S. and Frank J. Johns, II, P.E. in the Matter of Revisions to Regulation #35 – Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins San Miguel River Segment 4 Before the Colorado Water Quality Control Commission. Prepared for Tri-State Generation and Transmission Association.

EXHIBIT K

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18TH STREET - SUITE 500
DENVER, CO 80202-2466
http:www.epa.gov/region08

October 30, 2006

Ref: 8EPR-EP

Mr. Brian Nazarenus, Chair
Water Quality Control Commission
4300 Cherry Creek Drive South
Denver, CO 80222-1530

Subject: Revisions to Regulations 34, 35 and 38

Dear Mr. Nazarenus:

The U.S. Environmental Protection Agency (EPA) has completed its review of the water quality standards revisions adopted by Colorado's Water Quality Control Commission (Commission) for segments in the San Juan River and Dolores River Basins (Regulation 34), the Gunnison and Lower Dolores River Basins (Regulation 35), and the South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin (Regulation 38). The revisions addressed today were adopted on August 14, 2006 and submitted to EPA Region 8 for approval with a letter dated August 21, 2006. The revisions to Regulation 34 and 35 were adopted with an effective date of January 1, 2007. The revisions to Regulation 38 were adopted with an effective date of September 30, 2006. The submission letter included an Attorney General's opinion certifying that the standards were duly adopted pursuant to State law. Receipt of the revised standards on August 23, 2006 initiated EPA's review pursuant to § 303(c) of the Act. EPA has completed its review of the revisions, and this letter is to notify you of our action.

The Region commends the Commission and the Water Quality Control Division (Division) for the significant improvements to the water quality standards for the three basins. Especially commendable were the revisions to antidegradation designations. In addition to adding an Outstanding Waters designation to several water bodies, including waters within Mesa Verde National Park, revisions were adopted to move 22 segments into a fully "reviewable" status. We are also appreciative of the State's efforts to resolve the EPA disapproval issue, which concerned the selenium and zinc standards applicable to Lower Dolores segment 3. Generally, the adopted revisions were well supported by the evidence submitted by the Division and the parties, and we congratulate both the Commission and the Division for these significant improvements to the State's water quality standards.

AGENCY REVIEW

Clean Water Act (CWA) § 303(c)(2) requires States and authorized Indian Tribes to submit new or revised water quality standards to EPA for review. EPA is to review and approve or disapprove the submitted standards. Pursuant to CWA § 303(c)(3), if EPA determines that any standard is not consistent with the applicable requirements of the Act, the Agency shall, not later than the ninetieth day after the date of submission, notify the State or authorized Tribe and specify the changes to meet the requirements. If such changes are not adopted by the State or authorized Tribe within ninety days after the date of notification, EPA shall promulgate the needed standard pursuant to CWA § 303(c)(4). The Region's goal has been, and will continue to be, to work closely with States and authorized Tribes throughout the standards revision process as a means to avoid the need for such disapproval and promulgation actions.

TODAY'S ACTION

I am pleased to inform you that today the Region is approving all revisions to Regulations 34, 35, and 38 adopted by the Commission on August 14, 2006. Enclosure 1 presents a summary of the adopted revisions and a rationale for EPA's action.

The water quality standards approvals in today's letter apply only to water bodies in the State of Colorado, and do not apply to waters that are within Indian Country, as defined in 18 U.S.C. Section 1151. Today's letter is not intended as an action to approve or disapprove water quality standards applying to waters within Indian Country. EPA, or authorized Indian Tribes, as appropriate, will retain responsibilities for water quality standards for waters within Indian Country.

ENDANGERED SPECIES ACT REQUIREMENTS

It is important to note that EPA approval of new or revised State water quality standards is considered a federal action which may be subject to the Section 7(a)(2) consultation requirements of the Endangered Species Act (ESA).[1] Section 7(a)(2) of the ESA states that "each federal agency ... shall ... insure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined to be critical..."

EPA's approval of the water quality standards revisions, therefore, may be subject to the results of consultation with the U.S. Fish and Wildlife Service pursuant to Section 7(a)(2) of the ESA. Nevertheless, EPA also has a Clean Water Act obligation, as a separate matter, to complete its water quality standards approval action. Therefore, in approving the water quality standards revisions today, EPA is completing its CWA Section 303(c) responsibilities. However, should the consultation process with the U.S. Fish and Wildlife Service identify information that supports a conclusion that one or more of these revisions is likely to jeopardize the continued existence of any endangered or threatened species, EPA will revisit and amend its approval decision for those revised or new water quality standards.

[1] Where EPA concludes that an approval action will have no effect on endangered or threatened species, or is otherwise not subject to ESA consultation, EPA can issue an unconditional approval.

Today's action includes a finding that EPA's approval of certain elements of the revised water quality standards will have no effect on listed or proposed endangered or threatened species, or is otherwise not subject to ESA consultation. For these revisions, no consultation with the U.S. Fish and Wildlife Service is required. The discussion below, therefore, covers two categories of revisions: (1) revisions approved without condition, and (2) those that are approved, subject to ESA consultation.

APPROVED REVISIONS

EPA has concluded that approval of certain revisions will have no effect on listed or proposed endangered or threatened species, or is otherwise not subject to ESA consultation. Accordingly, revisions that are approved without condition include the following:

- All revisions to antidegradation standards.
- All revisions to recreation classifications.
- All revisions to numeric standards for the protection of recreation classifications.
- All revisions to water supply classifications.
- All revisions to human health-based numeric standards.
- All revisions to agriculture classifications.
- All revisions to numeric standards for the protection of agriculture classifications.

APPROVED REVISIONS, SUBJECT TO ESA CONSULTATION

With the exception of the revisions described above, the remaining revisions are approved for purposes of CWA Section 303(c), subject to the results of consultation under Section 7(a)(2) of the ESA. Should the consultation process with the U.S. Fish and Wildlife Service identify information that supports a conclusion that one or more of the revisions in this category are likely to jeopardize the continued existence of any listed endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat of such species, the Region will revisit and revise, as necessary, its approval decision for the identified water quality standards. Revisions that are approved subject to ESA consultation include the following:

- All revisions to aquatic life classifications.
- All revisions to the numeric standards for the protection of aquatic life.
- All other revisions, including the adoption of temporary modifications and revisions that resulted in the re-segmentation, re-naming and consolidation of segments.

CONCLUSION

EPA Region 8 congratulates the Commission and the Division for the significant improvements to the water quality standards contained in Regulation 34, 35, and 38. The Region looks forward to working with the State to make additional improvements to the standards for these basins. If you have questions concerning this letter, please call me or Max Dodson, Assistant Regional Administrator, Office of Ecosystems Protection and Remediation at 303-312-6598, or have your staff contact David Moon at 303-312-6833 or Bill Wuerthele, Regional Water Quality Standards Coordinator, at 303-312-6943.

Sincerely,

Robert E. Roberts
Regional Administrator

Enclosure

ENCLOSURE 1

RATIONALE FOR EPA'S ACTION ON THE REVISIONS TO THE WATER QUALITY STANDARDS FOR THE SAN JUAN AND DOLORES (REGULATION 34), GUNNISON AND LOWER DOLORES (REGULATION 35), AND SOUTH PLATTE (REGULATION 38) RIVER BASINS

Today's EPA action letter addresses the revisions to the Regulation 34, 35, and 38 adopted by the Water Quality Control Commission (Commission) on August 14, 2006. This enclosure provides a summary of the revisions and a rationale for the action taken by EPA. The discussion below covers two categories of revisions: (1) revisions that are approved for purposes of CWA § 303(c), and (2) revisions that are approved for purposes of CWA § 303(c), subject to ESA consultation.

I. APPROVED REVISIONS

EPA has concluded that approval of certain revisions either will have no effect on listed or proposed endangered or threatened species, or is otherwise not subject to ESA consultation. Major revisions in this category are discussed below.

Antidegradation Designations

The revisions included various changes to Outstanding Waters and Use Protected designations for individual water bodies. Revisions to Use Protected designations were adopted to implement the changes to Colorado's antidegradation rule adopted during the 2005 review of the Basic Standards regulation. Where a Use Protected designation is deleted, the Region notes that this results in a more stringent antidegradation standard (i.e., the segment becomes "reviewable"). Based on the evidence submitted, the Region has concluded that the revisions to antidegradation designations are consistent with Colorado's antidegradation rule, as contained in Section 31.8 of the Basic Standards and Methodologies for Surface Waters. Colorado's antidegradation rule was previously approved by the Region (most recently, on October 17, 2005). The Region has likewise concluded that the segment-specific revisions to antidegradation designations are consistent with the federal antidegradation requirements at 40 CFR § 131.12. Accordingly, all revisions to antidegradation designations are approved.

San Juan and Dolores Basin Segment	Revision
San Juan 3	Use Protected Designation Deleted
Los Pinos 6a, 7a	Use Protected Designation Deleted
Animas and Florida 13a, 13b, 15	Use Protected Designation Deleted
Animas and Florida 12c	Outstanding Waters Designation Added
La Plata 2a	Use Protected Designation Deleted
La Plata 6c	Outstanding Waters Designation Added
Dolores 9, 11	Use Protected Designation Deleted

Gunnison//Lower Dolores Basin Segment	Revision
Upper Gunnison 1 (Powderhorn Wilderness Area)	Outstanding Waters Designation Added
Upper Gunnison 6a, 13a, 13b, 15, 17	Use Protected Designation Deleted
Uncompahgre 6a, 7, 8, 9, 10, 13	Use Protected Designation Deleted
Lower Gunnison 7	Use Protected Designation Deleted
San Miguel 12	Use Protected Designation Deleted

Recreation Classifications

The recreation classifications for all segments were revised, consistent with the new recreation classifications adopted during the 2005 review of the Basic Standards regulation. For the vast majority of segments, these changes were in name only (e.g., from "Class 1a" to "Class E"), with no difference in the stringency of the associated *E. coli* standard. For a few segments, more stringent recreation classifications (or longer warm weather seasons) were adopted. For example, based on evidence of increased use by the public, the recreation classification was upgraded to Recreation Class E for Red Rock Creek within the Black Canyon of the Gunnison National Park. None of the revisions resulted in adoption of a less stringent recreation standard. Based on review of the revisions and the supporting evidence, the Region has concluded that the revisions are consistent with federal requirements at 40 CFR § 131.10. Accordingly, all revisions to recreation classifications are approved.

Numeric Standards for the Protection of Recreation Classifications

The fecal coliform standards were deleted from all segments in both basins, thereby completing the transition from fecal coliform-based standards to (previously adopted) *E. coli*-based standards. These revisions are consistent with EPA's national criteria guidelines, which recommend that States use the indicator organisms *E. coli* or enterococci as the basis for their freshwater bacteriological criteria. In contrast to the wholesale deletion of the fecal coliform-based numeric standards, there were relatively few changes to the *E. coli*-based numeric standards (adopted in a previous WQS rulemaking). The revisions which were adopted generally resulted in a longer warm weather recreation season (e.g., Piedra segments 2 and 3), elimination of the cold weather recreation season altogether (e.g., La Plata segment 4b and 6c), adoption of a more stringent *E. coli* standard, or application of *E. coli* standards to segments where this had not been completed previously. None of the revisions resulted in a less stringent *E. coli* standard. The revisions are consistent with federal requirements at 40 CFR § 131.11, because the adopted numeric standards describe a level of water quality that will protect the assigned recreation classification. Accordingly, the Region approves all revisions to the numeric standards for the protection of recreation uses.

Water Supply Classifications

For several segments, revisions to water supply classifications were adopted. The water supply classification was added to Uncompahgre segment 3a, and removed from some of the small tributaries previously included in North Fork of the Gunnison segment 6 (a new Segment

6a was created for these tributaries). The decision to remove the water supply classification from North Fork segment 6a was based on the lack of existing water supply diversions/uses (i.e., these waters have never been used as a source of drinking water), as well as the lack of flow and other conditions which limit the potential for water supply use. These revisions are consistent with federal requirements at 40 CFR § 131.10 because the adopted classifications appropriately reflect the existing and attainable uses for these waters. Accordingly, the Region approves all revisions to water supply classifications.

Human Health-Based Numeric Standards

Revisions to human health-based numeric standards were adopted for most segments. Most commonly, the previous water supply table value standard for arsenic was replaced with the water + fish table value, the (revised) water supply table value, or the fish ingestion table value. Other revisions included the addition of water+fish and water supply standards (consistent with the adoption of a water supply classification) to Uncompahgre segment 3a, and removal of human health-based standards from North Fork segment 6a. The decision to remove human health-based standards from North Fork segment 6a was based on low flows, absence of habitat to support fish of a catchable size, and other conditions which limit the potential for human exposure via either water or fish ingestion. The Region notes that North Fork segment 6a is tributary to North Fork segment 2, where a full set of human health-based standards are applicable. As such, any activities resulting in discharges to segment 6a will be subject to meeting the downstream North Fork segment 2 standards. All revisions to human health-based standards are consistent with federal requirements at 40 CFR § 131.11 because the adopted numeric standards describe water quality levels that will protect the assigned classifications. Accordingly, all revisions to human health-based numeric standards are approved.

Agriculture Classifications

An agriculture classification was added to several segments (e.g., Uncompahgre segment 6a, San Miguel segments 3a, 6a, 6b, and 7a) based on evidence that agricultural uses are existing or attainable. These revisions are consistent with federal requirements at 40 CFR § 131.10. Accordingly, the Region approves all revisions to agriculture classifications.

Numeric Standards for the Protection of the Agriculture Classification

For a number of segments, new or revised numeric standards for the protection of the agriculture classification were adopted. For example, for segments without a human exposure pathway requiring protection, the chronic arsenic standard for protection of agriculture uses was added (e.g., San Juan segment 10, Los Pinos segment 7a, Animas segment 3c, Upper Gunnison segment 31, Uncompahgre segment 12, and Lower Gunnison segment 9). For segments with a water supply classification, the chronic arsenic standard for protection of agriculture uses was replaced by the water+fish or water supply table value standard. For segments with a fish consumption exposure pathway requiring protection, the chronic arsenic agriculture standard was replaced by the (more stringent) fish consumption table value standard (e.g., La Plata segments 2a, 7a, and 9, Dolores segments 3 and 9, Upper Gunnison segment 10 and 12, North Fork segment 3, Uncompahgre segment 13 and 14, Lower Gunnison segment 6, 7, 10, and 13, San Miguel segments 5 and 11, and Lower Dolores segment 2). For San Juan segment 12a and La Plata segment 10a, which had only a limited set of numeric standards (pH, dissolved oxygen, bacteria), a full set of numeric agriculture standards was adopted. The revisions are consistent with the CWA and EPA's implementing regulations at 40 CFR § 131.11 because the adopted standards describe a level of water quality that will protect the agriculture use classification. Accordingly, the Region approves all revisions to numeric standards for the protection of the agriculture classification.

II. APPROVED REVISIONS, SUBJECT TO ESA CONSULTATION

The remaining revisions are approved for purposes of CWA Section 303(c), subject to the results of consultation under Section 7(a)(2) of the ESA. In some cases the Region is deferring to the national consultation[1] that has been initiated by EPA Headquarters and the Services on EPA's published water quality criteria for the protection of aquatic organisms. The national consultation provides Endangered Species Act Section 7(a)(2) consultation coverage for any aquatic life criteria included in State water quality standards, approved by EPA, that are identical to or more stringent than EPA's recommended Section 304(a) criteria. Should the consultation process with the U.S. Fish and Wildlife Service identify information that supports a conclusion that one or more of the revisions in this category are likely to jeopardize the continued existence of any listed endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat of such species, EPA will revisit and revise, as necessary, its approval decision for the identified water quality standards. The discussion below identifies major revisions in this category and the basis for EPA's approval action.

Aquatic Life Classifications

There were several revisions to aquatic life classifications for segments located in the Gunnison and Lower Dolores Basin (Regulation 35).

- For Uncompahgre segment 6b (lower Red Mountain Creek), the Cold 2 aquatic life classification was removed, based on a proposal by the Water Quality Control Division. This revision is supported by a Use Attainability Analysis (UAA) prepared by the Division. The UAA concluded that attaining the Cold 2 classification is not feasible due to human caused conditions or sources of pollution that cannot be remedied (40 CFR § 131.10(g)(3)).

- San Miguel segment 4 was split into two segments. The Cold 1 aquatic life classification was retained for the upper segment (4a), but changed to Cold 2 for the lower segment (4b), based on a proposal by the Water Quality Control Division. The use change for new segment 4b is supported by physical and biological data, and based upon a conclusion that the

[1] See the *Memorandum of Agreement Between the Environmental Protection Agency, Fish and Wildlife Service and National Marine Fisheries Service Regarding Enhanced Coordination Under the Clean Water Act and Endangered Species Act* (66 Federal Register 11202, February 22, 2001).

significantly reduced flows downstream of the CC Ditch headgate preclude attainment of a Cold 1 classification (40 CFR § 131.10(g)(4)).

- The aquatic life classification for Upper Gunnison segment 17 (Antelope Creek) and Uncompahgre segment 13 (several named tributaries to the Uncompahgre) was changed from Cold 2 to Cold 1. These revisions were proposed by the Water Quality Control Division, based on evidence that a Cold 1 aquatic life classification is attainable and appropriate. Both segments support diverse cold water aquatic communities, including Colorado River Cutthroat Trout, a Colorado State Species of Special Concern.

- The aquatic life classification for Lower Gunnison segment 2 was changed from Cold 1 to Warm 1, based on a proposal from the Water Quality Control Division. This revision is based on the physical and biological data demonstrating that physical conditions related to the natural features of the waterbody preclude attainment of a Cold 1 aquatic life classification (40 CFR § 131.10(g)(5)).

After reviewing the evidence supporting these revisions, the Region has concluded that they are consistent with the requirements of the Clean Water Act and EPA's implementing water quality standards regulation at 40 CFR § 131.10. Accordingly, the Region approves all revisions to aquatic life classifications, subject to ESA consultation. With respect to the removal of the aquatic life classification from Uncompahgre segment 6b, the Region notes that all water body segments with water quality standards that do not include the uses specified in Section 101(a)(2) of the Clean Water Act must be re-examined every three years to determine if new information has become available. If new information becomes available indicating that an aquatic life classification is attainable in Uncompahgre segment 6b, the federal water quality standards regulation requires the State to revise its standards accordingly (40 CFR § 131.20(a)).

Numeric Standards for the Protection of Aquatic Life Classifications (Equal To or More Stringent Than CWA § 304(a) Criteria)

The adopted revisions included several changes to the numeric standards for the protection of aquatic life classifications. Revisions in this category are discussed below:

- Ammonia – For segments with aquatic life classifications and a full set of aquatic life numeric standards, revised acute and chronic numeric standards for ammonia were adopted, consistent with the revised table values in the Basic Standards regulation that were adopted in 2005. The revisions are also consistent with EPA's latest (1999) criteria guidance for ammonia.

- Arsenic – For many segments, an acute numeric standard for arsenic was added, consistent with the acute table value in the Basic Standards. The revisions are also consistent with EPA's latest acute criteria guidance for arsenic.

- Cadmium – For segments with a cold water aquatic life classification and populations of trout, the acute (trout) cadmium table value was adopted. The acute (trout) table value for cadmium is more stringent than EPA's latest (2001) acute criteria guidance. This revised criterion was adopted into the Basic Standards regulation in 2005.

- Zinc – For certain cold water aquatic life segments with populations of sculpin and hardness levels less than 113 mg/L, a chronic zinc standard to protect sculpin (a species that is particularly sensitive to zinc) was adopted. At low levels of hardness, the chronic sculpin standard is more stringent than EPA's latest chronic criteria guidance (the difference in stringency increases as hardness levels decrease).

- A full set of numeric standards for the protection of aquatic life classifications was added to Los Pinos segment 7a and Upper Gunnison segment 6a. Where these changes resulted in application of aquatic life numeric standards equal to, or more stringent than, CWA § 304(a) criteria, they are included in this category.

- Chronic aquatic life standards for copper were added to Animas River segment 3c. These new chronic standards for copper are consistent with EPA's latest chronic criteria guidance for copper.

- Other revisions to aquatic life numeric standards equal to or more stringent than EPA's latest CWA § 304(a) criteria.

The Region has determined that all revisions in this category are consistent with the federal requirements in EPA's water quality standards regulation (40 CFR Part 131) because the adopted numeric standards describe a level of water quality that will protect the aquatic life classifications. The Region approves all revisions to aquatic life numeric standards, subject to ESA consultation. The Region defers to the national consultation for each of the revisions in this category.

Numeric Standards for the Protection of Aquatic Life Classifications (Less Stringent Than CWA § 304(a) Criteria)

The adopted revisions included some aquatic life numeric standards less stringent than the latest CWA § 304(a) criteria recommendations. Revisions in this category include the following:

- Cadmium – For most aquatic life segments, revisions were adopted to apply, on a site-specific basis, the updated acute and chronic table value standards that were adopted into the Basic Standards regulation in 2005. Although these updated acute and chronic table value standards are less stringent than the latest CWA § 304(a) criteria guidance, they were approved by EPA as consistent with the requirements of the Clean Water Act and EPA's implementing regulation. The Region notes that CWA § 304(a) criteria are national guidance values, and that EPA's regulation provides States and Tribes with the flexibility to adopt alternative numeric criteria on a statewide or site-specific basis[2]. EPA approved the revised cadmium table values, subject to ESA consultation, in an action letter dated October 17, 2005.

- Zinc - For most aquatic life segments, revisions were adopted to apply, on a site-specific basis, the updated acute and chronic table value standards that were adopted into the Basic Standards regulation in 2005. Although these updated acute and chronic table value standards are less stringent than the latest CWA § 304(a) criteria guidance, they were approved by EPA as consistent with the requirements of the Clean Water Act and EPA's implementing regulation. The Region notes that CWA § 304(a) criteria are national guidance values, and that EPA's regulation provides States and Tribes with the flexibility to adopt alternative numeric criteria on a statewide or site-specific basis[2]. EPA approved the revised zinc table values, subject to ESA consultation, in an action letter dated October 17, 2005.

The Region has determined that all revisions in this category are consistent with the federal requirements in EPA's water quality standards regulation (40 CFR Part 131) because the adopted numeric standards describe a level of water quality that will protect the aquatic life classifications. The Region approves all new/revised aquatic life numeric standards less stringent than the latest CWA § 304(a) criteria recommendations, subject to ESA consultation.

Temporary Modifications

Revisions were adopted to delete, revise/extend, or add new temporary modifications to water body segments in the San Juan/Dolores (Regulation 34), Gunnison/Lower Dolores (Regulation 35), and South Platte (Regulation 38) basins (see Enclosure 2). The evidence in support of each new/revised temporary modification has been reviewed by the Region.

Generally, two different types of temporary modifications were retained or added. First, temporary modifications were retained/added to allow time for implementation of pollution controls necessary to achieve compliance with underlying numeric standards (consistent with 31.7(3)(a)(i) of the Basic Standards regulation). For example, various temporary modifications were extended for waters in the Upper Animas River basin, to allow time for implementation of the TMDLs which have been established for those waters. Second, temporary modifications were retained/added to provide an opportunity to conduct additional water quality studies for the purpose of reviewing use classifications and/or numeric standards (consistent with 31.7(3)(a)(iii) of the Basic Standards regulation). This type of temporary modification was adopted, for example, for San Miguel segment 4b, to allow time for collection of additional data necessary to complete a review of the numeric temperature standard for that segment. The status and need for each of the new/revised temporary modifications will be reviewed on an annual basis beginning two years prior to the expiration date, pursuant to 31.7(4)(b) of the Basic Standards regulation.

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[2] EPA's implementing regulation at 40 CFR § 131.11(b) allows States to adopt water quality criteria based on CWA § 304(a) criteria, CWA § 304(a) criteria modified to reflect site-specific conditions, or other scientifically defensible methods.

These revisions to temporary modifications were adopted consistent with the authorizing provision, previously approved by EPA, which is included in section 31.7 of Colorado's Basic Standards regulation. The Region approves all revisions to temporary modifications, subject to ESA consultation. Resolution of the issues necessitating adoption of the new/revised temporary modifications should be considered a high priority.

Other Revisions, Including Resegmentation, Renaming, and Consolidation of Segments

Various other changes were adopted, including revisions to re-segment, re-number, and/or re-configure particular segments or to change the description of segments. The Region approves all such revisions, subject to ESA consultation.

ENCLOSURE 2

SEGMENTS WHERE REVISIONS TO TEMPORARY MODIFICATIONS WERE ADOPTED

San Juan/Dolores Basin (Regulation 34)

Deleted Temporary Modifications
Animas 3a (copper)
La Plata 4a (copper)
Dolores 9 (zinc)

Revised/Extended Temporary Modifications
Animas 2 (metals), 3a (cadmium, manganese, zinc), 3b (metals), 3c (copper, zinc), 4a (aluminum, iron, zinc, copper, cadmium, pH), 4b (zinc), 7 (metals), 8 (metals), 9 (aluminum, copper, iron, zinc)

New Temporary Modifications
San Juan 11a (iron)
La Plata 3a (iron), 5a (NH_3), 7a (NH_3), 8a (NH_3, iron), 8c (NH_3)

Gunnison/Lower Dolores Basin (Regulation 35)

Deleted Temporary Modifications
Upper Gunnison segments 10 (cadmium, copper, zinc), 11 (cadmium, zinc)
Uncompahgre segments 4a (selenium), 6b (aquatic life standards)
Lower Gunnison segment 9 (dissolved oxygen)
San Miguel Segments 3a (zinc), 6a (zinc), 6b (zinc), 7b (lead)

Revised/Extended Temporary Modifications
Upper Gunnison segment 12 (zinc)
North Fork of the Gunnison segments 5 (selenium), 6b (iron, selenium)
Uncompahgre segments 4b (selenium), 4c (selenium), 12 (selenium)
Lower Gunnison segments 2 (selenium), 4a (selenium), 4b (selenium), 7 (selenium, iron)
San Miguel segments 3b (cadmium, zinc), 4b (temperature)

New Temporary Modifications
Upper Gunnison segments 8 (cadmium), 12 (cadmium), 16 (zinc)
North Fork of the Gunnison segment 3 (selenium)
Uncompahgre segments 3a (cadmium, iron), 4a (NH_3), 4b (NH_3)
Lower Gunnison segments 2 (NH_3), 4a (NH_3)
San Miguel segments 2 (cadmium), 5 (NH_3)
Lower Dolores segment 2 (NH_3)

South Platte Basin (Regulation 38)

New Temporary Modifications
Big Thompson Segment 2 (dissolved oxygen, *E. coli*, NH_3, NO_3, boron, cadmium, copper, lead, mercury, nickel, selenium, silver, zinc)

EXHIBIT L

Electronic Filing: Received, Clerk's Office 6/27/2018

COLORADO WATER QUALITY CONTROL COMMISSION STATE OF COLORADO

PRE-HEARING STATEMENT OF COLORADO PARKS AND WILDLIFE

IN THE MATTER OF PROPOSED REVISIONS TO THE WATER QUALITY CLASSIFICATIONS, STANDARDS AND DESIGNATIONS FOR VARIANCES IN THE ARKANSAS RIVER BASIN REGULATION #32 (5CCR 1002-32), UPPER COLORADO RIVER AND NORTH PLATTE RIVER BASINS REGULATION #33 (5CCR 1002-33), SAN JUAN RIVER AND DOLORES RIVER BASINS REGULATION #34 (5 CCR 1002-34), GUNNISON AND LOWER DOLORES RIVER BASINS REGULATION #35 (5 CCR 1002-35), RIO GRANDE RIVER BASIN REGULATION #36, LOWER COLORADO RIVER BASIN REGULATION #37, AND THE SOUTH PLATTE BASIN REGULATION #38 (5CCR 1002-38).

Colorado Parks and Wildlife (CPW) submits this Prehearing Statement (PHS) to the Water Quality Control Commission (WQCC).

I. STATEMENT OF FACTUAL AND LEGAL CLAIMS

CPW is a proponent to this hearing for the purpose of proposing temporary modifications for temperature for several hatcheries. In addition, CPW provides aquatic data, interpretation of the data, and other technical expertise to the WQCD, other parties, and the Water Quality Control Commission (WQCC). CPW's interest at this hearing is to propose temporary modifications to the water quality standards in the Middle Arkansas River, Segment 2 in accordance with Regulation No. 31.7 and to ensure that revisions to Regulations 32, 33, 34, 35, and 38 are appropriate to restore or protect aquatic life and recreational fisheries.

II. EXECUTIVE SUMMARY

CPW is withdrawing all but one of the temporary modifications of the temperature standard included in the Notice. CPW is maintaining its proposal for a 4.5-year temporary modification for the Pueblo Hatchery. The proposed temporary modification will be reviewed by the WQCC in December 2019 and December 2020 at the annual temporary modification rulemaking hearings.

III. WRITTEN TESTIMONY

A. *Withdrawn Proposals for Temporary Modifications*

WQCD is in the process of renewing the general permit for all fish hatcheries in Colorado. At the time the Notice was due, CPW was aware that some of its hatcheries might have compliance issues with the temperature standards, but did not know specifically which hatcheries would be affected. To ensure that CPW would have the option to pursue temperature temporary modifications for any hatchery, CPW proposed temperature temporary modifications for most of its facilities. The majority of CPW's hatcheries will not have compliance issues with the limits in this permit. Therefore CPW is withdrawing its proposal for temporary modifications of the temperature standards for all hatcheries except for Pueblo. Temporary modifications for the following segments are withdrawn:

Regulation 32

Upper Arkansas segment 3 (COARUA03): *Mainstem of the Arkansas River from a point immediately above the confluence with the Lake Creek to the Chaffee/Fremont County line.*
Upper Arkansas segment 12a (COARUA12a): *Mainstem of Chalk Creek from the source to the confluence with the Arkansas River.*

Regulation 33

Roaring Fork segment 8 (COUCRF8): *Mainstem of the Crystal River, including all tributaries and wetlands, from the source to the confluence with the Roaring Fork River, except for specific listings in Segments 1, 9 and 10*
Yampa segment 3 (COUCYA03): *All tributaries to the Yampa River, including all wetlands, from the source to the confluence with Elk River, except for specific listings in Segments 4-8, 13a-f and 19. Mainstem of the Bear River, including all tributaries and wetlands from the boundary of the Flat Tops Wilderness Area to the confluence with the Yampa River.*

Regulation 34

Animas/Florida segment 5a (COSJAF05a): *Mainstem of the Animas River, including wetlands, from Bakers Bridge to the Southern Ute Indian Reservation boundary.*

Regulation 35

Upper Gunnison segment 5b (COGUUG05b): *Mainstem of the East River from a point immediately above the Slate River to the confluence with the Gunnison River.*
Upper Gunnison segment 19 (COGUUG19): *All tributaries to Tomichi Creek, including wetlands, which are within the boundaries of the Gunnison National Forest, except for specific listings in Segments 20 through 24. Mainstems of Barret, Hot Springs, Razor and Quartz Creeks from their sources to their confluences with Tomichi Creek.*

Regulation 37

Lower Colorado segment 10 (COLCLC10): *West Rifle Creek, including all tributaries and wetlands, from the source to Rifle Gap Reservoir. East Rifle Creek, including all tributaries and wetlands, from the White River National Forest boundary to Rifle Gap Reservoir. Rifle Creek, including all tributaries and wetlands, from Rifle Gap Reservoir to the confluence with the Colorado River.*

Regulation 38

Cache la Poudre segment 2a (COSPCP02a): *Mainstem of the Cache La Poudre River, including all tributaries and wetlands, from the boundaries of Rocky Mountain National Park and the Rawah, Neota, Comanche Peak, and Cache La Poudre Wilderness Areas to a point immediately below the confluence with the South Fork Cache La Poudre River.*
Cache la Poudre segment 10b (COSPCP10b): *Mainstem of the Cache La Poudre River from a point immediately above the Larimer County Ditch diversion (40.657, -105.185) to Shields Street in Ft. Collins, Colorado.*
Cache la Poudre segment 13a (COSPCP13a): *All tributaries to the Cache La Poudre River, including all wetlands, from the Munroe Gravity Canal/North Poudre Supply canal diversion to the confluence with the South Platte River, except for specific listings in Segments 6, 7, 8, 13b and 13c.*

B. Pueblo Hatchery Temporary Modification Proposal

CPW proposes a 4.5-year temporary modification of the temperature standard for its Pueblo Hatchery near Pueblo, Colorado (Figure 1). The Pueblo Hatchery discharges to the mainstem of the Arkansas River below Pueblo Reservoir (segment COARMA02).

Middle Arkansas segment 2 (COARMA02): *Mainstem of the Arkansas River from the outlet of Pueblo Reservoir to a point immediately above the confluence with Wildhorse/Dry Creek Arroyo*

CPW proposes a 4.5-year temporary modification of the temperature standard for the Pueblo Hatchery, with a narrative of "current conditions" (Table 2). While the temporary modification is in place, CPW intends to collect data to support a proposal for a site-specific temperature standard for Middle Arkansas segment 2 that protects the existing fishery, but also recognizes that current cold-stream tier II temperature standard is not attainable.

Table 1. Summary of CPW's proposal.			
Segments	Parameter	Expiration Date	Proposed temporary modification
Middle Arkansas segment 2	temperature	7/1/2021 (4.5-years)	Temperature (ac/ch)=current conditions

Pueblo Hatchery

CPW's Pueblo Hatchery raises both coldwater and warmwater fish. Rainbow trout (CS-II), brown trout (CS-II), and kokanee (CLL) are raised from late fall through early summer in a series of raceways and in the hatchery building. Bluegill, black crappie, grass carp, smallmouth bass, largemouth bass, redear sunfish, saugeye, wiper, walleye, and white bass are raised in a series of ponds.

Pueblo Hatchery is able to take water from Pueblo Reservoir and/or groundwater. When taking water from Pueblo Reservoir, the hatchery can access water at four different levels in the reservoir (4851 feet, 4811, 4786, 4763). This allows the hatchery to intake water of different temperatures. The temperature difference between the reservoir intakes is often very small (only 3°C) indicating that thermal stratification is occurring in the summer. The US Bureau of Reclamation (BOR) operates the dam, and adjusts water flowing from the reservoir to the hatchery at CPW's request. Most of our requests are met. The hatchery can also run on well water.

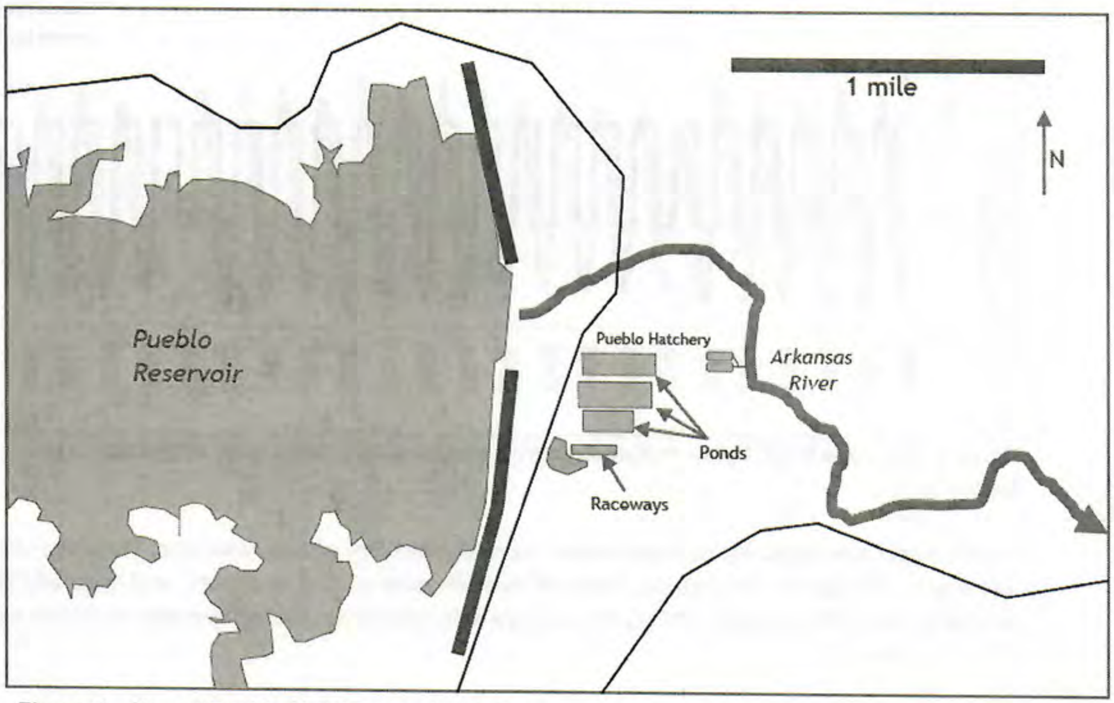

Figure 1. Map of Pueblo Hatchery and vicinity.

Middle Arkansas segment 2

The Arkansas River below Pueblo Reservoir has an Aquatic Life use classification of Cold 1, and a temperature tier of cold stream tier II (Table 2). CPW records indicate black bullhead, central stoneroller, channel catfish, fathead minnow, flathead chub, green sunfish, longnose dace, longnose sucker, plains minnow, red shiner, sand shiner, saugeye, walleye, and white sucker are present in this segment. Additionally, segment 2 is routinely stocked with ten-inch "catchable" rainbow trout, and stocked once-a-year with juvenile three-inch brown trout.

It is not known if the coldwater species in this segment are able to successfully reproduce, or if the populations of coldwater fish are maintained entirely by stocking.

Table 2. Summary of Applicable Temperature Standards.					
Temperature Tier	Tier Code	Species Expected to be Present	Applicable months	MWAT	DM
Cold Stream Tier II	CS-II	Other coldwater species (brown trout, rainbow trout, mottled sculpin, mountain whitefish, longnose sucker)	Apr-Oct	18.3	24.3
			Nov-Mar	9.0	13.0

The temperatures in the Arkansas River below the reservoir are below lethal levels for rainbow and brown trout, but routinely exceeded the chronic summer temperature standard of 18.3 °C, and in November routinely exceed the chronic winter standard of 9°C (Figure 2).

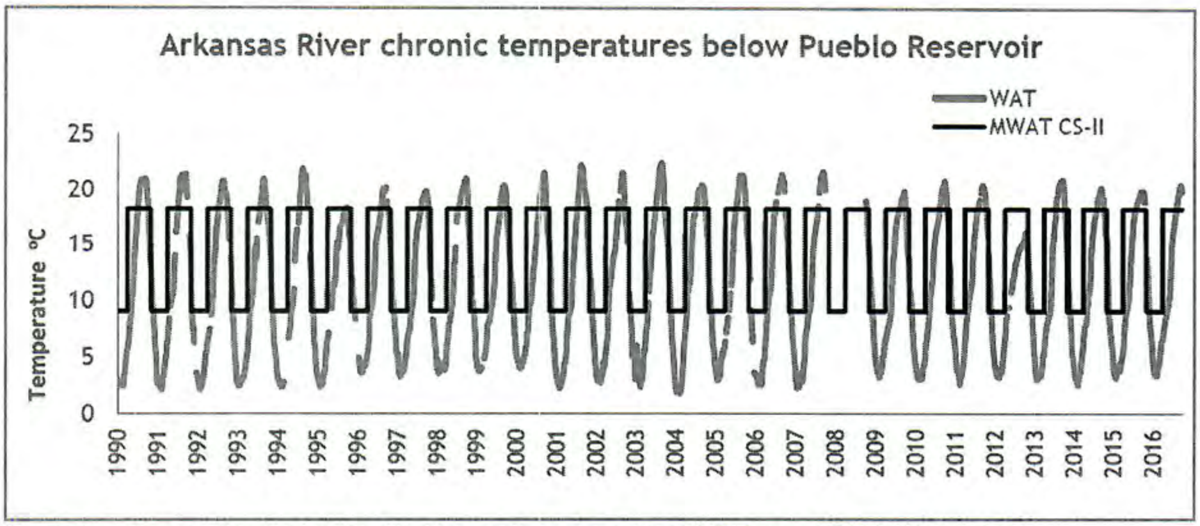

Figure 2. Arkansas River below Pueblo Reservoir temperatures (USGS gage 07099400 "above Pueblo").

Pueblo Reservoir typically releases water from the bottom of the reservoir. Flow over the spillway is infrequent. Therefore, thermal stratification of the reservoir, and specially the temperature of the bottom water, has a large influence over the temperatures in the tailwater below the dam.

Requirements for Granting a Temporary Modification

CPW's justifications for a temporary modification of the temperature standards are organized following 31.7(3) "Granting, Extending, and Removing Temporary Modifications to Numeric Standards," relying upon the version of Regulation 31 that becomes effective December 31, 2016.

Conditions Justifying a Tempoary Modification (31.7(3)(a))

The WQCC may adopt a temporary modification if an existing permitted discharge has a demonstrated or predicted water-quality based effluent-limit compliance problem (31.7(3)(a)(i)). The Arkansas River above and below the hatchery currently exceeds CS-II standards, and the hatchery discharge also exceeds the standard (Figure 3). There is no assimilative capacity in the river.

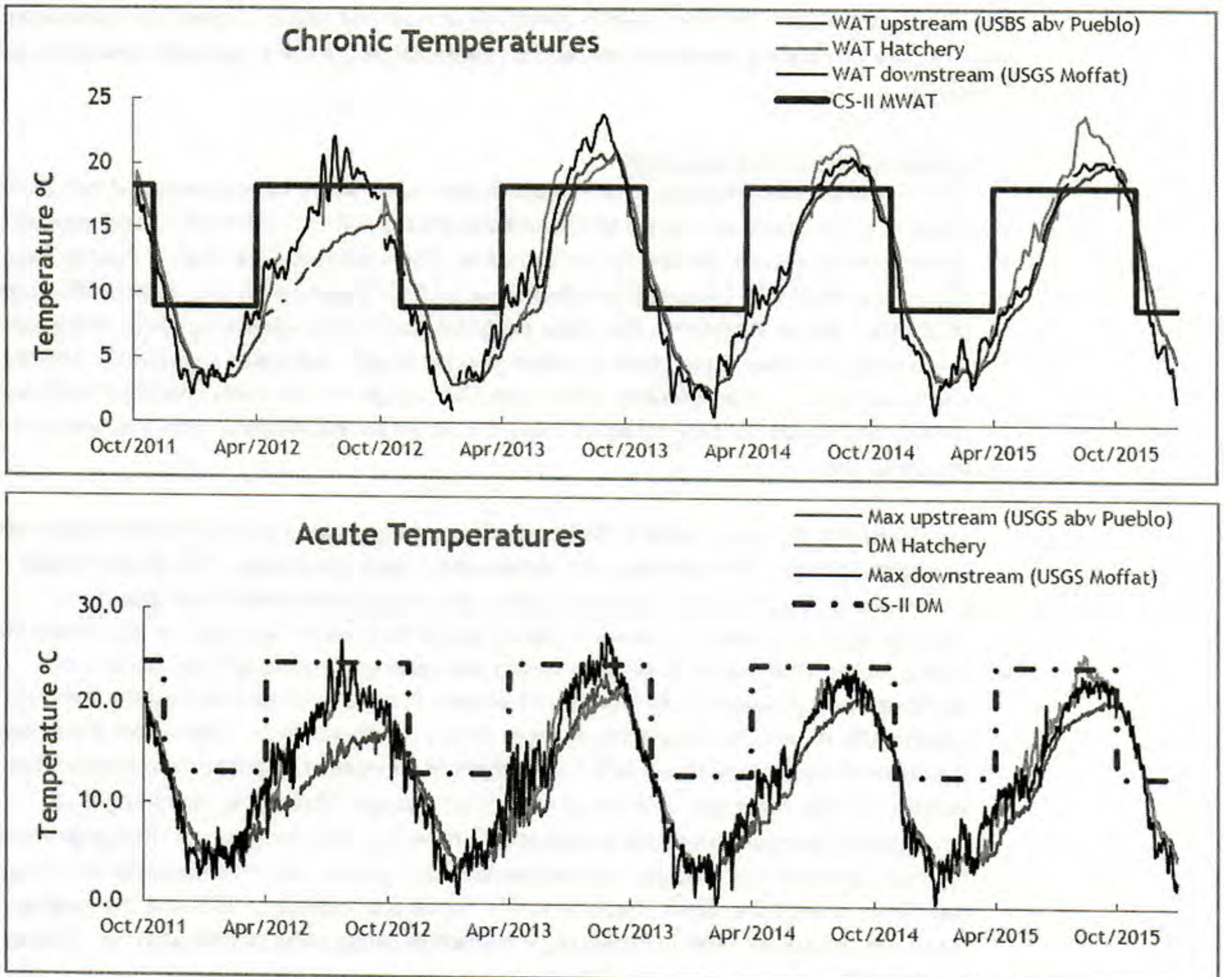

Figure 3. Arkansas River and Pueblo Hatchery temperatures compared to current temperature standards.

In addition to a demonstrated or predicted water quality-based effluent limit compliance problem, there must also be significant uncertainty regarding the water-quality standard necessary to protect current and/or future uses, or significant uncertainty regarding the extent to which existing quality is the result of natural or irreversible human-induced conditions (31.7(3)(a)(ii)).

CPW believes that there is significant uncertainty regarding the extent to which the existing quality of the Arkansas River, Segment 2 is the result of natural or irreversible human-induced conditions. The thermal regime of the Arkansas River in segment 2 is impacted by the presence of Pueblo Reservoir. The temperature of the water released from the reservoir dictates the temperature of the tailwater. As water flows downstream of the reservoir, its temperature equilibrates with the ambient air-temperature. The existing water temperature data in the Arkansas River below the reservoir show the current temperature standards are exceeded (Figure 3).

Adequate Supporting Information (31.7(3)(b))

A temporary modification proposal must include adequate supporting information which includes "justification for the interim narrative or numeric value, a plan for eliminating the need for the temporary modification, and a justification for the proposed expiration date." 31.7(3)(b).

Justification for Interim Value

CPW believes that releases from Pueblo Reservoir or other human-induced conditions are impacting the thermal regime of the Middle Arkansas River segment 2, and making the current temperature standards unattainable. The Arkansas River below Pueblo Reservoir has a long record of temperature data from a USGS Gage below the dam (USGS gage 07099400 "above Pueblo"). This data could be used to develop a numeric value describing the current thermal conditions in upper portion Middle Arkansas segment 2. The thermal characteristics of the tailwater below the USGS gage are not well characterized and likely change quickly as bottom-releases from the reservoir equilibrate with the ambient air temperature.

The Southern Delivery System (SDS), which is a large pipeline from Pueblo Reservoir to Colorado Springs, was recently completed and began operation. This project pulls water from deep in the reservoir and could alter thermal stratification near the dam. Additionally, a hydropower plant is being added to Pueblo Reservoir in 2018 that might also affect water temperatures released from the reservoir. Although the Bureau of Reclamation's Finding of No Significant Impact for the hydropower facility does not specifically discuss temperature changes in the Arkansas River, their draft Environmental Assessment does state there will be no changes in water temperature because "the location of the reservoir withdraws would not change; therefore, no changes in downstream temperatures are predicted." However, the location of discharges and the type of outlet(s) will change. Consequently, changes in water temperatures will not be fully known until the plant is operational. Since the impact of SDS and the hydropower plant are unknown, CPW is proposing a narrative temporary modification of "current conditions".

Raw data describing effluent and ambient quality

The raw data for the Pueblo Hatchery and the Arkansas River is included in CPW Exhibit 1.

Study Plan to Eliminate the Need for a Temporary Modification

A study plan is required to demonstrate the need for the temporary modification, the data that will be collected while the temporary modification is in effect, and to justify the duration of the temporary modification (31.7(3)(b)). CPW is proposing a 4.5-year temporary modification to collect temperature and fish data, analyze the data, and prepare a proposal to change the underlying temperature standard. CPW's study plan will evaluate whether or not ambient-based temperature standards are appropriate in Middle Arkansas segment 2b, and evaluate the appropriateness of the downstream segment boundary.

CPW's study plan will determine the water-quality standards necessary to protect the Aquatic Life use by characterizing the fishery below the reservoir, determining how far downstream coldwater fish are present, and whether or not the coldwater fishery is self-reproducing or maintained entirely by stocking.

CPW's study plan will characterize whether water temperatures are due to natural or irreversible conditions, and to what extent temperatures could be cooled. CPW's study plan will focus on characterizing the temperature of the water released from Pueblo Reservoir, and how temperature changes as it flows downstream. CPW will also characterize the thermal impact of the hatchery, other dischargers, and water withdrawals below Pueblo Reservoir. Once the study plan is completed, CPW will use the data to propose a site-specific temperature standard for Middle Arkansas segment 2, and may propose some adjustment of the lower segment boundary. CPW's intent is propose a site-specific standard that provides maximum protection for the existing fishery that is feasible to achieve, while recognizing that the current cold-stream tier II temperature standard is likely not attainable.

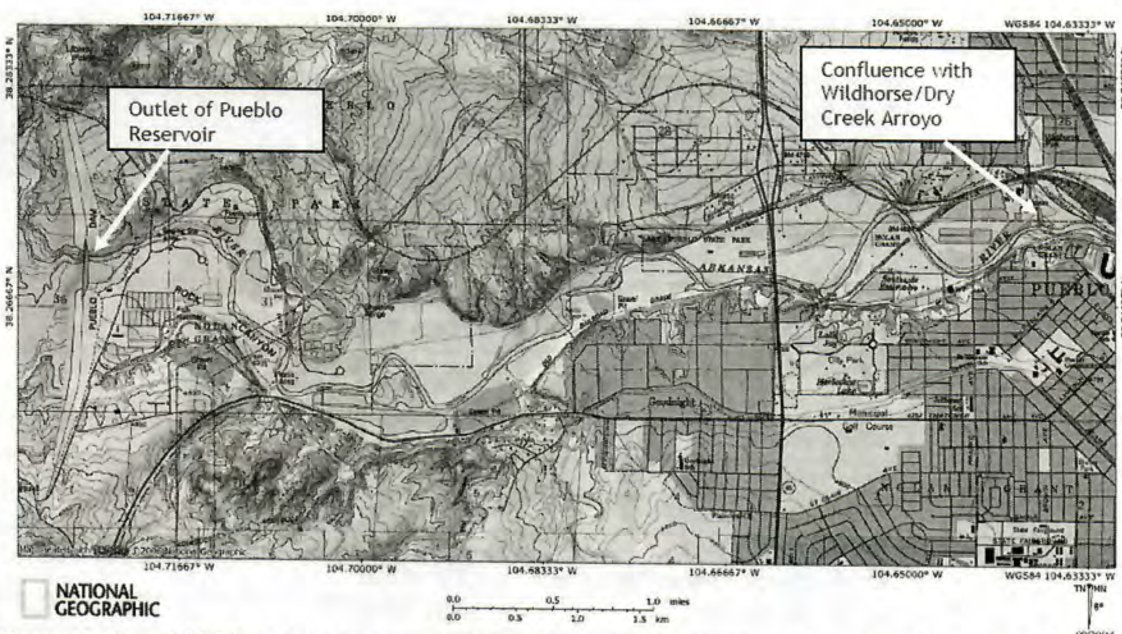

Figure 4. Map of Middle Arkansas segment 2 (*Mainstem of the Arkansas River from the outlet of Pueblo Reservoir to a point immediately above the confluence with Wildhorse/Dry Creek Arroyo*).

Study Area

CPW will study temperatures in Pueblo Reservoir, Middle Arkansas segment 2 (outlet of Pueblo Reservoir to Wildhorse/Dry Arroyo) and the upper end of Middle Arkansas segment 3. Approximately 10 river-miles are included in the study area.

Pueblo Reservoir

CPW will examine thermal stratification in Pueblo Reservoir. We will investigate temperature records from the hatchery intakes that can pull water from three different levels in the reservoir. Additionally, CPW will collect lake profile data near the dam, and CPW will use lake profile data collected by WQCD, USGS and any other available data sources.

Instream Temperature Monitoring

CPW will install OnSet temperature loggers in the Arkansas River in areas representative of instream temperatures (i.e. areas with good flow). Loggers will be placed in shields constructed of PVC pipe or similar material to protect the loggers from damage and sunlight. Loggers will collect temperature measurements at intervals of no less than 30-minutes. Loggers will be deployed during ice-free conditions when flows are low enough to permit safe deployment.

CPW will monitor temperatures in Pueblo Reservoir and at selected points 10 river-miles below the dam, encompassing three segments (Table 3). The monitoring plan includes instream temperature monitoring above and below the hatchery discharge to evaluate the thermal impact of the hatchery.

Additionally, CPW will use continuous temperature data collected at two USGS stations (above Pueblo and Moffat Street), the WQCD, CPW, and any other available sources.

Table 3. Summary of available temperature data and data to be collected.

Monitoring Location	Agency	Existing Data?	Middle Arkansas Segment
Pueblo Reservoir near Dam	WQCD 7810 USGS 381602104435200 CPW (TBD)	X X	20
Below Pueblo Reservoir	USGS 7099400 WQCD 7290	X X	2
Hatchery Inlet Water (from Reservoir)	CPW (TBD)		2
Above Pueblo Hatchery	CPW (TBD)		2
Hatchery Discharge	CPW	X	2
Below Pueblo Hatchery	CPW (TBD)		2
North Pueblo Blvd	CPW (TBD)		2
At Wildhorse Creek/Dry Arroyo	CPW (TBD)		2
At Moffat Street	USGS 7099970	X	2/3

Other Discharges and Water Rights

CPW will investigate the thermal impact of other discharges to the segment by exploring available DMR data. The following is a list of known discharges to segment 2.

- City of Pueblo (COG-071241)
- Lake Pueblo State Park (COG-5810080)
- Pate Construction Co (COG-0071160)
- Pueblo Board of Water Works (COG-640025)
- Transit Mix of Pueblo, Inc (COG-500035)
- West Pit (COG500035)
- Whitlock WTF (COG641025)

CPW will also investigate the impacts of water withdrawals on stream temperatures using water diversion records available from the Department of Water Resources.

Instream Fish Monitoring

CPW will conduct multiple fish surveys below the reservoir using various electrofishing techniques with the goal of analyzing species composition, developing population estimates and determining the downstream extent of the coldwater species during summer months. Additionally, fry sampling will be conducted with the goal of determining the level of natural reproduction and/or recruitment to adult size. The location of fry shocking will be determined by areas with suitable spawning gravels, or areas fish are known to attempt to spawn.

CPW currently stocks ten-inch catchable rainbow trout once-a-month, and stocks three-inch brown trout once a year. CPW will also make use of existing fish data for the study area.

Justification for Proposed Expiration Date

CPW is proposing a 4.5-year temporary modification to collect temperature and fish data, analyze the data, and prepare a proposal to change the underlying temperature standard for Middle Arkansas segment 2 (Table 4). CPW would like to collect at least 3-years of temperature data. Colorado Springs Utilities recently completed the Southern Delivery System, which is a pipeline that takes water from Pueblo Reservoir to Colorado Springs. Additionally, BOR is planning to add hydropower capability to the reservoir in 2018. These changes in reservoir operation could result in changes in water temperatures being released from the reservoir. We would like to collect at least one-year of temperature data after the hydropower operations begin to document any changes.

CPW proposes to complete data collection by January of 2020, and spend 6-months analyzing the data, preparing a proposal, and informing stakeholders. The proposal would be submitted to the WQCC after July 2020, and the WQCC would consider the proposal in the December 2020 temporary modification rulemaking hearing. Assuming the WQCC adopted CPW's proposal, the new standard would take effect July 1, 2021, and the temporary modification would expire.

Table 4. Justification for duration of the proposed temporary modification	
Date	Activity
2016	CPW installs temperature loggers
2017-2019	CPW collect temperature and fishery information, and conducts outreach to other stakeholders.
July 2019-December 2019	CPW submits progress report for the December 2019 temporary modification rulemaking hearing.
December 2019	WQCC considers progress of temporary modification, and decides to delete, retain, or extend the temporary modification (December temporary modification rulemaking hearing).
January 2020-July 2020	CPW analyzes data and prepares proposal to change underlying temperature standard. Additional outreach to stakeholders.
July 2020-December 2020	CPW files Notice and proposal to change the temperature standard for the December 2020 temporary modification hearing.
December 2020	WQCC considers CPW's proposal (December temporary modification rulemaking hearing).
July 2021	Proposed standard becomes effective and temporary modification expires.

Operative Value During the Time of the Temporary Modification (31.7(3)(d))
A temporary modification proposal must include a numeric or narrative value to represent the current condition of the waterbody 31.7(3)(b).

The Arkansas River below Pueblo Reservoir has a long record of temperature data from a USGS Gage below the dam (USGS gage 07099400 "above Pueblo"). This data could be used to develop a numeric value describing the current thermal conditions in upper portion Middle Arkansas segment 2. The thermal characteristics of the tailwater below the USGS gage are not well characterized and likely change quickly as bottom-releases from the reservoir equilibrate with the ambient air temperature.

The Southern Delivery System (SDS), which is a large pipeline from Pueblo Reservoir to Colorado Springs, was recently completed and began operation. This project pulls water from deep in the reservoir and could alter thermal stratification near the dam. Additionally, a hydropower plant is being added to Pueblo Reservoir in 2018 that might also affect water temperatures released from the reservoir. Although the Bureau of Reclamation's Finding of No Significant Impact for the hydropower facility does not specifically discuss temperature changes in the Arkansas River, their draft Environmental Assessment does state there will be no changes in water temperature because "the location of the reservoir withdraws would not change; therefore, no changes in downstream temperatures are predicted." However, the location of discharges and the type of outlet(s) will change. Consequently, changes in water temperatures will not be fully known until the plant is operational. Since the impact of SDS and the hydropower plant are unknown, CPW is proposing a narrative temporary modification of "current conditions".

Duration of a Temporary Modification (31.7(3)(e))

The WQCC determines the duration of a temporary modification on a case-by-case basis, based upon all relevant factors, including how soon resolving the issues that necessitated adoption of the temporary modification is deemed feasible (31.4(3)(e)).

CPW is proposing a 4.5-year temporary modification to collect temperature and fish data, analyze the data, and prepare a proposal to change the underlying temperature standard for Middle Arkansas segment 2 (Table 4, page 8). CPW would like to collect at least 3-years of temperature data. Colorado Springs Utilities recently completed the Southern Delivery System, which is a pipeline that takes water from Pueblo Reservoir to Colorado Springs. Additionally, BOR is planning to add hydropower capability to the reservoir in 2018. These changes in reservoir operation could result in changes in water temperatures being released from the reservoir. We would like to collect at least one-year of temperature data after the hydropower operations begin, to document any changes.

CPW proposes to complete data collection by January of 2020, and spend 6-months analyzing the data, preparing a proposal, and informing stakeholders. The WQCC would consider the proposal in the December 2020 temporary modification rulemaking hearing. Assuming the WQCC adopted CPW's proposal, the new standard would take effect July 1, 2021, and the temporary modification would expire.

Frequency of Commission Review (31.7(3)(f))

CPW is proposing a 4.5-year temporary modification, set to expire July 1, 2021. The WQCC reviews all temporary modifications that expire within 2-years of the hearing date. CPW's progress to collect data for the temporary modification will be reviewed at the December 2019 hearing (Table 4, page 8). CPW's proposed temporary modification meets the requirement for re-examination not less than once every three years (31.7(3)).

IV. EXHIBITS

CPW Exhibit 1 Temperature data for Pueblo Hatchery and Arkansas River (Excel File)
CPW Exhibit 2 Temporary Modification checklist

V. WITNESSES

The following CPW staff may provide testimony on the appropriateness of proposed changes and rebuttal testimony as necessary:

Mindi May, M.S., Water Quality Program Coordinator

CPW reserves the right to call other witnesses as needed.

Respectfully submitted this 4th day of October, 2016.

FOR COLORADO PARKS AND WILDLIFE

Margaret Taylor
Assistant Director for Capital Parks and Trails
Colorado Parks and Wildlife
6060 Broadway
Denver, Colorado 80216

EXHIBIT M

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region08

Ref: 8EPR-EP

OCT 12 2017

Mr. David Baumgarten, Chair
Water Quality Control Commission
4300 Cherry Creek Drive South
Denver, Colorado 80222-1530

Re: EPA Action on Three Sets of Revisions to Water Quality Standards

Dear Mr. Baumgarten:

The U.S. Environmental Protection Agency Region 8 has completed its review of certain revisions to water quality standards (WQS) adopted by Colorado's Water Quality Control Commission (Commission). The three sets of revisions addressed in today's action were adopted by the Commission on January 12, 2015, January 11, 2016, and January 9, 2017. The submission letters included an Opinion of the Attorney General certifying that the standards were duly adopted pursuant to State law. Receipt of the revised standards on January 23, 2015, February 2, 2016, and January 24, 2017, respectively, initiated the EPA's review pursuant to Clean Water Act (CWA) § 303(c). The EPA has completed its review, and this letter is to notify you of our action.

Taken collectively, the revisions include WQS changes for various individual water body segments listed in Regulations 32 – 38 as a result of the Commission's annual public hearing to review temporary modifications due to expire within approximately 2 years (see section 31.7(3)(e) of the Basic Standards and Methodologies for Surface Waters).

Clean Water Act Review Requirements

The CWA § 303(c)(2), requires States and authorized Indian Tribes[1] to submit new or revised WQS to the EPA for review. The EPA is required to review and approve, or disapprove, the submitted standards. Pursuant to CWA § 303(c)(3), if the EPA determines that any standard is not consistent with the applicable requirements of the Act, the Agency shall, not later than the ninetieth day after the date of submission, notify the State or authorized Tribe and specify the changes to meet the requirements. If such changes are not adopted by the State or authorized Tribe within ninety days after the date of notification, the EPA is to propose and promulgate such standard pursuant to CWA § 303(c)(4). The Region's goal has been, and will continue to be, to work closely with States and authorized Tribes throughout the standards revision process so that submitted revisions can be approved by the EPA. Pursuant to the EPA's Alaska Rule (40 CFR § 131.21(c)), new or revised state standards submitted to the EPA after May 30, 2000, are not effective for CWA purposes until approved by the EPA.

[1] CWA § 518(e) specifically authorizes EPA to treat eligible Indian tribes in the same manner as states for purposes of CWA § 303. See also 40 CFR § 131.8.

Today's Action

We are pleased to inform you that today the EPA is approving the WQS revisions adopted on January 12, 2015, January 11, 2016, and January 9, 2017. The revisions and the rationale for the EPA's approval are discussed in the enclosures.

Endangered Species Act Requirements

The EPA's approval of Colorado's WQS is considered a federal action which may be subject to the Section 7(a)(2) consultation requirements of the Endangered Species Act (ESA). Section 7(a)(2) of the ESA states that "each federal agency ... shall ...insure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined to be critical..." The EPA has initiated consultation under ESA Section 7(a)(2) with the U.S. Fish and Wildlife Service (Service) regarding our approval of the new or revised WQS. The EPA also has a CWA obligation, as a separate matter, to complete its WQS action. Therefore, in acting on the state's WQS today, EPA is completing its CWA § 303(c) responsibilities. However, because ESA consultation on the EPA's approval of certain standards is ongoing, for such revisions the EPA's approval is made subject to the outcome of the ESA consultation process. Should the consultation process with the Service identify information regarding impacts on listed species or designated critical habitat that supports amending the EPA's approval, the EPA will, as appropriate, revisit and amend its approval decision for those new or revised WQS.

Indian Country

The WQS approvals in today's letter apply only to water bodies in the state of Colorado, and do not apply to waters that are within Indian country, as defined in 18 U.S.C. § 1151. Today's letter is not intended as an action to approve or disapprove water quality standards applying to waters within Indian country. The EPA, or authorized Indian tribes, as appropriate, will retain responsibilities for water quality standards for waters within Indian country.

Conclusion

We thank the Commission for its efforts to improve the water quality standards that protect the waters of Colorado. Questions regarding this action may be directed to David Moon of my staff at (303) 312-6833.

Sincerely,

Darcy O'Connor
Assistant Regional Administrator
Office of Water Protection

Enclosures (3)

ENCLOSURE 1
ANNUAL REVIEW OF COLORADO TEMPORARY MODIFICATIONS
WQS REVISIONS ADOPTED JANUARY 12, 2015

This enclosure discusses the water quality standards revisions adopted by the Water Quality Control Commission (Commission) on January 12, 2015 (following a rulemaking hearing on December 8, 2014) and the rationale for the EPA's approval action. The revisions and EPA's action are summarized in Table 1.

Table 1
WQS Revisions Adopted January 12, 2015

Regulation	Segment	Summary of WQS Revision	EPA Action
33	Yampa 13i	1 year extension of iron temporary modification	Approved
34	La Plata 7a and 8c	1 year extension of ammonia temporary modification	Approved
35	San Miguel 3b and Uncompahgre 3b	New arsenic temporary modifications (expiration 12/31/2021)	Approved
37	Lower Colorado 4e	18 month extension of iron temporary modification	Approved
38	Upper South Platte 3	New ammonia temporary modification (expiration 12/31/2017)	Approved
	Upper South Platte 10a	3 year extension of copper temporary modification	Approved
	Clear Creek 2a and 2c	5 year extension of zinc (segment 2a) and cadmium (segment 2c) temporary modifications	Approved
	Big Thompson 2	Deletion of the copper temporary modification and adoption of site-specific numeric standards for copper	Approved

REVISIONS TO REGULATION #33 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR UPPER COLORADO RIVER BASIN AND NORTH PLATTE RIVER (PLANNING REGION 12)

<u>Yampa River Segment 13i</u>

The expiration date associated with the chronic iron temporary modification assigned to Segment 13i (Mainstem of Grassy Creek, including tributaries, from the source to Scotchman's Gulch) was extended by one year, from 12/31/2016 to 12/31/2017. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by the Seneca Coal Company and Peabody-Sage Creek Mining, LLC, so that uncertainty about what numeric standard is appropriate for protection of the aquatic life use can be resolved.

Based on the evidence presented during the rulemaking process, the EPA concludes that the revision is consistent with the general policy in *The Basic Standards and Methodologies for Surface Waters* (Regulation #31, Section 31.7(3)).[2] For example, Colorado's general policy states that "in making a decision as to whether a temporary

[2] Section 31.7(3) authorizes temporary modifications if an existing permitted discharge has a demonstrated or predicted water quality-based effluent limit compliance problem, and one of two situations is shown to exist: (1) significant uncertainty regarding the water quality standard necessary to protect current and/or future uses, or (2) significant uncertainty regarding the extent to which existing quality is the result of natural or irreversible human induced conditions. Section 31.7(3) requires that adequate supporting information must be submitted, including a justification for the interim narrative or numeric value, any data describing effluent and ambient quality, a plan for eliminating the need for the temporary modification, and a justification for the proposed expiration date. Temporary modification expiration dates are determined by the Commission based on relevant factors, including how soon resolving the issues that necessitated adoption of the temporary modification is deemed feasible. Pursuant to 31.7(3)(e), the Commission must hold an annual rulemaking hearing to review temporary modifications that will expire within approximately two years. Pursuant to such

modification should be removed or extended, the Commission will consider the existence of an implementation plan for eliminating the need for the temporary modification, the progress being made in trying to implement such a plan, the impact of the temporary modification on the uses of the stream in the area of the temporary modification and upstream and downstream of that area, and all other relevant factors." The EPA's regulation at 40 CFR § 131.13 provides that such general policies may be adopted at State discretion, while also specifying that they are subject to the EPA's review and approval. The Colorado general policy has been approved by the EPA on multiple occasions, and most recently on August 4, 2011. Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Yampa River Segment 13i is approved, subject to ESA consultation.

Revisions to Regulation #34 - Classifications and Numeric Standards for San Juan River and Dolores River Basins

La Plata River Segments 7a and 8c

The expiration dates associated with the ammonia temporary modifications assigned to Segment 7a (McElmo Creek and Yellow Jacket Creek) and 8c (unnamed tributary to Ritter Draw) were extended by one year, from 6/30/2015 to 6/30/2016. Several small domestic facilities discharge to these segments (Cortez Sanitation District, Vista Verde Village LLC, and Linde LLC discharge to segment 7a and Lee Mobile Home Park discharges to segment 8c). The extension was granted to provide additional time for the Division to work with these small domestic facilities to resolve uncertainty about whether it would be appropriate to establish discharger-specific variances for ammonia.

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to La Plata Segments 7a and 8c are approved, subject to ESA consultation.

Revisions to Regulation #35 - Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins

San Miguel River Segment 3b and Uncompahgre River Segment 3b

New chronic arsenic temporary modifications were assigned to San Miguel Segment 3b (mainstem of San Miguel River from Marshall Creek to the South Fork San Miguel River) and Uncompahgre River segment 3b (Uncompahgre River from Cascade Creek to Dexter Creek), with an expiration date of December 31, 2021. The temporary modifications require that existing discharges maintain and protect current conditions (see 35.6(2)(d)). The temporary modifications are consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 μg/L water + fish numeric standards have been assigned. The temporary modifications provide time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to San Miguel River Segment 3b and Uncompahgre River Segment 3b are approved.

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hearings, the Commission may delete, modify, or make no changes to each temporary modification. Compliance schedules requiring actions intended to eliminate the uncertainty regarding the appropriate underlying standard may be included in the permit pursuant to 31.9(4)(b) (formerly 31.14(15)(b)).

REVISIONS TO REGULATION #37 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR LOWER COLORADO RIVER BASIN

Lower Colorado River Segment 4e

The expiration date associated with the chronic iron temporary modification assigned to Segment 4e (Dry Creek) was extended by eighteen months, from 6/30/2015 to 12/31/2017. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by Tri-State Generation and Transmission Association, Inc., to resolve uncertainty about what numeric standard is appropriate for protection of the aquatic life use.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Lower Colorado River Segment 4e is approved, subject to ESA consultation.

REVISIONS TO REGULATION #38 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR SOUTH PLATTE RIVER BASIN, LARAMIE RIVER BASIN, REPUBLICAN RIVER BASIN, SMOKY HILL RIVER BASIN

Upper South Platte River Segment 3

A new ammonia temporary modification was assigned to Segment 3 (all tributaries to the South Platte River from Tarryhall Creek to the North Fork of the South Platte River) with an expiration date of December 31, 2017. The temporary modification applies below a small domestic facility (Florisant Water and Sanitation District) that discharges to the segment. The temporary modification was adopted to provide time to resolve uncertainty about whether there are feasible/affordable treatment options and whether it would be appropriate to establish a discharger-specific variance for ammonia.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to Upper South Platte Segment 3 are approved, subject to ESA consultation.

Upper South Platte Segment 10a

The expiration date associated with the copper temporary modification assigned to Segment 10a (East Plum Creek, West Plum Creek, and Plum Creek from the National Forest Boundary to Chatfield Reservoir) was modified to require maintenance of the current condition and extended by three years, from 12/31/2015 to 12/31/2018. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by Plum Creek Wastewater Reclamation Authority, to resolve uncertainty about what numeric standards are appropriate for protection of the aquatic life use.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Upper South Platte Segment 10a is approved, subject to ESA consultation.

Clear Creek Segments 2a and 2c

The expiration dates associated with the zinc temporary modification assigned to Segment 2a (Clear Creek and tributaries from the source to the I-70 bridge above Silver Plume) and the copper temporary modification assigned to segment 2c (Clear Creek and tributaries from Mill Creek to the Argo Tunnel discharge) were extended by five years, from 7/01/2015 to 7/01/2020. Two small domestic facilities discharge to these segments (Georgetown Wastewater Treatment Facility discharges to segment 2a, and Central Clear Creek Sanitation District discharges to segment 2c). The extension was granted to provide additional time to resolve uncertainty about what zinc and copper numeric standards are appropriate to protect the aquatic life use, including uncertainty about the extent of future water quality improvements as a result of the Clear Creek Superfund/CERCLA clean up, and also non-CERCLA remedial activities by other stakeholders (e.g., the Clear Creek Watershed Foundation).

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Clear Creek Segments 2a and 2c are approved, subject to ESA consultation.

<u>Big Thompson River Segment 2</u>

The previously-adopted copper temporary modification was deleted, and site-specific numeric standards for copper (11 µg/L acute, 7.5 µg/L chronic) were assigned to a portion of Segment 2 (mainstem of Big Thompson River from Rocky Mountain National Park to the Home Supply Canal diversion). The site-specific standards are based on the copper Biotic Ligand Model (BLM) and the Fixed Monitoring Benchmark (FMB) methodologies. The standards apply only to the lower portion of segment 2 (from immediately above the Upper Thompson Sanitation District wastewater treatment plant discharge to the Home Supply Canal diversion). The supporting analysis explains that the standards were derived using a large compilation of ambient monitoring data ($n = 115$ sampling events from 2004 through 2014) at station M50, which is located on the Big Thompson River about 1 mile downstream of the UTSD discharge. Higher FMB values were calculated for downstream stations within segment 2 (M60 and M70), indicating that the more stringent FMB values for station M50 will protect uses throughout the lower portion of the segment.

EPA's regulation at 40 CFR § 131.11(a)(1) specifies that states must adopt water quality criteria that protect the designated use based on sound scientific rationale. Since 2007, the EPA's recommended water quality criteria for copper have been expressed as a function of the BLM. The adopted site-specific standards were derived from BLM output and set equal to the acute and chronic FMBs for station M50. The FMB method uses a probability-based analysis of an ambient dataset to identify a fixed ambient copper concentration associated with an exceedance frequency of once in three years. The Region has concluded that the site-specific standards are protective of the designated use, based upon a sound scientific rationale, and consistent with the EPA's water quality standards regulation at 40 CFR § 131.11(a)(1). Accordingly, deletion of the copper temporary modification is approved, and adoption of the copper site-specific numeric standards is approved, subject to ESA consultation. As with all site-specific numeric standards, periodic review will be appropriate to ensure that the standards are updated as needed (e.g., to reflect any changes in site water characteristics).

ENCLOSURE 2
ANNUAL REVIEW OF COLORADO TEMPORARY MODIFICATIONS
WQS REVISIONS ADOPTED JANUARY 11, 2016

This enclosure discusses the water quality standards revisions adopted by the Water Quality Control Commission (Commission) on January 11, 2016 (following a rulemaking hearing on December 14, 2015) and the rationale for the EPA's approval action. The revisions and EPA's action are summarized in Table 2.

Table 2
WQS Revisions Adopted January 11, 2016

Regulation	Segment	Summary of WQS Revision	EPA Action
32	Upper Arkansas 8b	New acute zinc temporary modification (expiration 12/31/2017)	Approved
	Lower Arkansas 1a	2½ year extension of selenium and sulfate temporary modifications	Approved
	Lower Arkansas 3a, 3b, 4b, 5b, 5c, 6a, 6b, 15, 16, and 17	Deletion of temporary modifications for temperature	Approved
33	Blue River 14	1 year extension of molybdenum temporary modification	Approved
	Yampa River 13d	1 year extension of iron temporary modification	Approved
34	La Plata 7a and 8c	2 year extension of ammonia temporary modifications	Approved
35	Upper Gunnison 12	1 year extension of cadmium, copper, and zinc temporary modifications	Approved
	Upper Gunnison 20	Deletion of temporary modification for uranium	Approved
	Lower Gunnison 2	5 year extension of selenium temporary modification	Approved
36	Rio Grande 4a and 7	2 year extension of sunrise date for cadmium, copper, lead, manganese, silver, and/or zinc site-specific standards	Approved
	Rio Grande 4a and 7	2 year extension of cadmium, copper, lead, silver, and/or zinc temporary modifications	Approved
	Rio Grande 4a and 7	New ammonia temporary modification (expiration 12/31/2018)	Approved

REVISIONS TO REGULATION #32 – CLASSIFICATIONS AND NUMERIC STANDARDS FOR ARKANSAS RIVER BASIN

Upper Arkansas Segment 8b

A new temporary modification for acute zinc was applied to Segment 8b (mainstem of Iowa Gulch from the ASARCO water supply intake to the headgate of the Paddock #1 ditch) with an expiration date of 12/31/2017. The temporary modification was adopted to provide time for data collection and analysis, consistent with the implementation plan submitted by Resurrection Mining Company, to resolve uncertainty about the appropriate zinc standard to protect the Aquatic Life Cold 2 use classification. The scope of the implementation plan includes completion of a use attainability analysis, including collection of water quality data at multiple sites along Iowa Gulch, over multiple seasons, and sampling to characterize the aquatic species expected to occur at the site.

Based on the evidence presented during the rulemaking process, the EPA concludes that the revision is consistent with the general policy in *The Basic Standards and Methodologies for Surface Waters* (Regulation #31, Section

31.7(3)).[3] For example, Colorado's general policy authorizes adoption of a temporary modification where "there is significant uncertainty regarding the water quality standard necessary to protect current and/or future uses" (see 31.7(3)(a)(ii)(A). The EPA's regulation at 40 CFR § 131.13 provides that such general policies may be adopted at State discretion, while also specifying that they are subject to the EPA's review and approval. The Colorado general policy has been approved by the EPA on multiple occasions, and most recently on August 4, 2011. Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to Upper Arkansas Segment 8b are approved, subject to ESA consultation.

<u>Lower Arkansas Segment 1a</u>

The expiration dates associated with the selenium and sulfate temporary modification for Segment 1a (mainstem of the Arkansas River from Fountain Creek to the Colorado Canal headgate near Avondale) were extended by 2 ½ years, from 6/30/2016 to 12/31/2018. The extension was granted to provide additional time, consistent with the implementation plan submitted by the City of Pueblo, to resolve uncertainty about the appropriate underlying standards, including whether it would be appropriate to establish discharger-specific variances for selenium and sulfate. The underlying selenium standard was adopted for protection of the aquatic life use classification, and the underlying sulfate standard was adopted for protection of water supply use classification.

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to the selenium temporary modification is approved, subject to ESA consultation, and the revision to the sulfate temporary modification is approved.

<u>Lower Arkansas River Segments 3a, 3b, 4b, 5b, 5c, 6a, 6b, 15, 16, and 17</u>

Temporary modifications for temperature were deleted from these segments because the Commission determined that the site-specific factual situations did not meet the eligibility requirements for application of temporary modifications (see 31.7(3) of the Basic Standards and Methodologies for Surface Waters).

Deletion of the temporary modifications means that the underlying numeric standards (all of which are based on the table value standards for temperature) go into full effect. Because the underlying numeric standards have a sound scientific rationale and are protective of the assigned aquatic life use classifications, the Region has concluded that the adopted revisions are consistent with the EPA's water quality standards regulation at 40 CFR § 131.11(a)(1). Accordingly, deletion of the temporary modifications is approved.

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[3] Section 31.7(3) authorizes temporary modifications if an existing permitted discharge has a demonstrated or predicted water quality-based effluent limit compliance problem, and one of two situations is shown to exist: (1) significant uncertainty regarding the water quality standard necessary to protect current and/or future uses, or (2) significant uncertainty regarding the extent to which existing quality is the result of natural or irreversible human induced conditions. Section 31.7(3) requires that adequate supporting information must be submitted, including a justification for the interim narrative or numeric value, any data describing effluent and ambient quality, a plan for eliminating the need for the temporary modification, and a justification for the proposed expiration date. Temporary modification expiration dates are determined by the Commission based on relevant factors, including how soon resolving the issues that necessitated adoption of the temporary modification is deemed feasible. Pursuant to 31.7(3)(e), the Commission must hold an annual rulemaking hearing to review temporary modifications that will expire within approximately two years. Pursuant to such hearings, the Commission may delete, modify, or make no changes to each temporary modification. Compliance schedules requiring actions intended to eliminate the uncertainty regarding the appropriate underlying standard may be included in the permit pursuant to 31.9(4)(b) (formerly 31.14(15)(b)).

REVISIONS TO REGULATION #33 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR UPPER COLORADO RIVER BASIN AND NORTH PLATTE RIVER (PLANNING REGION 12)

Blue River Segment 14
The expiration date associated with the molybdenum temporary modification assigned to Segment 14 (Tenmile Creek including tributaries from West Tenmile Creek to Dillon Reservoir) was extended by one year, from 12/31/2016 to 12/31/2017. The extension was granted to provide additional time for completion of a molybdenum human health study, consistent with the implementation plan submitted by Climax Molybdenum Company, to resolve uncertainty about what numeric standard is appropriate for protection of the water supply use classification.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Blue River Segment 14 is approved.

Yampa River Segment 13d
The expiration date associated with the chronic iron temporary modification assigned to Segment 13d (Dry Creek and tributaries from the source to Temple Gulch) was extended by one year, from 12/31/2016 to 12/31/2017. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by the Seneca Coal Company and Peabody-Sage Creek Mining, LLC, so that uncertainty about what numeric standard is appropriate for protection of the aquatic life use can be resolved. A similar chronic iron temporary modification was previously established for Segment 13i (Grassy Creek) with the same expiration date (12/31/2017).

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Yampa River Segment 13d is approved, subject to ESA consultation.

REVISIONS TO REGULATION #34 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR SAN JUAN RIVER AND DOLORES RIVER BASINS

La Plata River segments 7a and 8c
The expiration dates associated with the ammonia temporary modifications assigned to Segment 7a (McElmo Creek and Yellow Jacket Creek) and 8c (unnamed tributary to Ritter Draw) were extended by two years, from 6/30/2016 to 6/30/2018. Several small domestic facilities discharge to these segments (Cortez Sanitation District, Vista Verde Village LLC, and Linde LLC discharge to segment 7a and Lee Mobile Home Park discharges to segment 8c). The extension was granted to provide additional time for the Division to work with these small domestic facilities to resolve uncertainty about whether it would be appropriate to establish discharger-specific variances for ammonia.

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to La Plata Segments 7a and 8c are approved, subject to ESA consultation.

REVISIONS TO REGULATION #35 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR GUNNISON AND LOWER DOLORES RIVER BASINS

Upper Gunnison River Segment 12
The expiration date associated with the cadmium, copper, and zinc temporary modifications assigned to Segment 12 (mainstem of Coal Creek including tributaries from the Crested Butte water supply intake to the Slate River) was extended by one year, from 6/30/2016 to 6/30/2017. The extension was granted to provide additional time, consistent with the implementation plan submitted by U.S. Energy, so that uncertainty about metals loading sources and what numeric standards are appropriate for protection of the aquatic life use can be resolved.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Upper Gunnison River Segment 12 is approved, subject to ESA consultation.

Upper Gunnison River Segment 20
The temporary modification for uranium was deleted from Segment 20 (mainstem of Indian Creek and tributaries from the source to the confluence with Marshall Creek) because it had expired on June 30, 2015. The non-substantive (housekeeping) revision is approved. A narrative "lowest practical level" standard for uranium remains in effect on this segment.

Lower Gunnison River Segment 2
The expiration date associated with the selenium temporary modification assigned to Segment 2 (mainstem of the Gunnison River from the Uncompahgre River confluence to the Colorado River confluence) was extended by five years, from 12/31/2017 to 12/31/2022. The extension was granted to provide additional time, consistent with the implementation plan submitted by the City of Delta, so that uncertainty about what numeric standard is appropriate for protection of the aquatic life use can be resolved. The City's plan includes monitoring and investigation of infiltration and inflow into the collection system, and pipe replacement where needed to reduce concentrations of selenium being discharged to the Gunnison River.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Lower Gunnison River Segment 2 is approved, subject to ESA consultation.

REVISIONS TO REGULATION #36 – CLASSIFICATIONS AND NUMERIC STANDARDS FOR RIO GRANDE BASIN

Rio Grande Segments 4a and 7 (Sunrise Dates for Site-Specific Standards)
The sunrise (effective) dates for the previously-adopted site-specific numeric standards for cadmium, lead, manganese, and zinc assigned to Rio Grande Segment 4a (mainstem of Rio Grande from Willow Creek to the South Fork Rio Grande) and the site-specific numeric standards for cadmium, copper, lead, manganese, silver, and zinc assigned to Segment 7 (mainstem of West Willow Creek from the Park Regent Mine dump to the confluence with East Willow Creek and the mainsteam of Willow Creek including tributaries from the confluence of East and West Willow Creeks to the Rio Grande) were extended by an additional two years (see 36.6(4)(b)). The extension was adopted based on evidence submitted by Rio Grande Silver that the Bulldog Mine redevelopment project has been delayed by two years.

During the period before the site-specific numeric standards become effective, the Segment 4a and 7 numeric standards are the table values associated with the aquatic life use classification, except that the manganese standard assigned to Segment 4a is the table value associated with the water supply use classification. Because the underlying numeric standards have a sound scientific rationale and are protective of the assigned use classifications, the Region has concluded that the decision to extend their applicability by an additional two years is consistent with the EPA's water quality standards regulation at 40 CFR § 131.11(a)(1). The revisions are approved.

Rio Grande Segments 4a and 7 (Extension of Temporary Modifications)
The expiration dates for the cadmium, lead, and zinc temporary modifications assigned to Rio Grande Segment 4a and the cadmium, copper, lead, silver and zinc temporary modifications assigned to Rio Grande Segment 7 were extended by an additional two years, from 12/31/2016 to 12/31/2018. These revisions were adopted based on evidence presented by Rio Grande Silver that implementation of the Bulldog Mine redevelopment project has been delayed by two years. The underlying cadmium, copper, lead, silver and zinc standards were adopted for protection of the aquatic life use classification.

Because the extension of the temporary modification expiration date is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to Rio Grande Segments 4a and 7 are approved, subject to ESA consultation.

Rio Grande Segments 4a and 7 (Ammonia)
A new ammonia temporary modification was assigned to Rio Grande Segment 4a and 7 with an expiration date of December 31, 2018. The Town of Creede submitted evidence that there is uncertainty about the feasibility of meeting its water quality-based effluent limits. The temporary modification was adopted to provide time to resolve the uncertainty, consistent with the implementation plan submitted by the Town of Creede, about whether there are feasible/affordable treatment options and whether it would be appropriate to establish a discharger-specific variance for ammonia.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to Rio Grande Segments 4a and 7 are approved, subject to ESA consultation.

ENCLOSURE 3
ANNUAL REVIEW OF COLORADO TEMPORARY MODIFICATIONS
WQS REVISIONS ADOPTED JANUARY 9, 2017

This enclosure discusses the water quality standards revisions adopted by the Water Quality Control Commission (Commission) on January 9, 2017 (following a rulemaking hearing on December 12, 2016) and the rationale for the EPA's approval action. The revisions and EPA's action are summarized in Table 3.

Table 3
WQS Revisions Adopted January 9, 2017

Regulation	Segment	Summary of WQS Revision	EPA Action
32	Upper Arkansas 8b	1 year extension of cadmium and zinc temporary modifications	Approved
	Upper Arkansas 8a, 8b, 9	Clarification of boundary between 8a and 8b, and adoption of site-specific acute cadmium standard for 8b and 9	Approved
	Middle Arkansas 2	New temporary modification for temperature (expiration 7/1/2021)	Approved
	Middle Arkansas 6b	2 year extension of temporary modification for temperature	Approved
	Multiple segments	New arsenic temporary modifications (expiration 12/31/2021)	Approved
33	Yampa 13d and 13i	1 year extension of chronic iron temporary modification	Approved
	Multiple segments	New arsenic temporary modifications (expiration 12/31/2021)	Approved
34	Multiple segments	New arsenic temporary modifications (expiration 12/31/2021)	Approved
35	Multiple segments	New arsenic temporary modifications (expiration 12/31/2021)	Approved
36	Closed Basin 3	New arsenic temporary modification (expiration 12/31/2021)	Approved
37	Lower Colorado 4e	1 year extension of chronic iron temporary modification	Approved
	Lower Colorado 4e	2 ½ year extension of copper temporary modification	Approved
38	St. Vrain 6 and 7	New iron and manganese temporary modifications (expiration 12/31/2020)	Approved
	Multiple segments	New arsenic temporary modifications (expiration 12/31/2021)	Approved

REVISIONS TO REGULATION #32 – CLASSIFICATIONS AND NUMERIC STANDARDS FOR ARKANSAS RIVER BASIN

<u>Upper Arkansas River Segment 8b (Extension of Temporary Modifications)</u>
The expiration date associated with the cadmium and zinc temporary modifications assigned to Segment 8b (mainstem of Iowa Gulch from the historic ASARCO water supply intake to the headgate of the Paddock #1 ditch) was extended by one year, from 12/31/2017 to 12/31/2018. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by Resurrection Mining Company, so that uncertainty about what numeric standard is appropriate for protection of the Aquatic Life Cold 2 use classification can be resolved. For example, there is a need for additional biological monitoring of ponded wetland habitats to resolve uncertainty about the aquatic species that are resident or expected to occur at the site.

Based on the evidence presented during the rulemaking process, the EPA concludes that the revision is consistent with the general policy in *The Basic Standards and Methodologies for Surface Waters* (Regulation #31, Section 31.7(3)).[4] For example, Colorado's general policy states that "in making a decision was to whether a temporary modification should be removed or extended, the Commission will consider the existence of an implementation plan for eliminating the need for the temporary modification, the progress being made in trying to implement such a plan, the impact of the temporary modification on the uses of the stream in the area of the temporary modification and upstream and downstream of that area, and all other relevant factors." The EPA's regulation at 40 CFR § 131.13 provides that such general policies may be adopted at State discretion, while also specifying that they are subject to the EPA's review and approval. The Colorado general policy has been approved by the EPA on multiple occasions, and most recently on August 4, 2011. Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Upper Arkansas River Segment 8b is approved, subject to ESA consultation.

<u>Upper Arkansas River Segment 8a, 8b, and 9 (Segment Boundary Clarification and Acute Cadmium)</u>
The boundary between Segment 8a and 8b was clarified with additional location information including the coordinates of the historic ASARCO water supply intake. EPA considers this to be a non-substantive, clarifying change. The revision is approved.

In addition, a site-specific, hardness-dependent acute cadmium standard was applied to Segment 8b and 9. The site-specific standard was derived using the EPA recalculation method. The supporting analysis, submitted by Resurrection Mining Company, utilized the updated aquatic life toxicity database supporting the CWA § 304(a) criteria recommendations issued by EPA in 2016. The site-specific acute standard was developed to protect the aquatic species currently present or expected to occur in Segments 8b and 9. The recalculation procedure resulted in a cadmium final acute value (6.9958 µg/L) higher than the cadmium species mean acute value for cutthroat trout (5.401 µg/L). Because cutthroat trout are native to the Upper Arkansas River basin, the site-specific final acute value was lowered to the cutthroat trout species mean acute value. The total recoverable to dissolved cadmium conversion factor is taken from the 2016 CWA § 304(a) criteria document. Accordingly, the site-specific standard is as follows:

Cadmium (acute) = Conversion factor*$e^{(0.9789*\ln[\text{hardness}] - 3.5146)}$
Conversion factor = 1.136672 – ln[hardness]*0.041838

The water quality standards regulation at 40 CFR § 131.11(b)(1)(ii) allows states to develop site-specific criteria based on national CWA § 304(a) criteria recommendations that have been modified to reflect site-specific conditions. The EPA recalculation procedure involves making changes to the toxicity dataset supporting the

[4] Section 31.7(3) authorizes temporary modifications if an existing permitted discharge has a demonstrated or predicted water quality-based effluent limit compliance problem, and one of two situations is shown to exist: (1) significant uncertainty regarding the water quality standard necessary to protect current and/or future uses, or (2) significant uncertainty regarding the extent to which existing quality is the result of natural or irreversible human induced conditions. Section 31.7(3) requires that adequate supporting information must be submitted, including a justification for the interim narrative or numeric value, any data describing effluent and ambient quality, a plan for eliminating the need for the temporary modification, and a justification for the proposed expiration date. Temporary modification expiration dates are determined by the Commission based on relevant factors, including how soon resolving the issues that necessitated adoption of the temporary modification is deemed feasible. Pursuant to 31.7(3)(e), the Commission must hold an annual rulemaking hearing to review temporary modifications that will expire within approximately two years. Pursuant to such hearings, the Commission may delete, modify, or make no changes to each temporary modification. Compliance schedules requiring actions intended to eliminate the uncertainty regarding the appropriate underlying standard may be included in the permit pursuant to 31.9(4)(b) (formerly 31.14(15)(b)).

national criteria recommendation so that it better represents the water quality requirements of the organisms expected to occur at the site. The recalculation procedure recommended by EPA is described on pages 90-97 of Appendix L to the Water Quality Standards Handbook (U.S. EPA, August 1994, EPA-823-B-94-005b).

EPA's regulation at 40 CFR § 131.11(a)(1) specifies that states must adopt water quality criteria that protect the designated use based on sound scientific rationale. The Region has concluded that the site-specific acute cadmium standard is protective of the designated use, based upon a sound scientific rationale, and consistent with the EPA's water quality standards regulation at 40 CFR § 131.11(a)(1). Accordingly, the revision is approved, subject to ESA consultation.

Middle Arkansas River Segment 2

A new temperature temporary modification was assigned to Segment 2 (mainstem of the Arkansas River from Pueblo Reservoir to the Wildhorse/Dry Creek Arroyo) with an expiration date of July 1, 2021. The temporary modification was adopted to provide time to resolve uncertainty about the temperature standard, consistent with the implementation plan submitted by Colorado Parks and Wildlife. CPW will compile additional water quality and biological data throughout the segment to support a decision about whether a site-specific standard would be appropriate.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Middle Arkansas Segment 2 is approved, subject to ESA consultation.

Middle Arkansas River Segment 6b

The expiration date associated with the temperature temporary modification assigned to Segment 6b (mainstem of Saint Charles River from Edson Arroyo to the Arkansas River) was extended by two years, from 6/30/2016 to 6/30/2018. The extension was granted to provide additional time to resolve uncertainty about the temperature standard, consistent with the implementation plan submitted by Public Service Company. Public Service Company will compile additional temperature data and investigate potential anthropogenic influences on water temperature to support a decision about whether a site-specific standard would be appropriate.

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to Middle Arkansas segment 6b are approved, subject to ESA consultation.

Multiple Segments

New chronic arsenic temporary modifications were assigned to Upper Arkansas River segments 2a, 2c, 7, 14b, 18, and 37, Middle Arkansas River segments 7a, 7b, 18a, and 20, Fountain Creek segments 1b, and 8, and Lower Arkansas River segments 9a, 11, and 19, with an expiration date of December 31, 2021. The temporary modifications require that existing discharges maintain and protect current conditions (see 32.6(2)(c)). The temporary modifications are consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 µg/L water + fish numeric standards have been assigned. The temporary modifications provide time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revisions to multiple segments are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions are approved.

Revisions to Regulation #33 - Classifications and Numeric Standards for Upper Colorado River Basin and North Platte River (Planning Region 12)

Yampa River Segments 13d and 13i

The expiration date associated with the chronic iron temporary modification assigned to Segment 13d (Dry Creek and tributaries from the source to Temple Gulch) and Segment 13i (Mainstem of Grassy Creek, including tributaries, from the source to Scotchman's Gulch) was extended by one year, from 12/31/2017 to 12/31/2018. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by the Seneca Coal Company and Peabody-Sage Creek Mining, LLC, so that uncertainty about what numeric standard is appropriate for protection of the aquatic life use can be resolved.

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions to Yampa River Segments 13d and 13i are approved, subject to ESA consultation.

Multiple Segments

New chronic arsenic temporary modifications were assigned to Upper Colorado River segment 1, Blue River segments 6a, 12, 17, and 18, Eagle River segments 2, 5c, 9b, and 12, and Roaring Fork segments 3c and 10b, with an expiration date of December 31, 2021. The temporary modifications require that existing discharges maintain and protect current conditions (see 33.6(2)(c)). The temporary modifications are consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 µg/L water + fish numeric standards have been assigned. The temporary modifications provide time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revisions to multiple segments are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions are approved.

Revisions to Regulation #34 - Classifications and Numeric Standards for San Juan River and Dolores River Basins

Multiple Segments

New chronic arsenic temporary modifications were assigned to San Juan River segments 9a and 11a, Piedra River segment 7, Los Pinos River segment 5, Animas/Florida River segments 10a, 13a, and 22, La Plata River segments 2b, 5a, and 12, and Dolores River segments 1, 2, 3, 4a, 4b, 5a, and 5b, with an expiration date of December 31, 2021. The temporary modifications require that existing discharges maintain and protect current conditions (see 34.6(2)(c)). The temporary modifications are consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 µg/L water + fish numeric standards have been assigned. The temporary modifications provide time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revisions to multiple segments are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions are approved.

REVISIONS TO REGULATION #35 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR GUNNISON AND LOWER DOLORES RIVER BASINS

Multiple Segments

New chronic arsenic temporary modifications were assigned to Upper Gunnison River segments 15b and 38, North Fork of the Gunnison segment 3, Uncompahgre River segments 1, 3c, 3f, 4a, 4b, 10, and 11, Lower Gunnison River segment 7b, San Miguel River segment 8, and Lower Dolores River segments 1a and 2, with an expiration date of December 31, 2021. The temporary modifications require that existing discharges maintain and protect current conditions (see 35.6(2)(c)). The temporary modifications are consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 µg/L water + fish numeric standards have been assigned. The temporary modifications provide time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revisions to multiple segments are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions are approved.

REVISIONS TO REGULATION #36 – CLASSIFICATIONS AND NUMERIC STANDARDS FOR RIO GRANDE BASIN

Closed Basin Segment 3

A new chronic arsenic temporary modification was assigned to Closed Basin segment 3 (all tributaries to the Closed Basin excluding waters in segments 2a, 2b, 2c, and 4 through 13), with an expiration date of December 31, 2021. The temporary modification requires that existing discharges maintain and protect current conditions (see 36.6(2)(d)). The temporary modification is consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 µg/L water + fish numeric standards have been assigned. The temporary modification provides time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Closed Basin Segment 3 is approved.

REVISIONS TO REGULATION #37 - CLASSIFICATIONS AND NUMERIC STANDARDS FOR LOWER COLORADO RIVER BASIN

Lower Colorado River Segment 4e (Iron)

The expiration date associated with the chronic iron temporary modification assigned to Segment 4e (Dry Creek) was extended by 1 year, from 12/31/2017 to 12/31/2018. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by Tri-State Generation and Transmission Association, Inc., to resolve uncertainty about what numeric standard is appropriate for protection of the aquatic life use.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Lower Colorado River Segment 4e is approved, subject to ESA consultation.

Lower Colorado River Segment 4e (Copper)
The expiration date associated with the copper temporary modification assigned to Segment 4e (Dry Creek) was extended by 2 ½ years, from 6/30/2017 to 12/31/2019. The extension was granted to provide additional time for site monitoring and data analysis, consistent with the implementation plan submitted by Tri-State Generation and Transmission Association, Inc., to resolve uncertainty about what numeric standard is appropriate for protection of the aquatic life use.

Because the revision is consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revision to Lower Colorado River Segment 4e is approved, subject to ESA consultation.

Lower Colorado River Segment 4e (Use Protected Designation)
The use protected designation assigned to Segment 4e was retained. Although this decision is not a revision to water quality standards, EPA acknowledges that the Commission's decision was based upon the EPA-approved water quality test at Regulation 31, section 31.8(2)(b)(i)(B), and not the section 31.8(2)(b)(i)(C) test for effluent-dependent and effluent-dominated waters (which is repealed effective 12/31/2019).

Multiple Segments
New chronic arsenic temporary modifications were assigned to Lower Yampa segments 9, 12a, 12b, 12c, and 15, White River segments 4b, 14a, and 20, and Lower Colorado River segment 17b, with an expiration date of December 31, 2021. The temporary modifications require that existing discharges maintain and protect current conditions (see 37.6(2)(c)). The temporary modifications are consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 µg/L water + fish numeric standards have been assigned. The temporary modifications provide time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revisions to multiple segments are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions are approved.

Revisions to Regulation #38 - Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin

St. Vrain River Segments 6 and 7
New iron and manganese temporary modifications were assigned to Segment 6 (all tributaries to St. Vrain Creek including wetlands from Hygiene Road to the confluence with the South Platte River, except for waters in the Boulder Creek sub-basin and segments 4a, 4b, 4c, and 5) and Segment 7 (Lefthand Valley Reservoir) with an expiration date of December 31, 2020. The temporary modifications were adopted to provide time for data collection and analysis, consistent with the implementation plan submitted by Raytheon Boulder, to resolve uncertainty about what numeric standards are appropriate for protection of the aquatic life use assigned to Segment 6 and the aquatic life and water supply use assigned to Segment 7 (Lefthand Valley Reservoir). The underlying iron standards were adopted for protection of the aquatic life use

classification, and the underlying manganese standard was adopted for protection of water supply use classification.

Because the revisions are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the aquatic life-based temporary modifications (segment 6 and 7) are approved subject to ESA consultation, and the water supply-based temporary modification (segment 7) is approved.

Multiple Segments

New chronic arsenic temporary modifications were assigned to Upper South Platte River segments 16b and 19, Cherry Creek segment 2, Clear Creek segments 2b, 6, and 12b, Big Dry Creek segment 2, Boulder Creek segment 17, St. Vrain Creek segments 4a and 12, Middle South Platte segment 7, Big Thompson River segments 14, 16, and 17, Cache La Poudre segment 7, and Republican River segment 1, with an expiration date of December 31, 2021. The temporary modifications require that existing discharges maintain and protect current conditions (see 38.6(2)(c)). The temporary modifications are consistent with Colorado's arsenic strategy, which has included application of temporary modifications to various segments on a statewide basis where 0.02 µg/L water + fish numeric standards have been assigned. The temporary modifications provide time to resolve uncertainty about what numeric standards are appropriate for protection of human health.

Because the revisions to multiple segments are consistent with the evidence presented to the Commission during the rulemaking process and Colorado's approved general policy, the revisions are approved.

EXHIBIT N

WATER QUALITY CONTROL COMMISSION
STATE OF COLORADO

PROPONENT'S PREHEARING STATEMENT OF PUBLIC SERVICE COMPANY OF COLORADO

IN THE MATTER OF CONSIDERATION OF THE ADOPTION OF NEW TEMPORARY MODIFICATIONS AND REVISIONS TO CURRENT TEMPORARY MODIFICATIONS OF WATER QUALITY STANDARDS EXPIRING ON OR BEFORE DECEMBER 31, 2018, AND NEW SITE SPECIFIC STANDARDS THAT ALLOW FOR THE DELETION OF CURRENT TEMPORARY MODIFICATIONS EXPIRING ON OR BEFORE DECEMBER 31, 2018, FOR MULTIPLE SEGMENTS IN THE CLASSIFICATIONS AND NUMERIC STANDARDS FOR ARKANSAS RIVER BASIN, REGULATION #32 (5 CCR 1002-32).

Public Service Company of Colorado ("PSCo") submits this Proponent's Prehearing Statement ("PPHS").

1. Executive Summary and Issue to Be Resolved.

PSCo respectfully requests that the Colorado Water Quality Control Commission ("Commission") extend the existing temporary modification for temperature on Middle Arkansas Segment 6b (Saint Charles River, Reg. 32, COARMA06b) in the Arkansas River Basin, until December 31, 2018.

The temperature temporary modification is currently scheduled to expire on June 30, 2017. PSCo started temperature monitoring in early 2014. However, field conditions made it impossible to collect enough data to support a site-specific standards proposal in this hearing. Due to continued uncertainties, and the need to collect additional data, PSCo seeks an extension of the temporary modification. PSCo has not previously received an extension of this temporary modification.

The Commission should approve PSCo's extension request based on the factors included in Regulation 31.7(3), including PSCo's progress under its study plan, the need to revise its study plan, and the need to collect additional data to eventually propose ambient-based standards. PSCo's proposed changes to Regulation 32 are attached as **Exhibit 1**. PSCo has completed the Temporary Modification Checklist to support its extension request. *See* **Exhibit 2**.

2. Background.

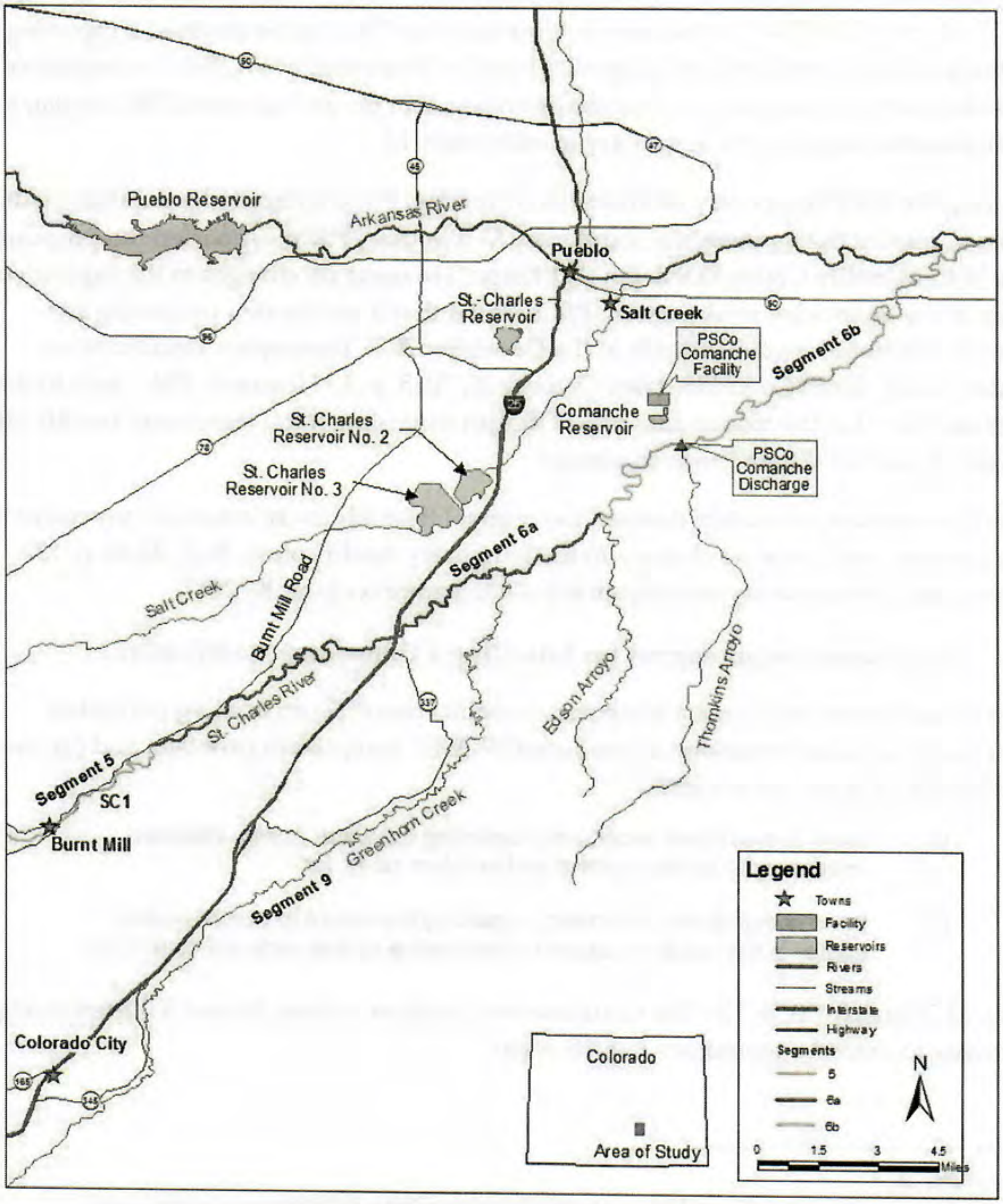
The following summarizes the current description, uses, and temperature standards on Middle Arkansas Segment 6b:

Regulation and Basin	Regulation 32, Arkansas River Basin
Segment ID	Middle Arkansas Segment 6b (COARMA06b)
Segment Description	Mainstem of the Saint Charles River from the confluence with Edson Arroyo to the confluence with the Arkansas River.
Use Classifications	Agriculture Aquatic Life Warm 2 Recreation E Water Supply
Temperature Standards	T=TVS (WS-II) °C TVS for Warm Stream Tier II: March-Nov. (DM/MWAT) = 28.6/27.5 °C Dec.-Feb. (DM/MWAT) = 14.3[1]/13.8 °C
Temporary Modifications:	Temperature (DM/MWAT) = "current conditions" Expiration date of 6/30/2017

See Regulation 32, Appendix 32-1, p. 36; Regulation 32.6(3), p. 9.

PSCo operates the Comanche Power Plant in Pueblo, Colorado, which is authorized to discharge to Middle Arkansas Segment 6b. The map below shows the Comanche Power Plant, Comanche discharge points, Segment 6b, and other relevant locations.

[1] The Commission recently increased the acute WS-II standard for December-February to 25.2 °C; this standard has not yet been adopted in the basin regulations. *See* Reg. 31.16, Table, 1, p. 51 (eff. 12/31/2016).


Pueblo Reservoir
Arkansas River
Pueblo
St. Charles Reservoir
Salt Creek
PSCo Comanche Facility
Segment 6b
Comanche Reservoir
St. Charles Reservoir No. 2
St. Charles Reservoir No. 3
PSCo Comanche Discharge
Segment 6a
Salt Creek
Burnt Mill Road
St. Charles River
Edson Arroyo
Thomkins Arroyo
Segment 5
SC1
Burnt Mill
Greenhorn Creek
Segment 9
Colorado City
Colorado
Area of Study
Legend
Towns
Facility
Reservoirs
Rivers
Streams
Interstate
Highway
Segments
5
6a
6b
N
0 1.5 3 4.5
Miles

During the 2013 Arkansas River Basin Hearing, the Commission divided Middle Arkansas Segment 6 (St. Charles River) into two segments: Segment 6a and Segment 6b. *See* Reg. 32.52(O), p. 132. The Commission adopted a temperature temporary modification on Segment 6b of "current conditions," with an expiration date of June 30, 2017. *Id.* at p. 133. The Commission determined that PSCo had submitted supporting information of a predicted water quality based effluent limit ("WQBEL") compliance problem with the temperature standards on Segment 6b, and accepted PSCo's plan to eliminate the need for the temporary modification. *Id.*

During the 2015 Temporary Modifications Hearing, PSCo submitted an update on its plan to resolve the temperature standards. At that time, PSCo supported the proposal of the Water Quality Control Division ("Division") to make no changes to the expiration date of the temporary modification. PSCo stated that it anticipated proposing site-specific ambient-based standards in the December 2016 Temporary Modifications Rulemaking. *See* PSCo RPHS dated October 26, 2015, p. 4.[2] However, PSCo also told the Commission that the loss of data meant that an extension of the temporary modification might be needed if data losses continued.

The Commission ultimately deemed the original time allotment adequate to resolve the uncertainty, and made no changes to the temporary modification. Reg. 32.56, p. 137. Therefore, the temporary modification is set to expire on June 30, 2017.

3. Regulatory Requirements for Extending a Temporary Modification.

The Commission may grant a temporary modification if (1) an existing permitted discharge has a demonstrated or predicted WQBEL compliance problem, and (2) one of the following is shown to exist:

> (A) there is significant uncertainty regarding the water quality standard necessary to protect current and/or future uses; [or]
>
> (B) there is significant uncertainty regarding the extent to which existing quality is the result of natural or irreversible human-induced conditions.

Reg. 31.7(3)(a)(i)-(ii), p. 12.[3] The Commission considers various factors in determining whether to extend a temporary modification:

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[2] Available at ftp://ft.dphe.state.co.us/wqc/wqcc/TemporaryModificationsRMH_2015/Responsive/PSCo.pdf.

[3] Unless otherwise noted, references to Regulation 31 are to the version effective until 12/31/2016, available at https://www.colorado.gov/pacific/sites/default/files/31_2016%2806%29hdr.pdf.

water for a short period of time, usually less than 15 minutes. The thermistor (HOBO Water Temperature Pro v2 Data Logger – U22-001) is attached to an offload device (HOBO Optic USB Base Station – BASE-U-4), and the temperature data is downloaded onto a laptop computer with HOBOware software. The thermistor is then placed back into the river to continue recording water temperature.

A set of quality control measures has been used to evaluate the dataset and eliminate data that do not appropriately represent instream temperatures due to various causes such as a dewatered thermistor or thermistor malfunction. Temperature data are discarded from the dataset and not evaluated further if they do not meet the following guidelines:

- Maximum temperature 36°C or greater
- Maximum temperature 25°C or greater and the difference between the minimum and maximum temperatures was 15°C or greater; or
- Difference between the minimum and maximum temperature was 25°C or greater
- Sample size for each day did not include the full range of interval data
- Sporadic daily values were bracketed by periods of no data

The revised data were used to calculate running two-hour daily averages and running weekly average temperature (WAT) parameters for comparison with the proposed Daily Maximum (DM) and Maximum Weekly Average Temperature (MWAT) standards for Warm Water Tier II stream segments in Regulation 31. The DM is defined as "the highest two-hour average water temperature recorded during a given 24-hour period." The MWAT is defined as "the largest mathematical mean of multiple, equally spaced temperatures over a seven-day consecutive period, with a minimum of three data points spaced equally through the day."

Results

There are several data gaps in 2014 and 2015. Data from June 20, 2014, through August 4, 2014, are missing from both sites due to four large storm events in July with flows in excess of 2000 cfs (USGS gage #07108900, St. Charles at Vineland, CO). Both the upstream and downstream temperature loggers washed away in one of the storm events in July. When GEI personnel went to retrieve data, the north and south banks where the T-posts were anchored eroded away, and all T-posts, cinderblocks, and the temperature loggers were lost. Complete replacement of the thermistor set-ups could not be completed until August 4, 2014. Data collected between the previous data download and the storms were lost with the loggers. Data are also missing from June 6, 2015 through July 7, 2015, and July 22, 2015 through August 3, 2015, from the upstream site due to the loggers being buried in sediment. Storm events with flows in excess of 300 cfs resulted in the logger being buried in sand each time. Data is also missing from the downstream site due to equipment malfunction on August 5, 2015, which was not discovered until data were downloaded. This resulted in inaccurate measurements from August 5, 2015 through August 27, 2015, resulting in a slightly shorter period of record for this site compared to the upstream site. Because of these data gaps in the summer months when temperature are expected to be highest, GEI increased data retrieval frequency from once every 4 to 6 weeks to twice monthly in summer 2016 to ensure better data continuity. There have been no data gaps to date in 2016.

The calculated MWAT and DM values for data collected to date from the St. Charles River upstream and downstream sites are shown in Figures 2 and 3. Even with the data gaps in summer 2014 and 2015, there have been exceedances of the summer DM temperature in the St. Charles River upstream of the Xcel Comanche facility in all three years. There are also exceedances of the DM at the downstream site, but temperatures are slightly lower at the downstream site than at the upstream site. The effluent also exceeds the DM temperature standard in the summer months in all three years, but only slightly (Figure 4). The highest summer temperatures in the effluent are lower than those at the upstream and downstream St. Charles sites. The effluent also exceeded the MWAT in the spring shoulder months, late January and February, in 2016.

Next Steps

The exceedances of summer DM temperature standards upstream of the discharge indicate that ambient-based temperature standards based on existing quality may be appropriate for this segment. Although temperature data have been collected for three years, there is still uncertainty as to the appropriate summer temperature standard due to the data gaps in July and August.

Additionally, after a meeting with the agencies in August 2016, it was determined that additional temperature spot monitoring should be initiated to help evaluate if temperatures in the vicinity of the Xcel outfall are representative of the entire Segment 6b. Spot temperature measurements will be collected at the same time as data downloads from the thermistors at six additional sites in Segment 6b. The spot measurement sites begin approximately 1 mile below the top of the segment, to a location approximately 2 miles above the confluence with the Arkansas River, matching sites sampled earlier as part of the selenium use-attainability analysis (GEI 2013). Spot measurements will be compared to concurrent thermistor measurements to determine if temperature is consistent throughout the segment.

Given the data gaps in summer, GEI recommends collecting an additional two years of data in 2016-2017 to have more complete data to calculate ambient-based standards. As was done in 2016, temperature data would be downloaded on a more frequent basis to help ensure no data gaps during the critical summer months over the next two years, along with the spot measurements to better represent the entire segment.

Furthermore, Xcel is revising its study plan to include investigation of any anthropogenic sources of temperature in the vicinity of the Comanche plant. Xcel plans on studying the sources of temperature over the next few years to make the required demonstrations for ambient-based standards based on revisions to Regulation 31.

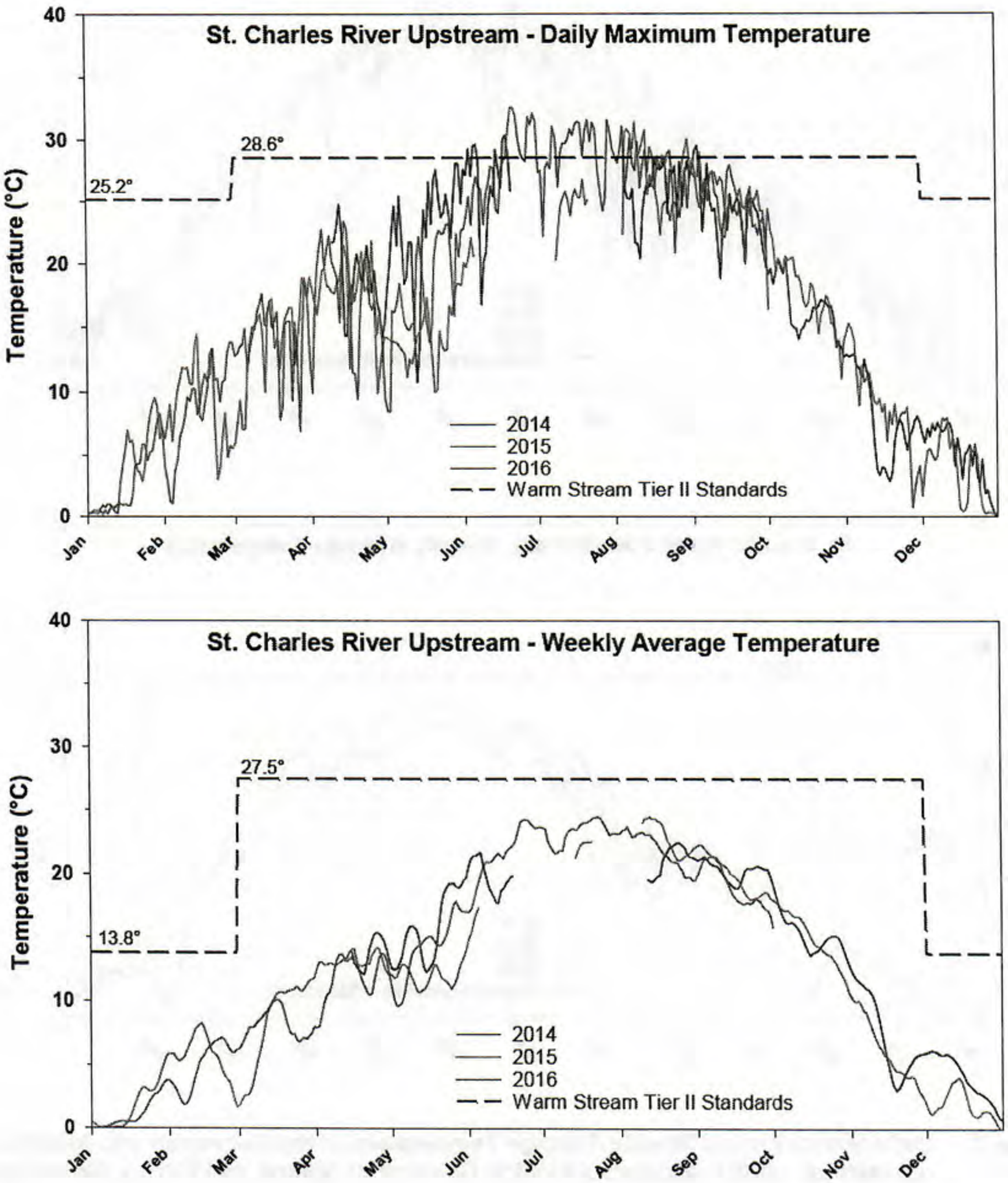
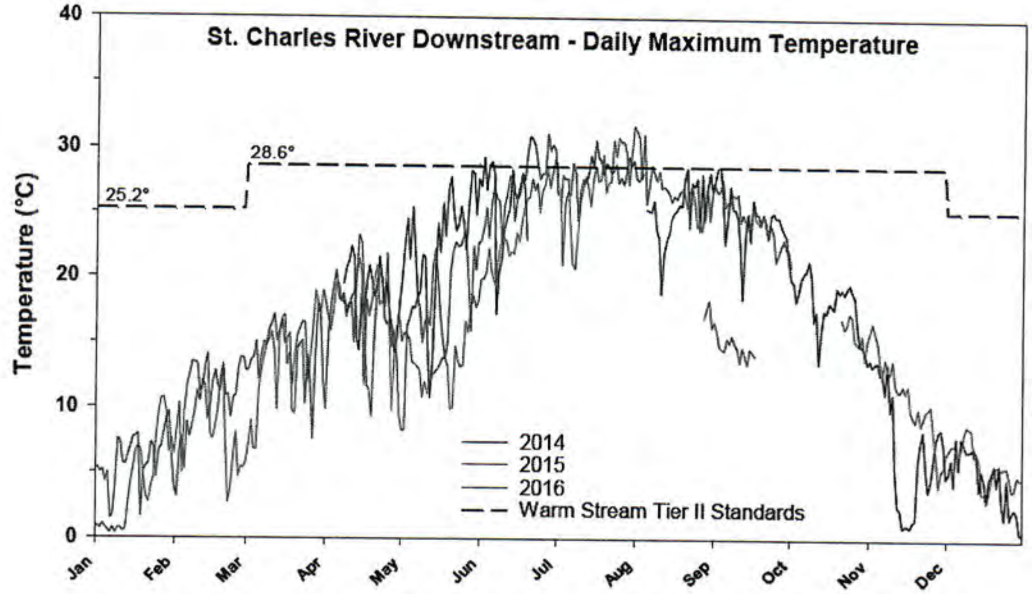


Figure 2: Daily Maximum and Weekly Average Temperature at the thermistor site location upstream of the Comanche Electric Generation Station and Outfall 001 on the St. Charles River.



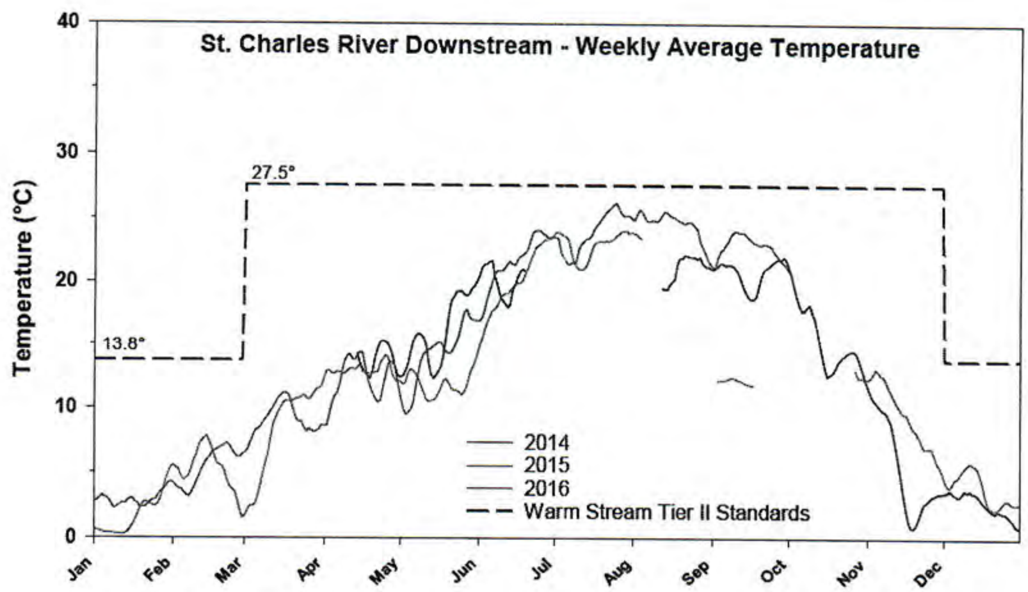
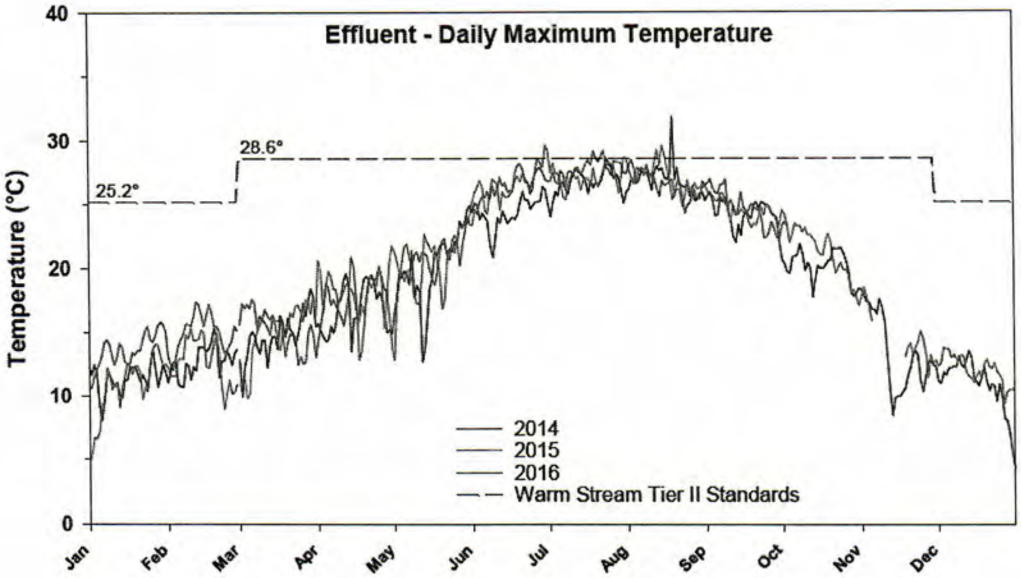


Figure 3: **Daily Maximum and Weekly Average Temperature at the thermistor site location downstream of the Comanche Electric Generation Station and Outfall 001 on the St. Charles River.**



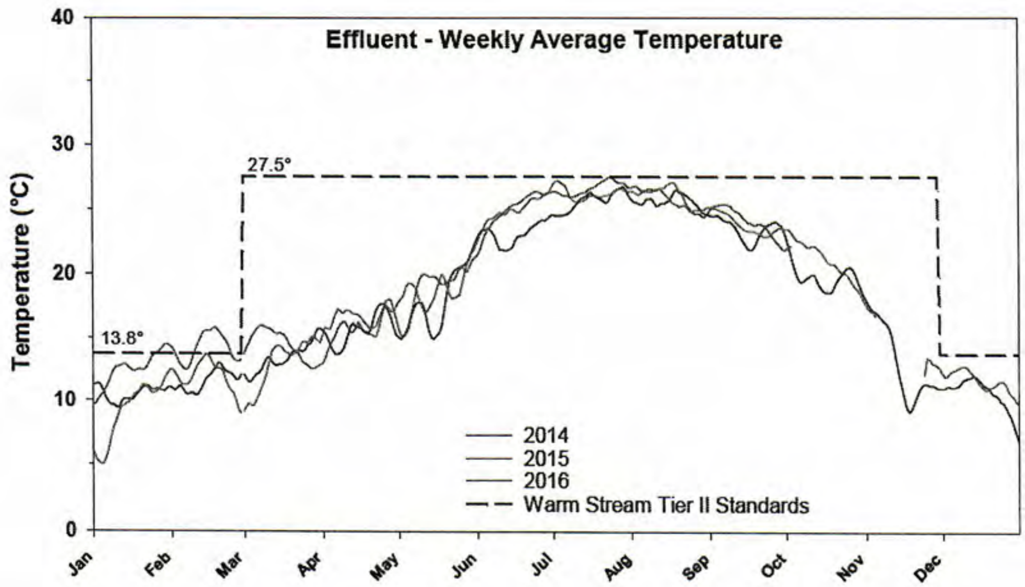


Figure 4: **Daily Maximum and Weekly Average Temperature in the effluent from Outfall 001.**

Suzanne Pargee, Water Quality Specialist

Steve Canton, Vice President

> In making a decision as to whether a temporary modification should be removed or extended, the Commission will consider the existence of an implementation plan for eliminating the need for the temporary modification, the progress being made in trying to implement such a plan, the impact of the temporary modification on the uses of the stream in the area of the temporary modification and upstream and downstream of that area, and all other relevant factors.

Reg. 31.7(3)(d).[4]

4. The Commission Should Extend the Temporary Modification for Temperature on Middle Arkansas Segment 6b.

a. PSCo's Plan and Progress Being Made Under the Plan.

PSCo submitted a Study Plan to the Commission when the temporary modification was adopted in 2013. PSCo provided an update on the plan, including the temperature monitoring, at the 2015 Temporary Modifications Rulemaking.[5]

An update, including progress made since the 2015 rulemaking, is presented in the Technical Memorandum from GEI Consultants, Inc. **Exhibit 3**. This technical memorandum also discusses PSCo's next steps in developing ambient-based standards.

As discussed more completely in **Exhibit 3**, PSCo contracted with GEI to collect temperature data at two sites, one upstream and one downstream of Comanche's discharge. **Exhibit 3**, p. 1. Temperature data has been collected year-round at 15 minute intervals since April 2014, although there have been several large gaps in data. **Exhibit 3**, pp. 2-3.

From late June until early August, 2014, data was lost from both sites due to large storm events in July, with flows in excess of 2000 cubic feet per second (cfs) (compared to the average flow of 11 cfs). Data was also lost from early June to early July 2015, and late July through early August 2015, due to loggers being buried in sediment as a result of storm events. This also led to inaccurate data measurements through the end of August

[4] Effective 12/31/2016, this section will be moved to Reg. 31.7(e). *See* Regulation No. 31, effective December 31, 2016, https://www.colorado.gov/pacific/sites/default/files/31_2016%2812%29hdr.pdf.
[5] *See* 2015 Temporary Modifications Rulemaking, PSCo Exhibit 2, GEI Consultants, Inc., Update on Temperature Monitoring for St. Charles River in the Vicinity of the Public Service Company of Colorado Comanche Plant (Oct. 23, 2015), available at: ftp://ft.dphe.state.co.us/wqc/wqcc/TemporaryModificationsRMH_2015/Responsive/PSCoEx2.GEI_Update_on_Temperature_Monitoring.pdf.

2015. Therefore, until 2016, PSCo had very little data during the summer months, when temperatures are expected to be higher.

GEI increased the frequency of its data retrieval in 2016 to ensure better data continuity. As of the date of this PPHS, there have been no data gaps this calendar year. Data collected in the summer months of 2016 are the first complete set of summer temperature data on Segment 6b since data collection began in 2014.

The data collected during the summer months in 2016, and the sparse data collected in the summer months in 2014 and 2015, indicate exceedances of the summer daily maximum ("DM") temperature upstream of the Comanche facility. There are also DM exceedances downstream of the Comanche outfall, however overall temperatures are slightly lower than at the upstream site. The exceedances of the summer DM temperature standards upstream of Comanche's discharge indicate that ambient-based standards based on existing quality may be appropriate for Segment 6b. However, there is still uncertainty on what those standards would be due to data gaps in the crucial summer months of July and August.

Comanche's effluent also slightly exceeded the summer DM temperature standard in all three years. In addition, Comanche's effluent exceeded the maximum weekly average temperature ("MWAT") in the spring shoulder months, late January and February, in 2016.

In preparing for this rulemaking, PSCo met with the Division, U.S. Environmental Protection Agency ("EPA"), and Colorado Parks and Wildlife ("CPW") in August 2016. At the meeting, the agencies suggested that additional temperature spot monitoring further downstream in the segment should be initiated to help evaluate if temperatures in the vicinity of the Comanche discharge are representative of the entirety of Middle Arkansas Segment 6b. PSCo understands this information will be helpful in both the Commission's and EPA's review of future ambient-based standards proposals for temperature on Segment 6b. Accordingly, PSCo has revised its study plan to include temperature monitoring at additional locations on the segment. *See* Revised Study Plan, **Exhibit 4**.

PSCo has also revised its study plan to include investigation of any anthropogenic sources of temperature in the surrounding area of Segment 6b. This information will help PSCo develop appropriate ambient-based standards that meet the regulatory requirements for ambient standards included in the recent revisions to Regulation 31. *See* Reg. 31.7(1)(b)(ii), p. 11 (effective 12/31/2016).

b. Impact of Temperature Temporary Modification on Uses of St. Charles Upstream and Downstream of Middle Arkansas Segment 6b.

Another consideration of the Commission in deciding whether to extend the duration of a temporary modification is the impact of the temporary modification on the uses of the stream, both upstream and downstream of the area. There has been no negative impact of the temperature temporary modification on Segment 6b.[6]

c. The Operative Value of "Current Conditions" Is Still Appropriate.

Recent rule changes to Regulation 31.7 defined the operative value during the temporary modification as either a numeric value or a narrative "current conditions." *See* Reg. 31.7(3)(d) (eff. 12/31/2016). "Current condition" is defined as a narrative "that assures existing uses are protected and that the status quo is preserved during the term of the temporary modification." Reg. 31.7(3)(d)(ii) (eff. 12/31/2016).

PSCo proposes to retain the operative value of "current conditions" for this temperature temporary modification. Retaining the "current conditions" temporary modification assures that the existing uses of Segment 6b are protected by the temporary modification, and that the status quo is preserved.

d. Justification for the December 31, 2018 Expiration Date.

The one-and-a-half-year extension of the temperature temporary modification on Middle Arkansas Segment 6b, to December 31, 2018, is necessary because of the time needed to complete studies, and develop and propose ambient-based standards. Furthermore, it allows additional time for progress to be made on the state's temperature standards, which has left a lingering uncertainty regarding temperature standards in general. Additionally, the status of the Comanche discharge permit is still unknown with respect to temperature limits, as a new permit has not yet gone to public comment.

The temperature temporary modification will be reviewed at the 2017 Temporary Modifications Hearing, with the goal that PSCo will propose an ambient-based standard in the June 2018 Arkansas Basin hearing.

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[6] *See* GEI Consultants, Inc., Use Attainability Analysis for the St. Charles River, Middle Arkansas River Segment 6, Colorado, Comanche Facility (Mar. 2013), available at ftp://ft.dphe.state.co.us/wqc/wqcc/32_36TriennialReviewRMH_2013/ProponentsPrehearingStatements/PublicService.pdf (*see* Exhibit 2, on pp. 10-96 of the PDF).

e. Other Relevant Factors Supporting Extension of the Temporary Modification.

Finally, there are other relevant factors that the Commission should consider in determining whether to extend the temperature temporary modification:

i. The need to collect more data to develop ambient based standards.

Because factors beyond its control caused PSCo to lose temperature data, PSCo needs to revise its study plan and collect additional data from across the segment in order to propose defensible ambient-based standards that would apply to the segment as a whole. In addition, PSCo will investigate potential anthropogenic sources of heat and will collect additional data at other sites to fully develop ambient based standards. *See* Revised Study Plan, **Exhibit 4**.

ii. The lingering uncertainty regarding temperature standards in Colorado.

The Commission considered a Division proposal to modify temperature standards in the fall and spring shoulder seasons in the June 2016 Regulation 31 rulemaking hearing. The end result was that no changes were made to the shoulder-season temperature standards. It is PSCo's understanding that at the next basin hearing for the San Juan and Rio Grande Basins in June 2017, the Division may be proposing site-specific solutions for shoulder season temperature issues. These proposals are likely to affect the development of PSCo's temperature standards, and/or the need for such site-specific standards versus temporary modifications. Additional time on the temporary modification will allow PSCo to learn from the next basin rulemaking and adapt any potential proposal accordingly.

iii. Uncertainty regarding the Comanche discharge permit.

The Comanche discharge permit expired in 2013, and has been administratively extended. The permit currently in effect does not have effluent limitations for temperature. It is uncertain at this time what temperature effluent limits the Division will use in the Comanche permit. Therefore, additional time under the temporary modification will allow PSCo time to determine the potential effect of a re-issued permit.

5. Conclusion.

PSCo has demonstrated that an extension of the temperature temporary modification is necessary to resolve the uncertainty underlying temperature standards on Middle Arkansas Segment 6b. Therefore, the Commission should extend the temperature temporary modification until December 31, 2018.

6. Witnesses

- Suzanne Pargee, GEI Consultants, Inc.
- Lee Bergstedt, GEI Consultants, Inc.
- Steve Canton, GEI Consultants, Inc.
- Christine Johnston, Public Service Company of Colorado

7. Exhibits

1.	Proposal and Statement of Basis and Purpose
2.	Temporary Modifications Checklist
3.	GEI Consultants, Inc., Technical Memorandum: Temperature Monitoring on St. Charles River for Public Service Company of Colorado Comanche Plant (Oct. 2016)
4.	Revised Plan to Resolve Uncertainty

Respectfully submitted this 4th day of October, 2016.

By: *s/ Gabe Racz*

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ATTORNEYS FOR PUBLIC SERVICE COMPANY OF COLORADO

Revised Study Plan to Resolve Uncertainty Regarding Temperature Standards Middle Arkansas Segment 6b

The Public Service Company of Colorado (PSCo) revised plan to resolve uncertainty about the appropriate temperature standards for Middle Arkansas Segment 6b (St. Charles River, Reg. 32, COARMA06b) includes the following elements:

- Continue temperature monitoring on Segment 6b.
- Add individual temperature samples to determine representativeness of temperature stations for Segment 6b.
- Investigate potential anthropogenic sources of heat.

EXHIBIT O

Consulting
Engineers and
Scientists

Technical Memorandum

Temperature Monitoring on the St. Charles River for Public Service Company of Colorado Comanche Plant

Introduction

At the request of Public Service Company of Colorado (PSCo) (dba Xcel Energy), in 2014 GEI Consultants, Inc. (GEI) initiated a temperature monitoring program in Segment 6b of the Middle Arkansas River Basin (COARMA06b) to assist with addressing the uncertainty in the appropriate temperature standards for the segment. Segment 6b is the mainstem of the St. Charles River from the confluence with Edson Arroyo to the confluence with the Arkansas River. GEI set up temperature monitoring stations on April 9th, 2014, at one site upstream of Comanche's Outfall 001 and one site downstream of Outfall 001 (Table 1, Figure 1). In addition, continuous temperature data from the effluent channel are available from the Division of Water Resources monitoring station. Segment 6b is currently classified as Aquatic Life Warm 2 (Tier II), Recreation E, Water Supply, and Agriculture in Regulation 32 with a temporary modification for temperature of "current conditions" with an expiration date of June 30, 2017 (Colorado Department of Public Health and Environment [CDPHE] 2016).

Table 1: GEI sampling site locations and dates on the St. Charles River.

St. Charles River - Segment 6b		
Thermistor Site Location	**GPS Coordinates**	**Current Period of Record**
St. Charles River Upstream of Outfall 001	N 38°11'29.96", W 104°34'17.80"	4/9/14-09/30/16
St. Charles River downstream of Outfall 001	N 38°11'29.53", W 104°34'10.55"	4/9/14-09/30/16

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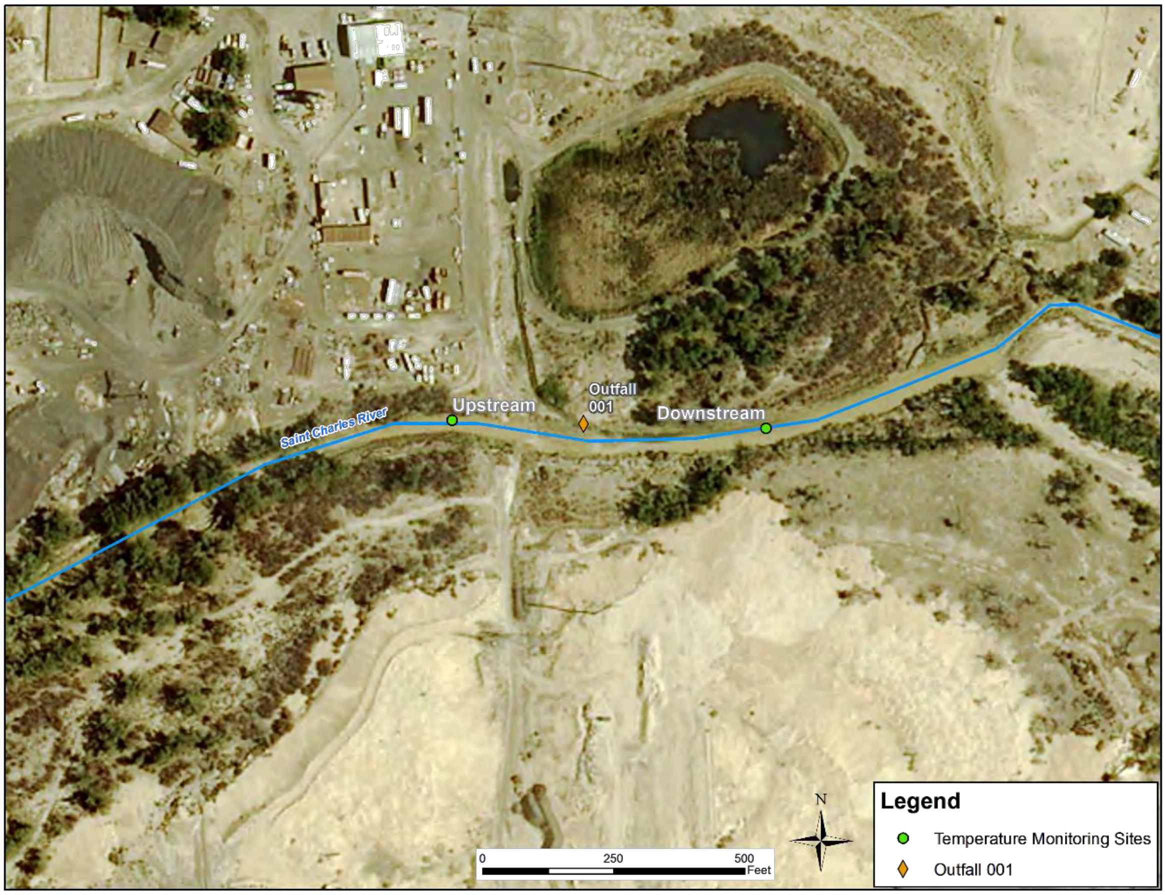


Figure 1: Thermistor site locations in St. Charles River, Segment 6b of the Upper Arkansas Basin.

Methods

Thermistors were placed in the main channel of the St. Charles River, with care taken to not place them in habitats where unusual temperature fluctuations would be expected (i.e. backwaters or eddies; or locations that would become dewatered with reduced flows). Thermistors were attached to a cinderblock with a 3/8 inch (in) steel cable, and the cinderblock was placed over a 6 foot (ft) T-post driven approximately 4 ft into the river substrate. The cinderblock was attached to a 15 ft length of 3/8 in steel cable that was attached to a second 6 ft T-post driven approximately 4 ft into the river bank. The T-posts on the river bank were approximately 5 ft above the water surface at both locations. Both thermistors were enclosed in a 6 in piece of perforated PVC piping to prevent inaccurate measurements due to solar heating.

Temperature data have been collected year-round at 15-minute intervals since thermistor placement in April 2014. Temperature data are retrieved by removing the thermistor from the water for a short period of time, usually less than 15 minutes. The thermistor (HOBO Water Temperature Pro v2 Data Logger – U22-001) is attached to an offload device (HOBO Optic USB Base Station – BASE-U-4), and the temperature data is downloaded onto a laptop computer with HOBOware software. The thermistor is then placed back into the river to continue recording water temperature.

A set of quality control measures has been used to evaluate the dataset and eliminate data that do not appropriately represent instream temperatures due to various causes such as a dewatered thermistor or thermistor malfunction. Temperature data are discarded from the dataset and not evaluated further if they do not meet the following guidelines:

- Maximum temperature 36°C or greater
- Maximum temperature 25°C or greater and the difference between the minimum and maximum temperatures was 15°C or greater; or
- Difference between the minimum and maximum temperature was 25°C or greater
- Sample size for each day did not include the full range of interval data
- Sporadic daily values were bracketed by periods of no data

The revised data were used to calculate running two-hour daily averages and running weekly average temperature (WAT) parameters for comparison with the proposed Daily Maximum (DM) and Maximum Weekly Average Temperature (MWAT) standards for Warm Water Tier II stream segments in Regulation 31. The DM is defined as “the highest two-hour average water temperature recorded during a given 24-hour period.” The MWAT is defined as “the largest mathematical mean of multiple, equally spaced temperatures over a seven-day consecutive period, with a minimum of three data points spaced equally through the day.”

Results

There are several data gaps in 2014 and 2015. Data from June 20, 2014, through August 4, 2014, are missing from both sites due to four large storm events in July with flows in excess of 2000 cfs (USGS gage #07108900, St. Charles at Vineland, CO). Both the upstream and downstream temperature loggers washed away in one of the storm events in July. When GEI personnel went to retrieve data, the north and south banks where the T-posts were anchored eroded away, and all T-posts, cinderblocks, and the temperature loggers were lost. Complete replacement of the thermistor set-ups could not be completed until August 4, 2014. Data collected between the previous data download and the storms were lost with the loggers. Data are also missing from June 6, 2015 through July 7, 2015, and July 22, 2015 through August 3, 2015, from the upstream site due to the loggers being buried in sediment. Storm events with flows in excess of 300 cfs resulted in the logger being buried in sand each time. Data is also missing from the downstream site due to equipment malfunction on August 5, 2015, which was not discovered until data were downloaded. This resulted in inaccurate measurements from August 5, 2015 through August 27, 2015, resulting in a slightly shorter period of record for this site compared to the upstream site. Because of these data gaps in the summer months when temperature are expected to be highest, GEI increased data retrieval frequency from once every 4 to 6 weeks to twice monthly in summer 2016 to ensure better data continuity. There have been no data gaps to date in 2016.

The calculated MWAT and DM values for data collected to date from the St. Charles River upstream and downstream sites are shown in Figures 2 and 3. Even with the data gaps in summer 2014 and 2015, there have been exceedances of the summer DM temperature in the St. Charles River upstream of the Xcel Comanche facility in all three years. There are also exceedances of the DM at the downstream site, but temperatures are slightly lower at the downstream site than at the upstream site. The effluent also exceeds the DM temperature standard in the summer months in all three years, but only slightly (Figure 4). The highest summer temperatures in the effluent are lower than those at the upstream and downstream St. Charles sites. The effluent also exceeded the MWAT in the spring shoulder months, late January and February, in 2016.

Next Steps

The exceedances of summer DM temperature standards upstream of the discharge indicate that ambient-based temperature standards based on existing quality may be appropriate for this segment. Although temperature data have been collected for three years, there is still uncertainty as to the appropriate summer temperature standard due to the data gaps in July and August.

Additionally, after a meeting with the agencies in August 2016, it was determined that additional temperature spot monitoring should be initiated to help evaluate if temperatures in the vicinity of the Xcel outfall are representative of the entire Segment 6b. Spot temperature measurements will be collected at the same time as data downloads from the thermistors at six additional sites in Segment 6b. The spot measurement sites begin approximately 1 mile below the top of the segment, to a location approximately 2 miles above the confluence with the Arkansas River, matching sites sampled earlier as part of the selenium use-attainability analysis (GEI 2013). Spot measurements will be compared to concurrent thermistor measurements to determine if temperature is consistent throughout the segment.

Given the data gaps in summer, GEI recommends collecting an additional two years of data in 2016-2017 to have more complete data to calculate ambient-based standards. As was done in 2016, temperature data would be downloaded on a more frequent basis to help ensure no data gaps during the critical summer months over the next two years, along with the spot measurements to better represent the entire segment.

Furthermore, Xcel is revising its study plan to include investigation of any anthropogenic sources of temperature in the vicinity of the Comanche plant. Xcel plans on studying the sources of temperature over the next few years to make the required demonstrations for ambient-based standards based on revisions to Regulation 31.

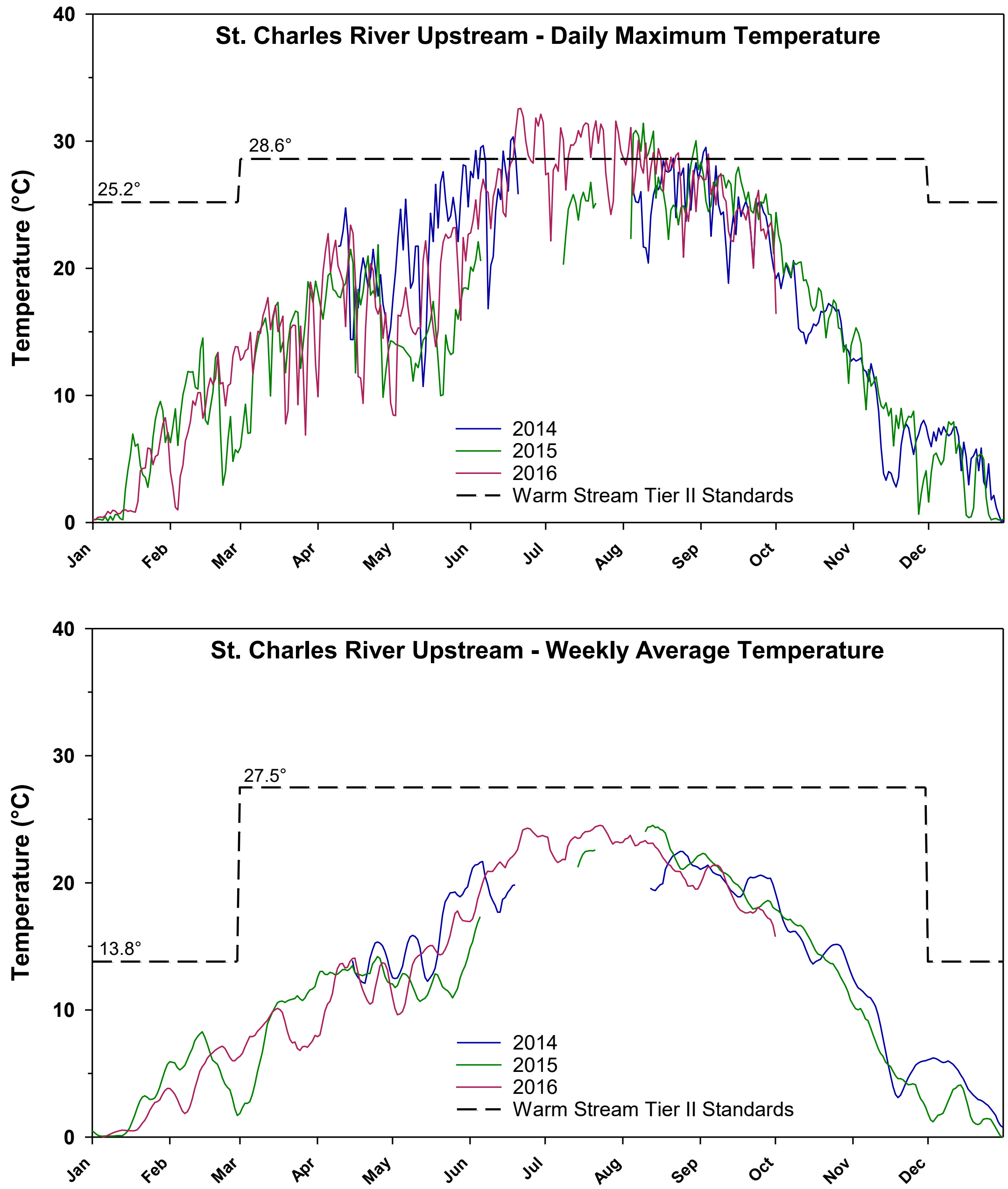
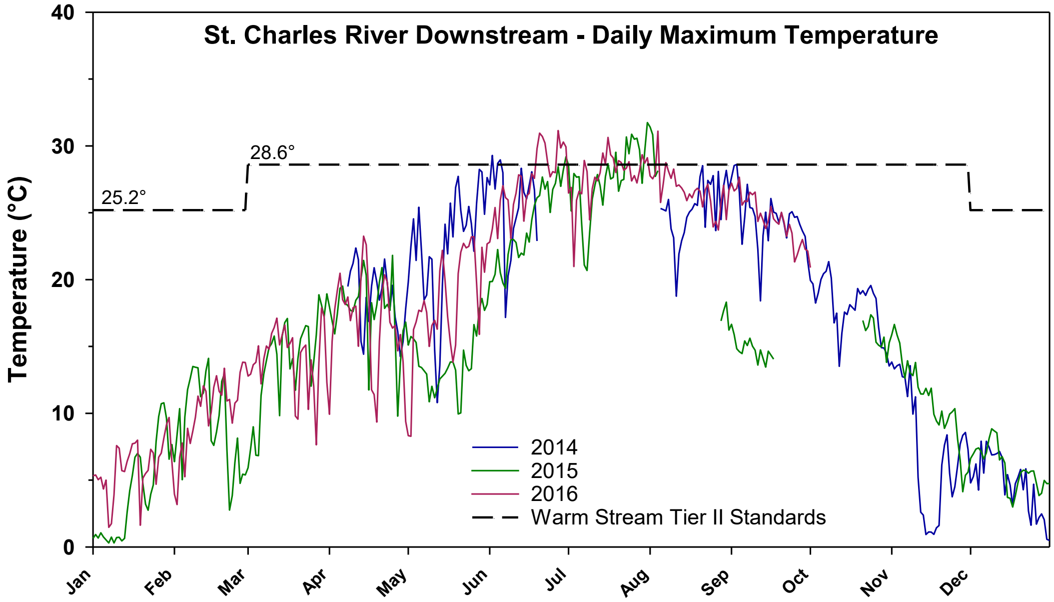


Figure 2: Daily Maximum and Weekly Average Temperature at the thermistor site location upstream of the Comanche Electric Generation Station and Outfall 001 on the St. Charles River.



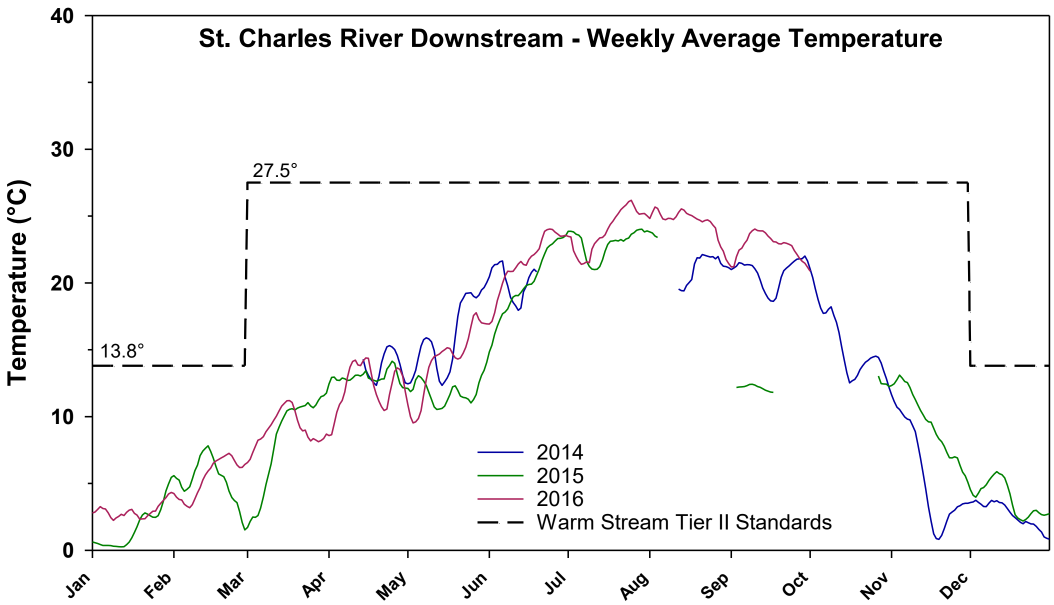
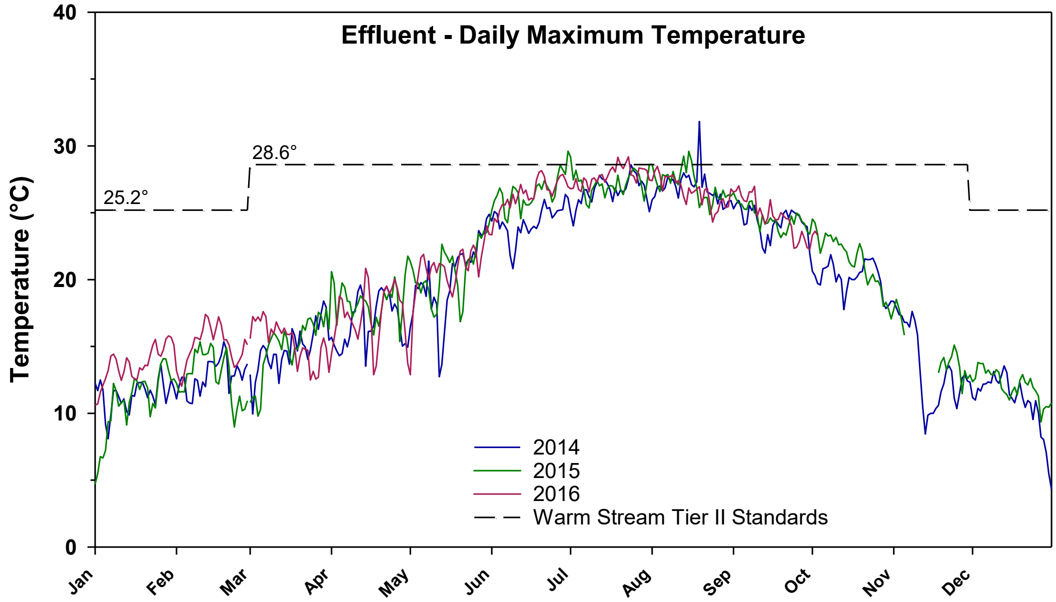


Figure 3: Daily Maximum and Weekly Average Temperature at the thermistor site location downstream of the Comanche Electric Generation Station and Outfall 001 on the St. Charles River.



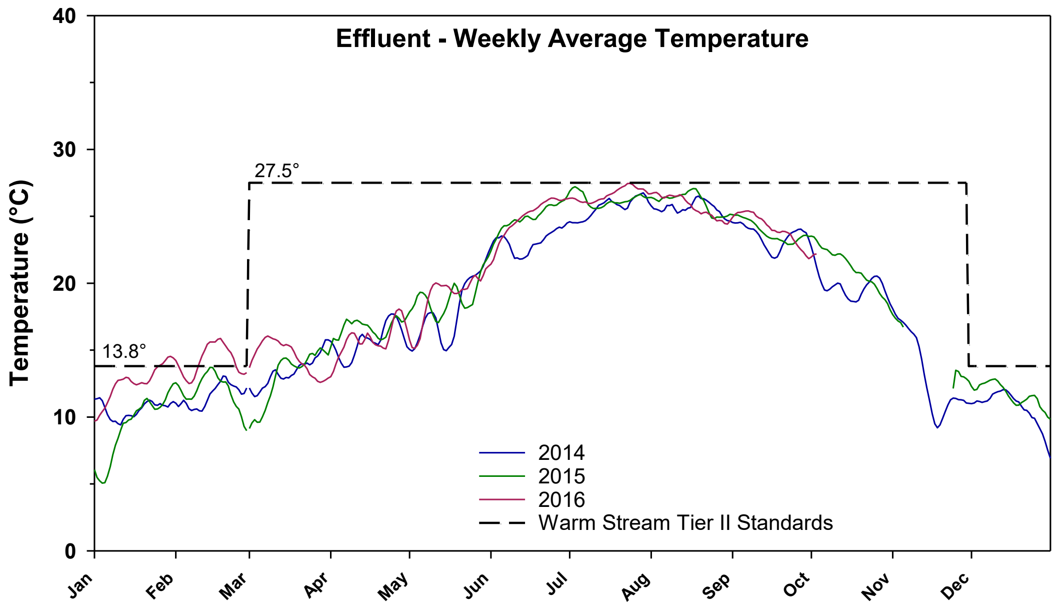


Figure 4: Daily Maximum and Weekly Average Temperature in the effluent from Outfall 001.

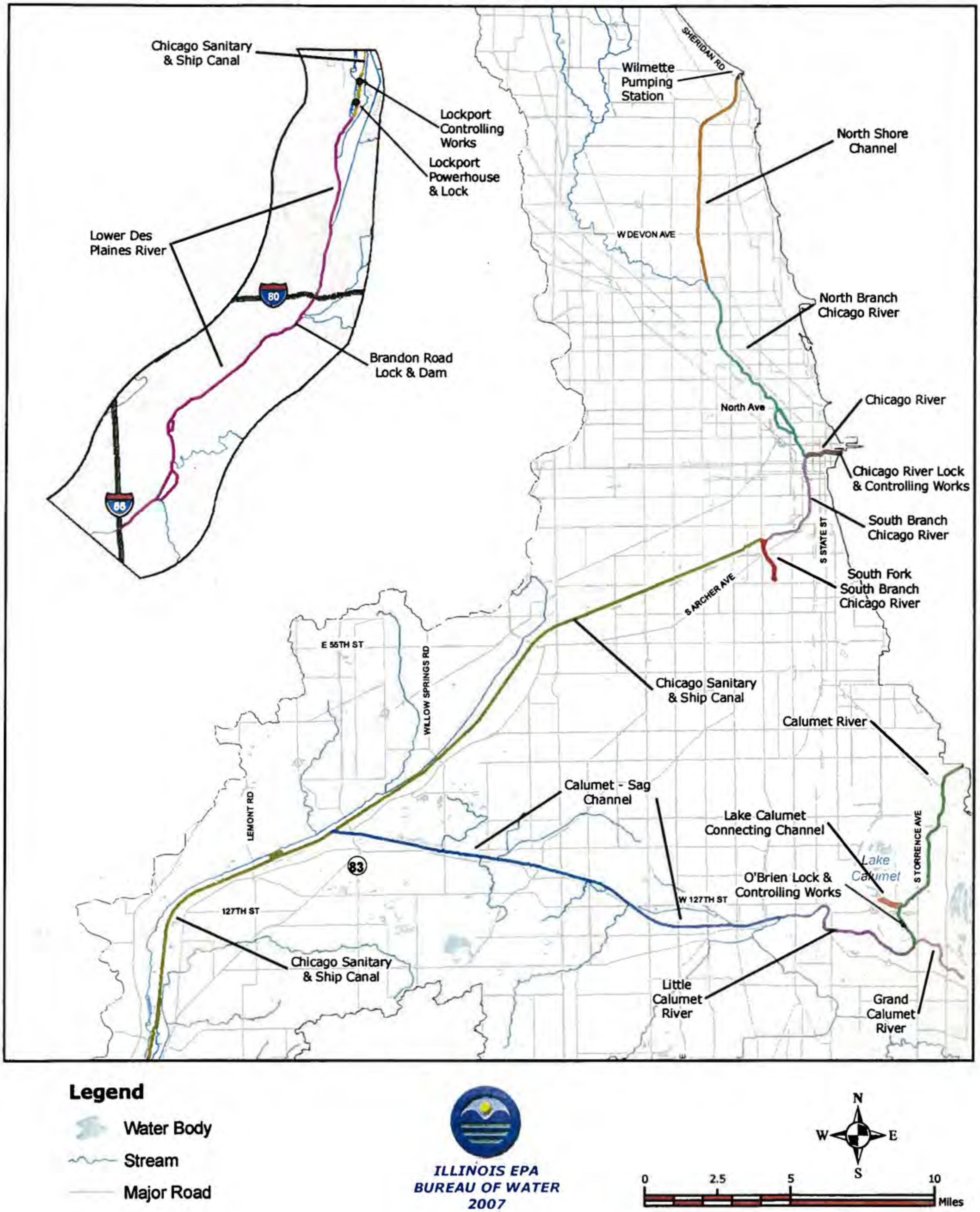
Suzanne Pargee, Water Quality Specialist

Steve Canton, Vice President

EXHIBIT P

IEPA ATTACHMENT NO. I

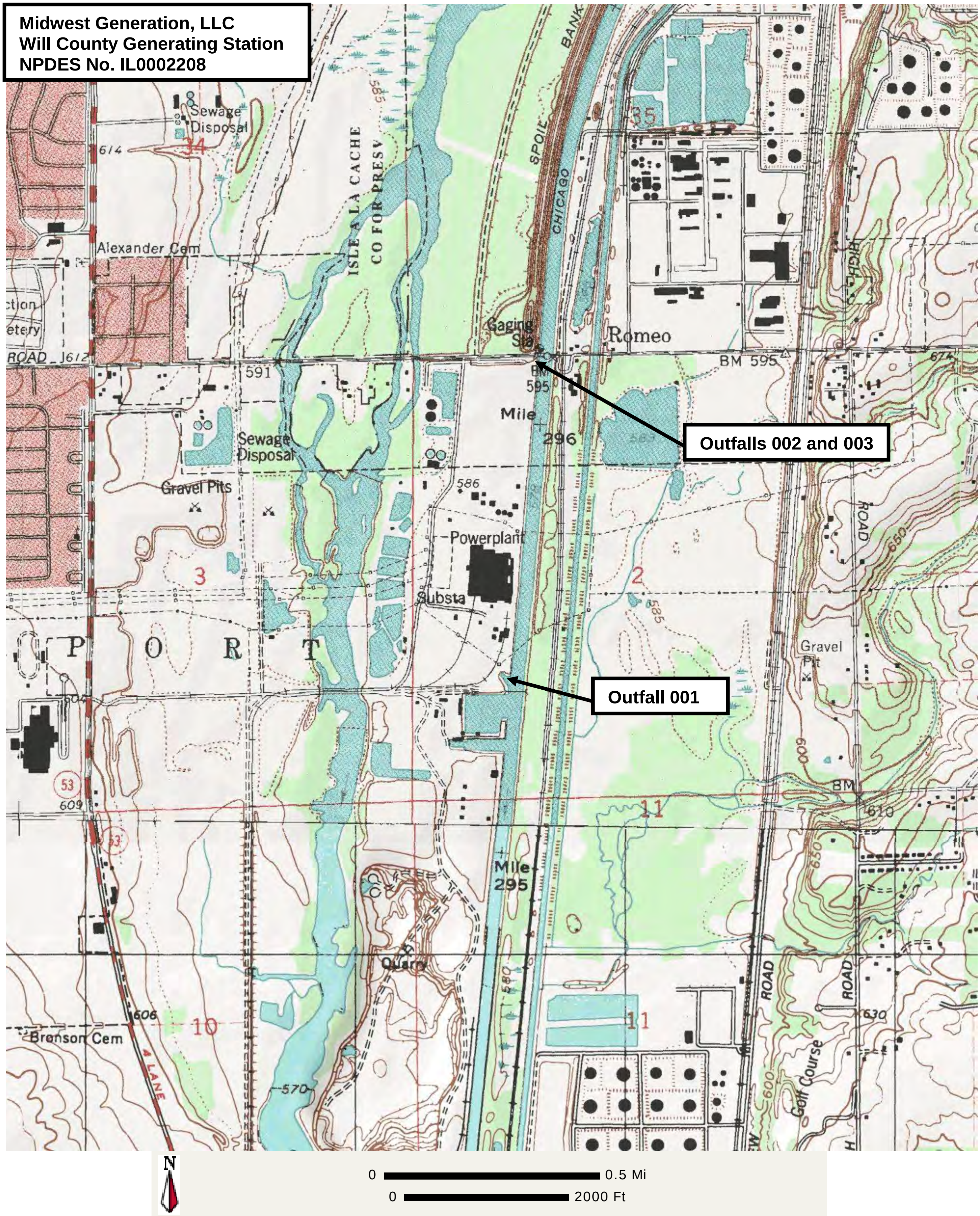
CHICAGO AREA WATERWAY SYSTEM AND DES PLAINES RIVER UAA SEGMENTS



ILLINOIS EPA
BUREAU OF WATER
2007

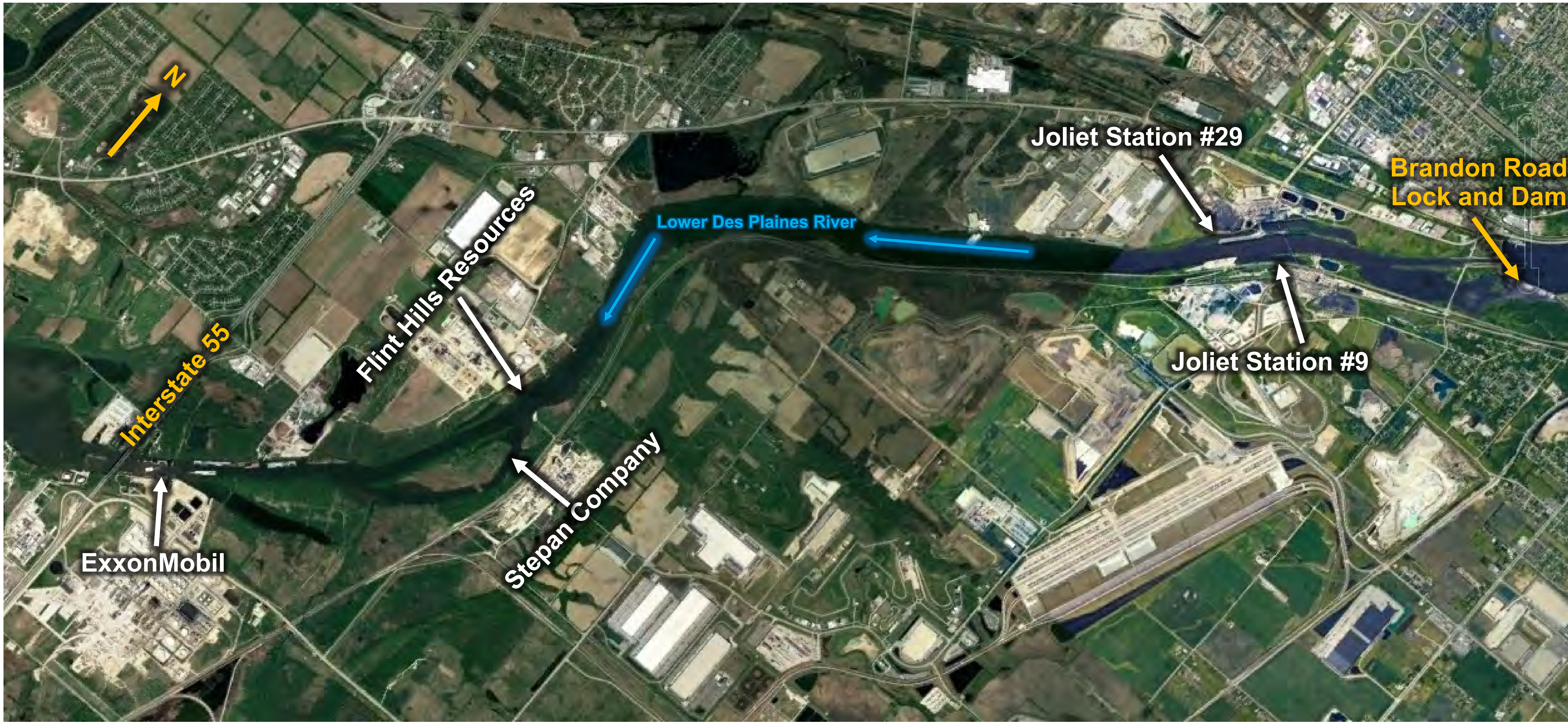
EXHIBIT Q

Location of the Will County Station Thermal Discharge into the Chicago Sanitary and Ship Canal of lower Lockport Pool.

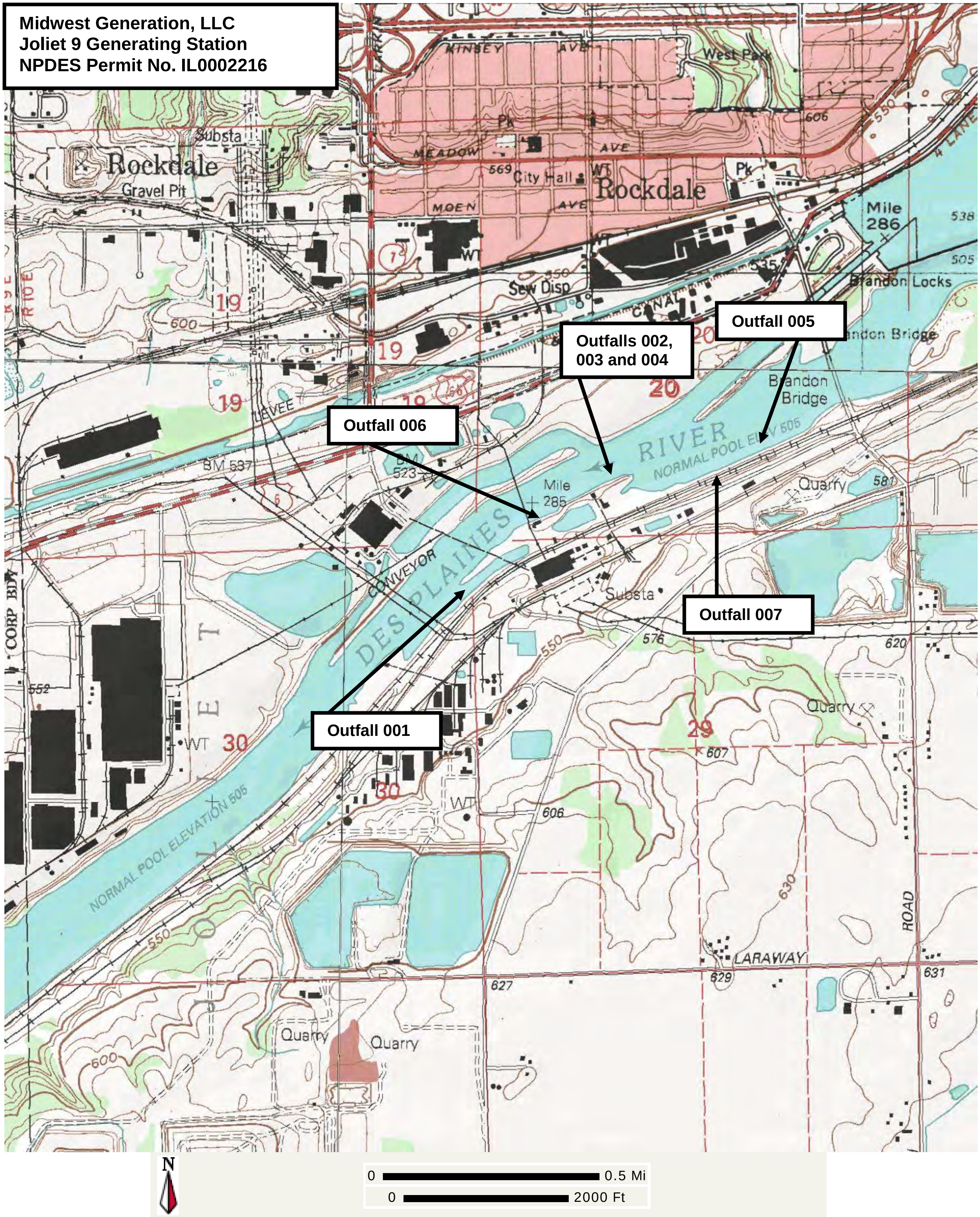


Note: Outfall 001 is the outfall for heated condenser water

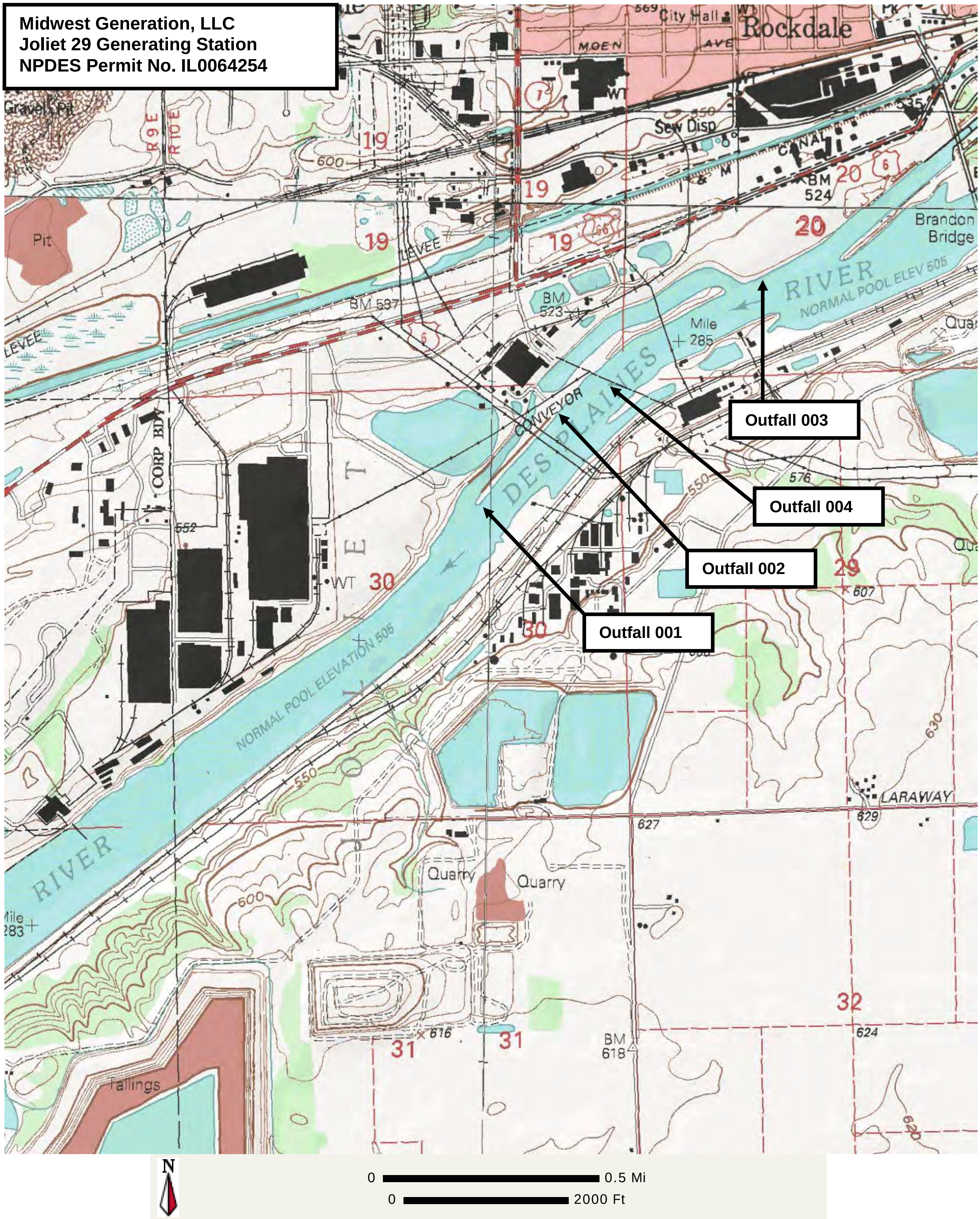
EXHIBIT R



Location of Joliet Station #9, Joliet Station #29, Flint Hills Resources, Stepan Company, and ExxonMobil Thermal Discharges into the lower Des Plaines River of Upper Dresden Island Pool.



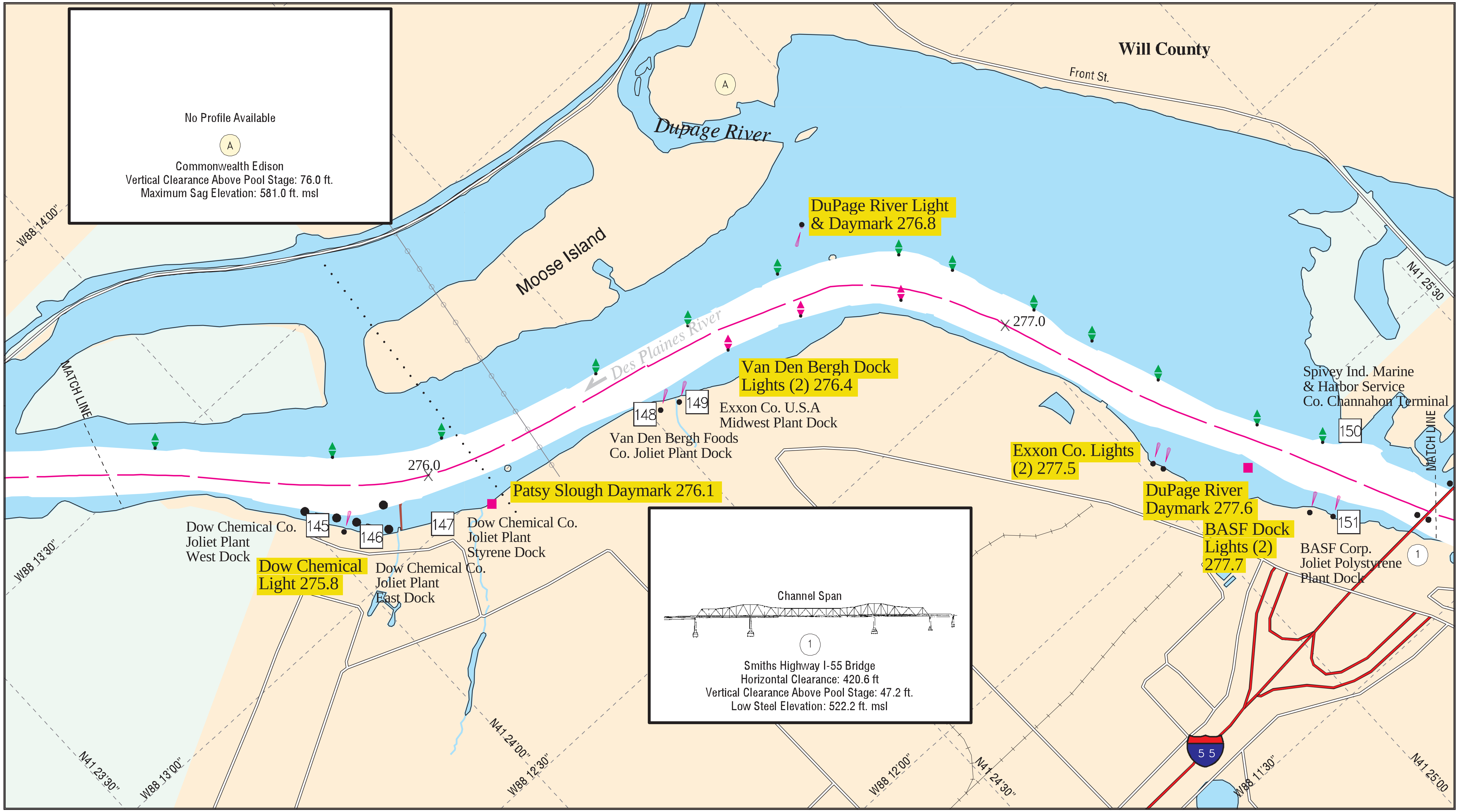
Note: Outfall 001 is the outfall for heated condenser water



Note: Outfall 1 is the outfall for heated condenser water.

EXHIBIT S

US ARMY CORPS OF ENGINEERS ILLINOIS WATERWAY MILE 275.5 TO 277.8



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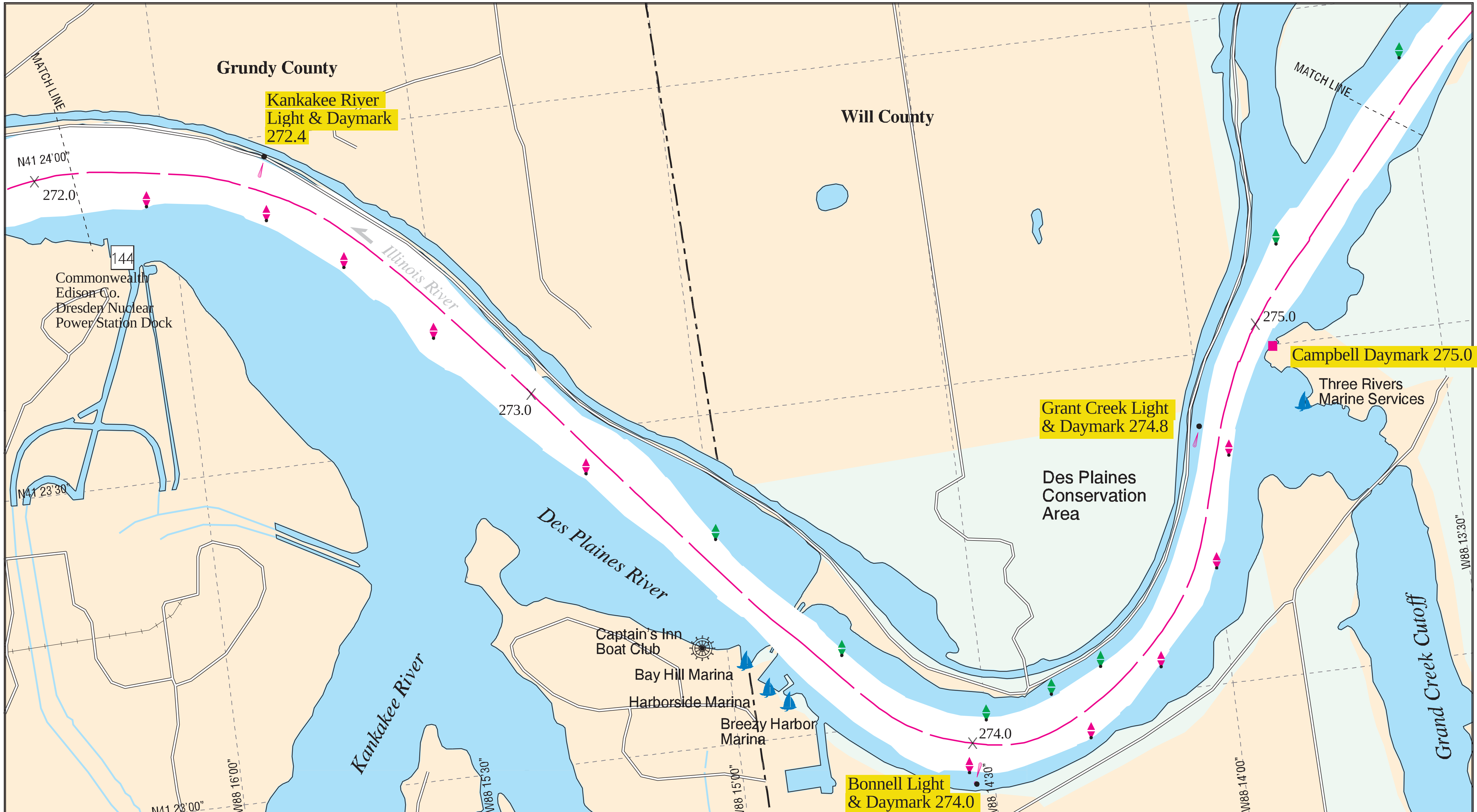
1) The legend is located immediately preceding map No. 1
2) Barge Facility information and submerged cable and pipeline clearances are located in appendices A and B respectively.

Scale 1:12000 Scale 1" = 1000 Feet
0 1150 2300 ft

MAP NO. 108

US ARMY CORPS OF ENGINEERS ILLINOIS WATERWAY MILE 272.0 TO 275.5



1998

1) The legend is located immediately preceding map No. 1
2) Barge Facility information and submerged cable and pipeline clearances are located in appendices A and B respectively.

Scale 1:12000 Scale 1" = 1000 Feet
0 1150 2300 ft

N E S W

EXHIBIT T

Intake Temperature Data:

J9 Hourly Intake Temperature (°F)																		
	2012			2013			2014			2015			2016			2017		
Month	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
JAN	33.2	42.6	52.5	37.8	45.5	60.6	32.0	37.0	52.5	34.2	40.4	52.4	32.8	38.9	54.3	32.9	38.5	44.1
FEB	37.3	44.8	58.5	35.9	39.9	44.3	33.6	42.4	59.8	35.3	43.0	55.3	35.8	41.3	49.7	34.7	43.3	55.0
MAR	32.7	56.3	68.4	37.2	43.2	55.4	34.7	41.7	50.1	38.0	46.1	67.5	40.9	50.6	57.7	41.7	46.7	53.8
APR	55.9	60.6	68.7	46.5	52.4	63.5	44.9	54.5	63.4	47.6	55.4	67.5	47.1	55.2	66.6	45.0	56.4	66.1
MAY	59.8	70.7	84.4	59.5	66.3	79.4	54.0	63.8	76.7	55.9	63.5	71.4	52.8	61.3	75.5	50.2	60.5	69.3
JUN	69.5	80.1	89.6	65.2	72.8	87.0	66.1	73.8	80.9	63.4	70.3	75.1	68.0	75.5	82.1	65.5	73.2	80.3
JUL	81.4	86.4	95.4	70.9	80.3	92.2	71.0	75.5	86.4	69.3	76.0	87.4	74.7	79.5	87.9	71.7	76.0	81.3
AUG	75.8	82.5	95.4	74.4	80.3	91.3	71.8	76.8	84.0	71.5	77.5	87.3	74.0	79.6	87.8	70.0	76.0	80.6
SEP	67.5	76.9	91.8	70.2	78.7	91.1	63.1	70.4	85.7	65.7	72.6	82.1	68.6	76.6	82.1	68.5	73.2	83.0
OCT	55.8	66.1	86.2	54.1	69.3	85.7	58.6	62.8	74.3	56.4	66.1	78.6	56.4	64.6	71.7	51.5	63.5	73.2
NOV	50.9	60.7	71.3	44.4	52.4	63.5	41.2	52.9	63.5	44.9	54.4	68.9	46.5	53.7	61.1	42.4	48.4	54.2
DEC	41.7	52.2	72.0	36.5	46.2	63.7	38.4	46.7	52.8	36.6	46.2	53.1	34.4	39.9	47.6	33.6	40.9	50.7

J29 Hourly Intake Temperatures (°F)																		
	2012			2013			2014			2015			2016			2017		
Month	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
JAN	38.4	43.5	48.8	39.3	44.5	52.2	32.9	38.0	47.0	34.7	40.5	47.6	33.9	39.1	48.5	35.8	39.3	44.4
FEB	31.2	46.2	53.0	36.6	40.7	44.8	35.2	40.6	52.0	38.0	42.5	48.0	39.0	41.1	47.0	35.5	43.6	52.4
MAR	35.0	56.6	69.5	38.4	43.8	52.4	36.7	42.4	48.4	38.8	45.9	52.6	41.3	50.5	56.9	43.7	47.1	52.1
APR	56.1	60.4	64.9	47.1	52.3	63.1	46.1	54.5	61.9	47.2	55.1	61.2	46.8	54.7	64.7	45.3	56.0	65.5
MAY	44.3	70.4	82.7	59.7	66.0	76.7	54.5	63.6	75.6	56.5	63.0	69.5	53.6	61.2	76.6	50.0	59.9	68.9
JUN	55.4	79.4	87.1	66.1	72.4	80.2	67.3	73.7	79.2	63.9	69.9	74.4	68.0	74.7	80.5	65.0	72.1	77.1
JUL	81.0	85.7	92.5	70.9	79.4	88.1	71.6	75.1	79.4	70.3	76.0	82.8	74.3	78.8	84.6	71.3	75.1	79.6
AUG	75.7	81.6	90.6	74.1	79.2	86.9	72.1	76.2	80.1	71.1	76.5	82.6	75.1	79.3	85.1	70.4	75.2	81.9
SEP	67.2	75.8	85.7	70.2	77.0	87.4	63.6	70.2	83.3	65.4	72.1	79.3	69.0	76.2	80.5	68.3	72.2	79.1
OCT	56.1	64.9	79.6	53.9	67.3	78.0	58.2	63.2	71.0	55.8	64.3	70.4	57.1	64.7	70.3	51.6	63.0	71.7
NOV	51.6	57.9	64.5	45.2	52.6	59.8	41.1	52.1	60.8	45.0	54.2	62.7	47.2	54.0	61.0	43.0	48.2	53.3
DEC	42.3	51.1	66.3	37.5	45.0	57.3	39.9	47.1	51.2	38.4	46.3	52.2	36.0	42.5	48.2	34.1	40.9	49.3

EXHIBIT U

CONCLUSION

Integrated ANS controls within the Tentatively Selected Plan and the waterway system (e.g., at Brandon Road Lock and Dam and at the Chicago Sanitary and Ship Canal Electric Barrier) would maximize the effectiveness of preventing upstream transfer of swimming and floating Mississippi River Basin ANS into the Great Lakes Basin while maintaining navigation and minimizing impacts. Life safety would be a primary consideration when designing, constructing and operating this plan.

Integrated ANS controls within the Tentatively Selected Plan and within the system (e.g., at Brandon Road Lock and Dam and at Romeoville) would maximize the effectiveness of preventing upstream transfer of swimming and floating Mississippi River Basin ANS into the Great Lakes Basin while maintaining navigation and minimizing impacts. Life safety would be a primary consideration when designing, constructing and operating this plan.

Collaborative groups such as the Asian Carp Regional Coordinating Committee – which is comprised of federal, state, and local governments and associated regulatory agencies – will continue to play a significant leadership role. Continued partnerships among these agencies will facilitate coordinated efforts toward the protection of aquatic and environmental resources and shape future decisions regarding long-term ANS strategies.

NEXT STEPS

The GLMRIS-BR Report was released in early August and is currently in a public comment period. The public comment period provides interested parties with an opportunity to make comments for the record.

Comments can be submitted in one of four ways:

1. completing a comment form located on the study website (glmris.anl.gov);
2. via traditional mail;
3. at public meetings; or
4. delivered by hand.

Please refer to the GLMRIS website for a copy of the draft report and how to submit comments.

RESOURCES & CONTACTS

To learn more about GLMRIS, visit the following locations:

Website: glmris.anl.gov

Twitter: twitter.com/glmris

Facebook: facebook.com/glmris

Or contact the GLMRIS Project Team at: glmris@usace.army.mil

U.S.ARMY

US Army Corps of Engineers ®

September 2017

GLMRIS BRANDON ROAD

SUMMARY OF THE GREAT LAKES MISSISSIPPI RIVER INTERBASIN STUDY - BRANDON ROAD

WHAT IS GLMRIS-BRANDON ROAD?

The Great Lakes and Mississippi River Interbasin Study - Brandon Road (GLMRIS-BR) Draft Integrated feasibility study and Environmental Impact Statement builds on the Great Lakes and Mississippi River Interbasin Study (GLMRIS) Report released in January 2014.

Study Objective

GLMRIS-BR is a Feasibility Study to evaluate options and technologies in the vicinity of Brandon Road Lock and Dam near Joliet, Illinois, to prevent upstream transfer of Aquatic Nuisance Species (ANS) from the Mississippi River Basin into the Great Lakes Basin through the Chicago Area Waterway System, while minimizing impacts to existing waterway uses and users.

The United States Army Corps of Engineers (USACE) is conducting this study in consultation with other federal agencies, Native American tribes, state agencies, local governments, and nongovernmental organizations.

ANS can cause harmful environmental, economic, political and social impacts!

Prevention is recognized as the best defense against ANS. USACE has interpreted the term "prevent" to mean the reduction of risk to the maximum extent possible,because it may not be technologically feasible to achieve an absolute solution.

BACKGROUND-2014 GLMRIS REPORT

GLMRIS is a study conducted by USACE as authorized by the United States Congress in 2007 in Section 3061(d) of the Water Resources Development Act of 2007, Public Law 110-114 (WRDA 2007).

In 2014, USACE released the GLMRIS Report which presented a range of options and technologies to prevent the upstream and downstream transfer of ANS between the Great Lakes and Mississippi River basins through aquatic pathways.

The report presented an array of eight alternative plans but did not include a recommendation for authorization.

Three of the plans included implementing a control point to prevent upstream transfer of Mississippi River Basin ANS at Brandon Road Lock and Dam near Joliet, Illinois.

Valuable information for the public and decision-makers was identified in the report, including ideas regarding available ANS control options and their potential impacts on waterway users and uses.

WHAT ARE ANS?

ANS are organisms, which can be plants, animals, or pathogens, that when introduced into a new habitat can produce harmful impacts on aquatic ecosystems and to the human uses of these systems. Recent ANS invasions to the Great Lakes and Mississippi River Basins include zebra mussels, quagga mussels, round goby and Eurasian ruffle.

Because ANS populations span watershed and government jurisdictional boundaries, efforts to manage them must be coordinated across these boundaries. For these reasons, ANS are of national and global concern.

HOW DO ANS TRAVEL?

Swim
Examples: fish

Hitchhike
Examples: plant fragments and crustaceans attached to vessels

Float
Examples: fish eggs, larvae and plant fragments

Swimming, floating and hitchhiking are called "**modes of transport**."

ANS control measures were developed to address ANS modes of transport and site-specific conditions in the area around Brandon Road Lock to prevent their upstream transfer.

NONSTRUCTURAL CONTROLS

Nonstructural controls do not require construction of structural features and may be implemented relatively quickly. The nonstructural control measures in the Tentatively Selected Plan include monitoring, overfishing, integrated pest management, public education and outreach. Through a shared responsibility, these are implemented by municipal, state and federal agencies.

SUPPORTING MEASURES

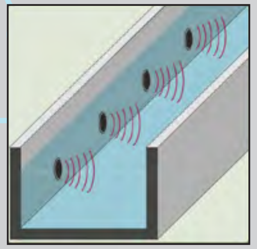
Supporting measures were developed to aid with implementation of the nonstructural control measures and the electric barrier.

Mooring area is a supporting measure included in alternatives with an electric dispersal barrier to provide for reconfiguration of tows downstream prior to locking through Brandon Road Lock.

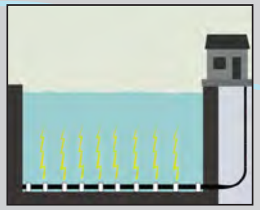
Boat launches are located upstream and downstream of Brandon Road Lock and Dam to address limited boat access for safety and ANS control measures.

STRUCTURAL CONTROLS

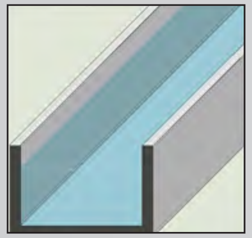
Structural controls require the design, construction and operation of a permanent feature in the vicinity of the lock and adjacent waterway and take longer to implement. The structural control measures in the Tentatively Selected Plan provide physical deterrents to swimming and floating ANS.



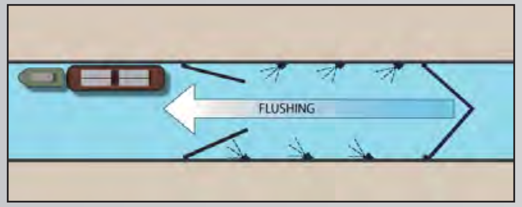
Complex noise is underwater sound generated to deter ANS fish species from entering the approach channel and lock; it is ineffective for floating and hitchhiking ANS.



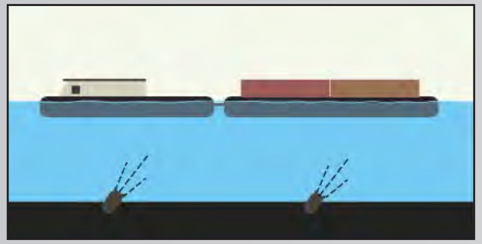
Electric dispersal barrier creates an electric field that repels fish.



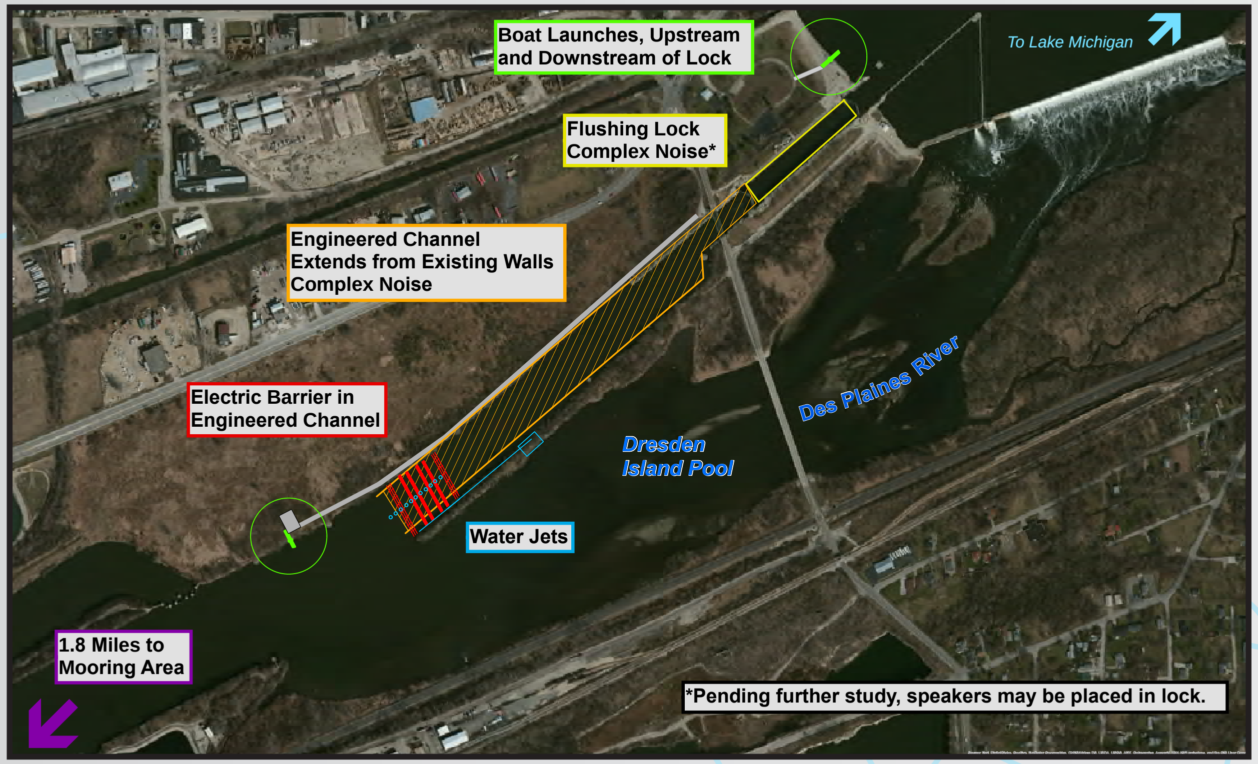
Engineered channel is a concrete structure installed within the downstream approach channel to the Brandon Road Lock that will house structural ANS controls. The engineered channel increases the efficacy and reduces the negative impacts of some ANS controls, and provides a platform from which to evaluate future ANS controls and potentially incorporate them.



Flushing lock removes floating ANS from the downstream pool by flushing the lock with water from the upstream pool. It does not control the passage of swimming or hitchhiking ANS.



Water jets installed along the bottom of the engineered channel are designed to remove small and stunned fish that may become entrained in spaces between barges.



Aerial view of Tentatively Selected Plan

USACE recommends the Technology Alternative - Complex Noise with Electric Barrier as the Tentatively Selected Plan. Life safety would be a primary consideration when designing, constructing and operating this plan.

The Tentatively Selected Plan includes the nonstructural and structural measures identified on page 2. The plan includes redundant ANS controls for swimmers, the electric barrier, currently the most effective fish deterrent available, and complex noise, and contains measures to address floating ANS. Initially, the electric barrier would only operate when there are no vessels immediately downstream of the approach channel, within the channel, or within the lock. Complex noise would be operated when the electric barrier is off.

Nonstructural controls add an additional layer of control by in part decreasing the population pressure below Brandon Road Lock and Dam through the removal of Asian Carp or other ANS species. Successful implementation of nonstructural controls would maximize the plan's effectiveness, and would be a shared responsibility with multiple stakeholders including federal, state and local agencies.

Structural controls downstream of the lock would be installed within an engineered channel. The engineered channel would increase the efficacy of certain structural and nonstructural controls and also would provide a platform to continue development and testing of future ANS controls and potentially incorporate them.

If the Tentatively Selected Plan becomes the recommended alternative, nonstructural controls would be implemented within one year of project authorization pending the availability of funding. Structural control measures are estimated to take approximately five years to design and construct once authorized and fully funded. After construction is complete, additional time would be required to complete all necessary testing, such as safety and calibration testing, prior to operation.

The Tentatively Selected Plan, in conjunction with the existing Chicago Sanitary and Ship Canal Electric Dispersal Barrier System in Romeoville, Illinois, would provide two control points for swimming ANS to protect Great Lakes' resources. Integrated ANS controls within the Tentatively Selected Plan and the waterway system (e.g., at Brandon Road Lock and Dam and at the Chicago Sanitary and Ship Canal Electric Barrier - *see figure on page 4*) would maximize the effectiveness of preventing upstream transfer of swimming and floating Mississippi River Basin ANS into the Great Lakes Basin while maintaining navigation and minimizing impacts.

TENTATIVELY SELECTED PLAN ESTIMATED COSTS

Element	Cost
Construction	$275,300,000
Nonstructural (Annual)	$11,300,000
OMRR&R (Annual)	$8,200,000

EXHIBIT V

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	
EFFLUENT LIMITATIONS FOR THE	)	R08-9 Subdocket C
CHICAGO AREA WATERWAY SYSTEM	)	(Rulemaking – Water)
AND THE LOWER DES PLAINES RIVER:	)	
PROPOSED AMENDMENTS TO 35 Ill.	)	
Adm. Code Parts 301, 302, 303 and 304	)	

NOTICE OF FILING

TO: John Therriault, Assistant Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph Street, Suite 11-500
Chicago, IL 60601

Attached Service List

PLEASE TAKE NOTICE that I have today filed with the Illinois Pollution Control Board Midwest Generation's Pre-Filed Testimony of Ray E. Henry, a copy of which is herewith served upon you.

Dated: February 1, 2011

MIDWEST GENERATION, L.L.C.

By: /s/ Susan M. Franzetti
One of Its Attorneys

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CERTIFICATE OF SERVICE

The undersigned, an attorney, certifies that a true copy of the foregoing Notice of Filing and Pre-Filed Testimony of Ray Henry were filed electronically on February 1, 2011 with the following:

John Therriault, Assistant Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph Street, Suite 11-500
Chicago, IL 60601

and that true copies were mailed by First Class Mail, postage prepaid, on February 1, 2011 to the parties listed on the foregoing Service List.

/s/ Susan M. Franzetti

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	
EFFLUENT LIMITATIONS FOR THE	)	R08-9
CHICAGO AREA WATERWAY SYSTEM	)	Subdocket C
AND THE LOWER DES PLAINES RIVER:	)	(Rulemaking - Water)
PROPOSED AMENDMENTS TO 35 Ill.	)	
Adm. Code Parts 301, 302, 303 and 304	)	

PRE-FILED TESTIMONY OF RAY E. HENRY

I. Introduction and Witness Background

My name is Ray E. Henry. I am employed as a Principal Consultant with Sargent & Lundy LLC. I have been employed with Sargent & Lundy since 1971 and have over 39 years of experience in the areas of pow er plant design, performance, testing and evaluation. I am testifying today on behalf of Midwest Generation EME, LLC ("MWGen").

Sargent & Lundy LLC (S&L) is a full-service architect-engineering firm dedicated to the electric power industry. S&L has been serving electric power clients exclusively since its founding in 1891. S&L is one of the oldest, largest and most experienced engineering companies in the United States. S&L has been authorized to design more than 885 electric generating units representing more than 129,500 megawatts of generating capacity. S&L designed approximately 80% of the large generating units in the State of Illinois, including most of the units currently owned and operated by MWGen, when they were first built. S&L has designed over 60 cooling systems with cooling towers, in several countries over the past 40 years. S&L's experience also includes the preparation of studies and designs for power plant modifications, including the addition of air pollution control equipment, such as flue gas desulfurization systems, mercury removal systems and NOx reduction systems.

I personally have worked on studies and evaluations of cooling towers for new units and the conversion of existing once-through cooling systems to cooling towers. These studies included sizing, performance and cost estimates. S&L has conducted at least 15 studies for the addition of cooling towers at existing plants in the past 30 years. Most of these studies involved the preparation of a conceptual design and accompanying cost estimates to convert an existing power plant's open-cycle cooling system to a closed-cycle cooling system. In all cases, the primary reason that a potential conversion to closed-cycle cooling was under consideration by the power plant operator was to evaluate what options were available for reducing thermal discharges to proposed or actual regulatory thermal standards. Based on both my personal knowledge and information obtained from other S&L personnel, only two of these projects actually were implemented. One project was the Quad Cites, Illinois Nuclear Plant, which was converted to closed-cycle cooling (using a spray canal instead of cooling towers) but was later converted back to once-through cooling. Th e other project was the Noblesville repowering project in Indiana, where as part of the conversion to a combined cycle plant the cooling system was converted to closed-cycle cooling using mechanical draft cooling towers. The Noblesville plant has two small steam turbines (approximately 50 MW each), which is much smaller than any of the MWGen units in this study. Also, the Noblesville site had more open space available for cooling tower installation than do any of the five MWGen station sites that are the subject of my testimony.

I have a Bachelor of Science in Mechanical Engineering from Purdue University. I am a member of the American Society of Mechanical Engineers (ASME) and a member of the ASME committees for codes and standards and the committee for performance test code for fans. I am a registered Professional Engineer in the states of Illinois and Indiana. A copy of my *curriculum vitae* is attached as Exhibit A.

My testimony will focus on describing and explaining the study performed by Sargent & Lundy (S&L) for MWGen which includes the following: (1) the review of potential options for the subject MWGen electric generating stations to achieve and maintain compliance with the thermal water quality standards proposed in this rule-making proceeding; (2) the design criteria for each of the MWGen stations developed by Sargent & Lundy for use as a basis for estimating the costs of achieving and maintaining such compliance; and (3) the estimated capital and operation and maintenance costs and estimated power loss revenues associated with the additional power demands associated with achieving and maintaining such compliance. A copy of the detailed study report prepared by S&L is attached as Exhibit B.

II. Retention by MWGen and Project Scope

The Illinois Environmental Protection Agency ("IEPA") has proposed a re-designation of the aquatic life use of the areas identified in its rule-making petition as the "Upper Dresden Island Pool" in the Lower Des Plaines River (the "UDIP") and the Chicago Area Waterways ("CAWS"). and the IEPA also has proposed revisions to the current thermal water quality standards to seasonal period average and daily maximum standards for both the UDIP and the CAWS (the "Proposed UAA Thermal Standards"). The Proposed UAA Thermal Standards would apply to receiving waters into which the following five MWGen stations discharge wastewater: Fisk, Crawford, Will County, Joliet 6 (also known as "Joliet Station 9") and Joliet 7&8 (also known as "Joliet Station 29"). MWGen requested that S&L evaluate the technologies that could be installed at these stations to comply with the Proposed UAA Thermal Standards and the estimated costs to do so.

Under the Proposed UAA Rules, the CAWS Aquatic Life Use B ("ALU B") standards would apply to the wastewater discharges from the Fisk, Crawford, and Will County stations, while the Upper Dresden Island Pool ("UDIP") standards would apply to the wastewater discharges from the two Joliet stations. Table 1 below lists the Proposed UAA Thermal Standards for ALU B and the UDIP. Currently, for both the UDIP and the CAWS, the applicable thermal water quality standard is a daily maximum temperature of 93°F which is not to be exceeded more than 5 percent of the time and an absolute maximum of 100°F. (IEPA Statement of Reasons, pps. 11-12). The proposed thermal standards for the UDIP would reduce the daily maximum temperature to 88.7°F which is not to be exceeded more than 2 percent of the time and would establish period averages ranging from 85.1°F during most summer periods down to 53.6°F during the month of February. (IEPA Statement of Reasons, p. 85) The proposed thermal standards for the ALU B waters would reduce the daily maximum to 90.3°F which is not to be exceeded more than 2 percent of the time and would establish period averages ranging from 86.7°F during most summer periods down to 53.6°F period average during the month of February. (IEPA Statement of Reasons, pp. 84-5) The only difference in the proposed period average standards between the UDIP and ALU B waters is during the summer months of July and August when the ALU B waters allowed maximum monthly average is 86.7°F versus 85.1°F for the UDIP. For both the UDIP and ALU B waters, the IEPA is proposing to allow excursions up to 3.6°F. (IEPA Statement of Reasons, p. 86) As the IEPA has explained, "[t]he proposed thermal water quality standards are more stringent than the General Use standards for the months April through November, especially when considering the period average" and they "are more stringent than the current Adjusted Water Quality Standards at Interstate-55 for all of the months, especially when considering the period average." (*Id.*)

Table 1
Proposed IEPA Water Temperature Limits

Month	Proposed UAA Period Average CAWs Aquatic Life Use B Thermal WQS	Proposed UAA Maximum CAWs Aquatic Life Use B Thermal WQS	Proposed UAA Period Average Upper Dresden Island Pool Thermal WQS	Proposed UAA Maximum Upper Dresden Island Pool Thermal WQS
Jan 1-31	54.3	90.3	54.3	88.7
Fab 1-29	53.6	90.3	53.6	88.7
Mar 1-15	57.2	90.3	57.2	88.7
Mar 16-31	57.2	90.3	57.2	88.7
Apr 1-15	60.8	90.3	60.8	88.7
Apr 16-30	62.1	90.3	62.1	88.7
May 1-15	69.2	90.3	69.2	88.7
May 16-31	71.4	90.3	71.4	88.7
Jun 1-15	74.2	90.3	74.2	88.7
Jun 16-30	86.7	90.3	85.1	88.7
Jul 1-15	86.7	90.3	85.1	88.7
Jul 16-31	86.7	90.3	85.1	88.7
Aug 1-15	86.7	90.3	85.1	88.7
Aug 16-31	86.7	90.3	85.1	88.7
Sep 1-15	86.7	90.3	85.1	88.7
Sep 16-30	77	90.3	77	88.7
Oct 1-15	73.2	90.3	73.2	88.7
Oct 16-31	69.6	90.3	69.6	88.7
Nov 1-30	66.2	90.3	66.2	88.7
Dec 1-31	59.9	90.3	59.9	88.7

All five MWGen stations are currently subject to an adjusted thermal standard granted by the Illinois Pollution Control Board (Docket AS 96-10, October 3, 1996), referred to as the "I-55 Adjusted Standards," whose limits must be achieved further downstream in the Lower Des Plaines River at the I-55 Bridge. The I-55 Bridge is approximately seven miles downstream of the Joliet Stations. The National Pollution Discharge Elimination System ("NPDES") permits for the five MWGen stations incorporate the I-55 Adjusted Thermal Standards. The S&L Study assumed that the I-55 Adjusted Standards will remain in effect.

III. Description of Sargent & Lundy (S&L) Cost Estimates Study

A. Background Regarding Steam Electric Generating Stations

In most power plants, heat from coal, natural gas, oil, nuclear, biomass or solar energy is used to generate steam that turns a steam turbine and generator to generate electricity. Steam electric generating stations, like the five MWGen stations here, all operate on the same principle: water is boiled to make steam, which drives a turbine, which powers an electric generator. All of the units at the five MWGen stations are "Rankine cycles." A Rankine cycle converts heat into "work", a form of energy. A Rankine cycle is the most common method of generating electricity. . The exhaust steam from the steam turbine must be condensed so that the water can be returned to the steam generator. Condensing the exhaust steam requires a cooling source, which is usually water.

The amount of heat generated from condensing the turbine exhaust steam is greater than the amount of electricity generated. For example, each unit at Joliet 7&8 has a rating of 569 Megawatt (MW) gross electrical output, and the design cooling system heat duty for each unit is greater, at approximately 830 MW (thermal). Thus, large cooling systems are required for these types of units. The five MWGen stations were not designed nor were the station sites selected or arranged to attain thermal water quality standards as strict as those proposed in this rule-making. All of the electrical generating units at all five stations were placed in service in 1966 or earlier.

The amount of cooling water withdrawn from a waterbody by a steam electric generating station depends on several factors, one of which is the type of condenser cooling system. There are two basic types of "wet" condenser cooling systems: open-cycle and closed-cycle. Open-cycle systems pass water through the condenser only once before returning virtually all the water to its source, albeit at a higher temperature. Closed-cycle systems recirculate the heated water from the condenser through an evaporative cooling structure (typically a cooling tower, pond, or lake), Evaporation of some of the water results in the build-up of salts in the water requires the system to "blow down" (*i.e.,* discharge). Closed-cycle cooling systems withdraw much less water than open-cycle systems, but they evaporate (*i.e.,* consume) most of the water withdrawn, returning very little to its source.

Joliet 7&8 is the only station that currently has any cooling towers. These supplemental "helper" cooling towers were not part of the original design of the station. They were installed in 1999, subsequent to the issuance of the I-55 Bridge Adjusted Standards. As previously explained in this proceeding in the testimony of Julia Wozniak of MWGen, the Joliet 7&8 towers are used primarily to maintain compliance with the I-55 Bridge Adjusted Thermal Standards. The towers are also used to meet the existing Secondary Contact thermal water quality standards during critical low flow periods that occur in the Dresden Pool. The use of the towers is necessary during the summer months and also at times of unseasonably warm spring and fall periods to meet the existing thermal water quality standards. The existing cooling towers are wholly insufficient to attain and maintain compliance with the Proposed UAA Thermal Standards for the Upper Dresden Island Pool. They also are not adequate for use as part of a design to convert Joliet 7&8 to a closed-cycle cooling system. The existing cooling towers do not have plume abatement and hence, plumes from these towers would cause fogging and icing if used during cold periods. Also, because the existing cooling towers are not "low drift" towers, they would probably exceed particulate matter emission standards if used in a closed-cycle operation. For all of these reasons, the conceptual design and cost estimate S&L prepared is not based on reusing the existing cooling towers.

B. Description of Technologies Considered by S&L

S&L applied the following criteria to evaluate candidate cooling technologies for the MWGen stations:

- A proven technology for large cooling systems (proven performance and reliability);
- A design that would fit within existing site boundaries;
- A system capable of operating during the range of expected weather conditions;
- A technology that would produce minimal ground level fog or icing;
- A cooling system that would have minimal impact on the efficiency and the net electrical output;
- A design that would minimize construction and station outage time; and
- A technology that would minimize capital and operating cost.

When the above criteria were applied to available cooling technologies, it became apparent that several technologies were not feasible for the MWGen stations due to the lack of sufficient land area at the stations on which to construct the necessary structures or equipment associated with a given technology. For example, two established cooling technologies are man-made cooling lakes and cooling ponds with sprays. However, both of these technologies require a significant amount of land area to construct. These technologies are not technically feasible for the MWGen stations because of their site area limitations.

An open-cycle cooling system with "helper" towers would not be able to meet the proposed temperature limits during all weather conditions. There are times, especially during the months of April, May and June, when the difference between the Proposed UAA Thermal Standards and the wet bulb temperature is too small to allow any practical size of cooling tower to meet these proposed standards. During these periods, the towers sized for closed-cycle operation would not be large enough to cool the effluent discharge to temperatures that comply with the Proposed UAA Thermal Standards if they were operated as "helper" towers. Because open-cycle cooling is more efficient than closed-cycle cooling, the conceptual design for each MWGen station includes provisions to operate open-cycle when the actual river water temperature is low enough to allow open-cycle operation and still meet the Proposed UAA Thermal Standards.

As part of its study, S&L also considered several alternative types of closed loop cooling technologies, including wet and wet/dry mechanical draft cooling towers, radiator type towers (external water required), air cooled condensers (new condenser is located external to the turbine room), and hyperbolic cooling. With the exception of the wet and wet/dry mechanical draft cooling towers, the remaining closed loop cooling technologies considered have either not been proven on such large scale installations as the MWGen stations or are considerably more expensive than the wet and wet/dry mechanical cooling tower technologies. Accordingly, these technologies were eliminated from further consideration.

Mechanical draft cooling towers (either wet or dry) are the most common type of cooling system for use in a closed-cycle system for a large heat load. Mechanical draft cooling towers have the advantages of being a proven design, are usually the lowest cost cooling option and require the smallest land area to construct. A mechanical draft tower is typically 40 to 60 feet tall and anywhere from 40 to several hundred feet long, depending on how much circulating water flow the tower is designed to process.

A cooling tower is actually comprised of several semi-independent modules referred to as "cells". Each cell consists of: 1) a structural steel, concrete or fiberglass frame; 2) walls (to confine the air and water flow); 3) piping near the top of the framework to distribute the water evenly; 4) a section of "fill" that enhances the contact between the air and water; 5) a large-diameter fan to pull air upward through the tower; and 6) an exhaust stack to help direct warm air upward and away from the sides of the tower. A group of cells is typically linked end-to-end to form a single cooling tower assembly. The group of cells is constructed inside a concrete basin which collects the cool water. The pumps which return the cool water to the condenser are installed on one end of the basin. A more detailed description of mechanical draft cooling towers is provided in Section 2.B of the attached S&L report (Exhibit B).

Wet cooling towers dissipate heat to the atmosphere primarily by evaporating some of the cooling water. The temperature of the cooling water that is not evaporated is reduced. The extent of the reduction in the temperature of the cooling water is limited by what is called the "inlet air wet bulb temperature." The amount of humidity in the atmosphere air determines the wet bulb temperature, which, in turn influences the effectiveness of a cooling tower in removing heat from the circulating water. The wet bulb temperature changes continually (*i.e.*, hour to hour and day to day) as the weather changes. Higher humidity levels result in higher wet bulb temperatures, and lower humidity levels result in lower wet bulb temperatures. In general, the lower the wet bulb temperature, the lower the cold water temperature – the temperature of the circulating cooling water after it has passed through the cooling tower. Thus cooling towers are more effective on cool, dry days and less effective on warm, humid days. Therefore, tower design for cooling performance and the ability to meet thermal discharge limits involves consideration of meteorology probabilities.

The difference between the cold water temperature leaving the cooling tower and the inlet air wet bulb temperature is called the "approach." The approach is a measure of the effectiveness of the cooling tower. A lower approach results in a lower water temperature but requires a larger and more expensive cooling tower. A larger tower will provide greater contact time between the circulating water and the airflow, which increases heat removal and lowers the circulating water temperature prior to its discharge. A larger tower is more expensive for a given circulating water flow rate, but it will increase the likelihood that the generating station can remain running at its capacity during hot and humid days, when cooling tower efficiency is reduced.

Although not nearly as widely used as wet cooling towers, another alternative means of cooling the steam generated at power plants is to use "dry cooling" towers. Unlike a wet cooling tower, a dry cooling tower has no direct contact between the circulating water and air and no evaporation. The heat transfer is all "sensible heat" (*i.e.*, the water temperature decreases and the air dry bulb temperature increases). A dry cooling tower uses natural or mechanical air drafts to remove heat and requires little or no water. However, dry cooling is less effective than wet cooling. Also, a dry cooling tower is much larger and results in higher discharge water temperatures than does a wet tower. Dry cooling towers are costly, reduce water intake only minimally compared to closed-cycle wet tower cooling and have other disadvantages. One advantage of a dry tower is that it does not produce a vapor plume (as does a wet tower) because it does not evaporate the cooling water.

A wet/dry tower is, as it sounds, a combination of both wet and dry cooling tower technology. As its name implies, a wet/dry tower has both a wet section and a dry section. The wet section achieves a low cooling water temperature and effective cooling through evaporation. The dry section in turn reheats the air leaving the wet section and thereby reduces the water vapor plume exiting the tower. The S&L study concluded that mechanical draft wet/dry cooling towers were the most cost effective type of cooling for all five MWGen stations.

The use of "helper" cooling towers also was considered for the MWGen stations. "Helper" cooling towers are used to reduce the temperature of the cooling water from the station before it is discharged back to the river. However, applying the Proposed UAA Thermal Standards, under certain reasonably expected weather conditions, such as when the wet bulb temperature is close to the applicable thermal standard, it would not be possible to achieve and maintain compliance, regardless of cooling tower size. For this reason, the cooling towers have to be sized for the full circulating water flow rate and heat load and must be operated in a closed-cycle mode during certain weather conditions.

C. Description of Closed-Cycle Cooling Options for MWGen Stations

The mechanical draft wet/dry cooling towers systems selected for the MWGen stations were sized for closed-cycle operation for the expected range of weather conditions throughout the year. The condition that determines the size of the cooling tower is the maximum wet bulb temperature. The specified design point is a 78°F wet bulb, which corresponds to the 1% occurrence in the summer. (, *Facility Design and Planning Engineering Weather Data*, Departments of the Air Force (USAF), the Army, and the Navy, A FM 88-29, TM 5-785, NAVFAC P-89, Washington D.C., 1978). This ensures that the cold water temperature from the cooling tower to the plant will be equal to or less than the design temperature of 85°F (7°F approach), except for 1% of the time in the summer. The use of the 1% summer wet bulb temperature is the standard industry practice for specifying the cooling tower design point. During periods when the wet bulb temperature is greater than 78°F, the generating units will be able to operate but some load reduction may be required.

Gates, piping and pumps to maintain the flexibility to operate in an open-cycle mode and to operate in a closed-cycle mode were included in the design. This allows the stations both to achieve compliance with the Proposed UAA Thermal Standards and to achieve higher operating efficiency (and hence, lower O&M costs for tower operation) by using once-through cooling when the river and ambient air temperatures are favorable.

Converting a once-through cooling system at a power plant into a closed-cycle system, as would be necessary for each of the five MWGen stations, is a major undertaking for many reasons. First, it is difficult because of the size of the cooling system that is needed. For example, the design cooling water flow rate at Joliet 7&8 is 920,000 gallons per minute. For this cooling water flow rate, three cooling tower sections, two 21-cell, 1008 feet long and one 22-cell, 1056 feet long, 48 feet wide and 58 feet high, would be required. The cooling towers have 64 fans that are 250 horsepower each. The length of these cooling tower sections is approximately the equivalent of slightly over 3.5 football fields laid end to end and reaching approximately 6 stories high across the length of that expanse. The circulating water pipes would be up to 14 feet in diameter, over twice the height of the average person. Also, for a power plant such as the MWGen Joliet 7&8, the cooling system would require at least two new sets of large circulating water pumps in addition to the existing set of pumps in place at the station. Operating the new pumps will require over 18MW of power.

The installation of the closed-cycle cooling system at an existing station requires that a major construction project be completed. The construction of the closed-cycle cooling system requires not only large excavations and foundation work which may need to be conducted in a relatively confined area but also requires work to interface the new cooling system with other existing plant systems, including the auxiliary power system, fire protection system, auxiliary cooling system and controls, in addition to the main cooling system.

As noted above, although there have been several studies of existing plants with once-through cooling systems to evaluate retrofitting them to once-through cooling, few have actually converted to once-through cooling because of the high capital cost, impact on plant performance and the complexity of converting an operating station from once-through to closed-cycle cooling. Plants that have closed-cycle cooling systems were typically designed as closed-cycle stations. When a new plant is designed, the cooling system is a major factor in both the site selection and the overall site arrangement.

D. Key Design Parameters for Estimating Closed-Cycle Cooling System Costs

In order to calculate the estimated costs for installing closed-cycle cooling systems at the five MWGen stations, the key elements of the system conceptual design needed to be identified. For closed-cycle cooling systems, the key design elements include: circulating water design flow rate; design wet bulb temperature and circulating water pump size. However, a complete, detailed design of the cooling system was beyond the scope of the S&L Study. Accordingly, there are likely items that are not included in the S&L design concept that would become necessary to include in an actual design of a closed-cycle cooling system for each of the stations. The costs of such additional items are not included in the cost estimates prepared by S&L for this study.

The closed-cycle cooling system conceptual design includes redundancy that is consistent with normal industry practice. The cooling towers have multiple cells, each with a fan, and the failure of one fan or cell will only slightly reduce cooling that should not require a generating unit shutdown or derating. The cooling system will have multiple pumps, but the design is based on all pumps operating (*i.e.*, there is no spare pump). If a pump fails, the load may need to be reduced through derating at the station, depending on the weather conditions, but it should not require a generating unit to be shut down. Multiple pump losses and/or fan failures can put the affected station at greater risk of having to derate to maintain thermal compliance.

As noted above, the closed-cycle-cooling system for each MWGen station was sized for 100% of the circulating water design flow rate. The cooling tower size is determined by the 1% summer wet bulb temperature.

In addition to cooling towers, a closed-cycle cooling system requires large pumps and piping to supply the circulating water to the cooling towers and to return the water to the existing circulating water pumps. Preliminary sizes were determined for the pumps and piping to use in the S&L cost estimates. The quantities of concrete and steel required for the cooling tower basin and pump and cooling tower supports were estimated along with other commodities, such as a rack system for supporting pipe and conduit.

The preliminary cooling tower design used to estimate costs is based on towers with a low drift design to minimize emissions of particulate matter. Based on a preliminary review of applicable air regulations, the installation of cooling towers at the MWGen stations may trigger New Source Review under the Clean Air Act that would require modeling work to be performed and permitting issues to be addressed. The estimated costs included in the S&L Study did not include the additional costs that would be associated with New Source Review requirements.

Based on a review of receiving waters temperature data for the past several years, and due to the wide variability and uncertainties of flow and temperature in the CSSC and Lower Des Plaines River, a credit for a mixing zone was not utilized in the cooling tower sizing for once-through operation. For each of the MWGen stations, there are many days (over 100 days per year in recent years for some of the stations) where the upstream river temperature exceeds the Proposed UAA Thermal Standards. During these periods, mixing of the stations' respective discharges with the receiving water would not reduce the outlet water temperature to below the proposed standards. However, it was beyond the scope of the S&L Study to try to identify a way to predict the various receiving water conditions and any resulting, available mixing zone based on those conditions, that might allow the stations to operate at limited times during the year in a once-through mode bef ore switching back to closed-cycle operation. Further, even with a closed-cycle cooling system, there is a small (~650 to ~3000 gpm) cooling tower blowdown flow generated. Although this cooling tower blowdown flow will not contribute to any significant water temperature rise within the receiving stream, based on existing receiving stream data, it is expected that there may be times when no mixing is available due to low river flow and/or ambient river temperatures which are higher than the Proposed UAA Thermal Standards. If a small mixing zone is needed but not available, an additional cooling mechanism (likely a chiller at an approximate cost of $3 million per station) may be required to ensure compliance under all operating and receiving water scenarios. However, for purposes of S&L's study, supplemental cooling of the condenser blowdown discharge for the MWGen stations was not included in the study cost estimates.

E. General Description of Design Concept for Each MWGen Station

After identifying the basic design elements common to each of the MWGen stations, S&L then proceeded to evaluate the preliminary design criteria further based on relevant site-specific conditions for each of the stations. During this "station-specific" phase of the preliminary design development for cost estimating purposes, the design criteria were refined as appropriate to address the relevant conditions and issues presented by each of the MWGen stations. To a significant extent, the relevant characteristics of the MWGen stations were similar enough that the preliminary design criteria remained relatively the same for most of the stations. Exhibits A and B in the attached S&L Report include arrangement drawings and flow diagrams that illustrate how the cooling systems would be modified for each station. The results of this phase of the S&L costs study are further explained below.

1. Fisk, Crawford and Joliet 6 Stations

For closed-cycle cooling system design purposes, the Fisk, Crawford and Joliet 6 Stations presented similar conditions. Hence, the preliminary design criteria was substantially the same for these stations. Two cooling tower sections were included in the preliminary design to provide adequate cooling and to fit within the site boundaries. The existing intake and discharge canals would be blocked with diversion walls and gates. The diversion gates could be opened during favorable weather and receiving stream conditions to allow once-through cooling water operation. The existing circulating water pumps would pump water from the intake through the condenser to the discharge, similar to current operation. A new pump house and pumps would be installed in the discharge bay to pump the water to the new cooling towers. Water from the cooling towers would be pumped by new pumps, located in the cooling tower basin, to the existing intake area.

Makeup water for the cooling system will come from the existing intake bay. The existing circulating water inlet channel would be partially left open to the river in closed-cycle operation so that makeup water to the cycle can be drawn in as needed. No separate makeup pumps or piping were included in the design or cost estimate. Blowdown from the system will be taken from the discharge of the pumps located in the cooling tower basin, which will be the coldest water in the cooling system.

2. Will County Units 3 and 4

The design of the closed-cycle cooling system at Will County Station for Units 3 and 4 generally would be similar to the arrangement at Fisk and Crawford. However, due to the larger capacity of the Will County Station as compared to either Fisk or Crawford, the size of the cooling tower would need to be larger to provide the cooling necessary for compliant operations. For Will County, the design criteria include three cooling tower sections instead of the two sections specified for the Fisk and Crawford cooling towers.

3. Joliet 7&8

As is the case for Will County Units 3 and 4, three cooling tower sections would be necessary at Joliet 7&8 to supply adequate cooling. The existing intake and discharge canals would be blocked with diversion gates. The existing circulating water pumps would pump water from the intake through the condenser to the discharge, similar to current operation. A division wall would be installed in the discharge bay to divide the bay into two sections. A new pump house and pumps would be installed in one section of the discharge bay and would be isolated from the other section by a movable gate. Pumps in the new pump house would pump the water to the new cooling towers. Water from the cooling towers would be pumped by new pumps, located in the cooling tower basin, to the existing intake area.

While the preliminary design for all of the MWGen stations includes the ability to operate in two possible modes of operation, closed and open-cycle, Joliet 7&8 would have three possible modes of operation. Joliet 7&8 could operate in closed-cycle or open-cycle mode similar to the other stations but could also operate in open-cycle mode using the new cooling towers as helper towers. This would provide more operating time in open-cycle mode, which would reduce operating costs. Because of the site layout and existing intake and discharge arrangement, this is only practical for Joliet 7&8.

F. Cooling System Design Challenges and Constraints

The new cooling system at all five MWGen stations requires installing large equipment in relatively small areas. The space constraints presented by each of the MWGen station properties affected the design of the cooling tower arrangements, making it less than an optimal design if space were not limited. More specifically, the cooling tower arrangements included in the preliminary design are less than ideal with respect to preventing recirculation of air between cooling towers. Recirculation of air between cooling towers is typically something that is prevented or minimized in designing cooling towers because any such recirculation will reduce tower performance. Reduced tower performance results in higher operating costs.

In addition to space limitations at the MWGen stations, additional design issues arise from existing structures and equipment at the stations that interfere with retrofitting them to closed-cycle operations. At Fisk, Crawford and Will County Stations, the available area for locating the cooling towers is also the location of existing high voltage transmission lines owned by Commonwealth Edison ("ComEd"). Therefore, the preliminary design for each of these stations includes having to move and relocate these high voltage transmission lines. However, S&L does not know whether an evaluation by ComEd would determine that the relocation of its transmission lines is feasible or, if feasible, what conditions or costs ComEd would require in return for its agreement to move and relocate these lines.

Another design consideration was the noise that is generated from the operation of cooling towers. S&L's review concluded that noise emissions from the cooling towers are expected to be below the regulatory limits for all of the units except for Joliet 7&8 due to the proximity of an existing office building west of the proposed Joliet 7&8 cooling tower location. However, because of the preliminary scope of the design work completed for this study, the cost of noise abatement was not included in the Joliet 7&8 capital cost estimates prepared by S&L.

Due to the nature of the preliminary design concept work conducted by S&L, certain assumptions needed to be made to complete the cost estimates. This was primarily the case in the area of permitting. The design concept and cost estimates are based on the assumption that state and federal permitting authorities, *e.g.*, Illinois EPA and the U.S. Army Corps of Engineers, will grant all of the necessary permits for the construction and operation of the cooling tower system at each of the MWGen stations. Such permits would include the required construction permit(s) for the towers and the modifications to intake and discharge canals as included in the design concept, as well as any related environmental operating permits, such as for particulate matter emissions from the towers. Due to the relatively high level of uncertainty associated with the extent of the effort necessary to complete the permitting process for each of the stations, S&L did not include a cost estimate line item for permitting in the capital and O&M estimated costs presented in its study. S&L also assumed that the permits could be obtained within the estimated project schedule it prepared as part of its report.

IV. Estimated Economic Costs of Compliance with Proposed UAA Thermal Standards

Based on the preliminary design criteria S&L identified for each of the five MWGen stations, S&L then developed estimates for the costs that are involved in implementing the retrofitting of each of the five MWGen stations to closed-cycle cooling. These estimated costs included capital and O&M cost estimates and estimated power loss revenues associated with the additional power required to operate the cooling towers. The cost estimates for each of the MWGen stations, and how they were prepared for each of the cost categories, is explained further below.

A. Capital Cost Estimates

The estimated capital costs for each MWGen station to convert to closed-cycle cooling systems are listed in Table 2 below, and are explained in more detail in Section 5 of the S&L report (Exhibit B). The estimated capital costs range from $115 million for Joliet 6 to $300 million for Joliet 7&8, for a total capital cost of nearly $1 billion for all five of the MWGen stations.

Table 2

Capital Cost Estimates for Conversion of MWGen Stations to Closed-Cycle Cooling

UNIT	STATION TOTAL GROSS MW	CAPITAL COST WET/DRY TOWER ($)	WET/DRY CAPITAL COST ($) PER KW
FISK 19	348	$137,100,000	$394
CRAWFORD 7&8	585	$165,200,000	$282
WILL COUNTY 3&4	832	$257,100,000	$309
JOLIET 6	341	$115,700,000	$339
JOLIET 7&8	1,138	$300,900,000	$264
TOTALS	3,244	$976,000,000	$301 (AVERAGE)

S&L generated the capital cost estimates based on a combination of budgetary equipment quotes, engineering material quantity estimates and the use of S&L's cost estimating database. The largest cost component is the physical cooling tower itself, which is approximately 15% to 25% of the total capital cost, depending on the station. Budgetary quotes were obtained from SPX/Marley, a major cooling tower supplier. The cost for pumps, piping, electrical equipment and labor were obtained both from S&L's estimating database, which includes data from budget quotes and contracts from past S&L projects, and from published rates for labor and productivity.

The cost estimates provided are "order of magnitude" – meaning that the accuracy is limited to -30%/+50%. These are reasonable cost estimates in the context that they are based on conceptual designs, physical layouts and contain a fair level of detail in all the major account categories.

However, detailed engineering and detailed design have not been performed. During the detailed design and engineering phase of installing a new system into an existing plant, it is common to encounter unforeseen problems that increase the cost. Thus, the +50% is more likely than the -30%. The design parameters used for the cost estimates are based on assumption of the scope and design basis. There are several unknowns that could, and likely will, lead to changes in the cost estimates. Generally, these unknowns are items that would increase the estimated costs, as further explained below.

B. Closed-Cycle Cooling Systems Estimated O&M Costs for MWGen Stations

In addition to the capital costs, the closed-cycle cooling systems will also require annual expenditures to operate and maintain the system (the "O&M costs"). The principal elements of O&M costs for closed-cycle cooling systems are a) cooling tower fan and circulating water system pump power costs, b) preventative maintenance and repair of cooling tower fan and circulating water pump systems, and 3) chemicals for control of corrosion and biological growth. The estimated annual O&M costs, including the costs for the auxiliary power consumptions are listed in Table 3.

Table 3

Estimated Annual Operating and Maintenance Costs for Conversion of MWGen Stations to Closed-Cycle Cooling

Unit	Station Total Gross MW	Wet/Dry Towers
Fisk 19	348	$2,127,000
Crawford 7&8	585	$3,960,000
Will County 3&4	832	$5,750,000
Joliet 6	341	$2,660,000
Joliet 7&8	1,138	$9,080,000
Totals	**3,244**	**$23,577,000**

In addition to the auxiliary power consumption (as discussed further below) and the O&M costs associated with closed-cycle cooling, the cooling water temperature to the condensers will be higher than with once-through cooling. This will result in a loss in gross electrical output and plant efficiency. The loss will vary with ambient temperature, but is expected to be approximately 1%.

C. Auxiliary Power Use Associated with Conversion to Closed-Cycle Cooling

The operation of cooling towers requires a power supply. The power demand of the cooling towers results in additional power that would have to be supplied by each MWGen station on an ongoing basis. This additional power would be supplied by the electricity generated by each of the stations. This additional power demand, referred to here as the "auxiliary power use," results in a loss of revenue to MWGen because it can no longer be sold on the open market. It instead must be used to operate the new cooling towers. It also means that other electrical generating station units must produce more power to supply to the electric grid to make up for the power consumed by the cooling towers. The cooling tower fans and new pumps will consume 2 to 3% of the gross electrical output of the stations. For Joliet 7&8, the cooling system will require over 35MW of power. The auxiliary power consumption for the closed-cycle cooling system for each MWGen station is listed below in Table 4.

Table 4

Cooling Tower Annual Auxiliary Power Use (MW) for MWGen Stations

	Fisk 348 MW	Crawford 585 MW	Will County 3&4 832 MW	Joliet 6 341 MW	Joliet 7&8 1,138 MW
Cooling Tower Fan Power	3.24	6.08	9.32	4.28	16.20
Supply Pump Power	3.89	6.48	9.72	4.78	17.01
Discharge Pump Power	0.65	0.97	0.81	.0.81	1.94
Average Aux Power Use	**7.78**	**13.53**	**19.85**	**9.87**	**35.15**
Percentage of MW Output	**2.2**	**2.3**	**2.4**	**2.9**	**3.1**

D. Loss of Plant Generating Capacity

The circulating water inlet temperature to the condenser is higher in closed-cycle mode than in open-cycle mode, because it is not possible to reduce (with cooling towers) the cold-water temperature of the circulating water system to the temperature of the body of water previously used for open-cycle cooling. This higher condenser inlet temperature reduces turbine-generator efficiency and results in a loss of plant generating capacity, and a corresponding loss of revenue from electricity sales. The estimated annual loss in revenue for all five stations is approximately $3,800,000.

E. Potential Additional Costs

Although the work required in preparing the above cost estimates involved an extensive effort, there are still several unknowns in the design basis that could lead to changes in the cost estimates, primarily changes which would increase the cost estimates provided here. These items including the following:

- Noise abatement for the cooling towers is not included in the cost estimates. Noise abatement could cost up to $12.6 million at Joliet 7&8. Although noise abatement is not expected to be required at the other stations, if it does become an issue during permitting, it would increase the S&L estimated costs.

- Blowdown from the cooling towers will be higher than the allowable discharge temperature during some weather conditions. Since the blowdown flow rate will be small compared to the total flow rate, S&L assumed additional cooling of the blowdown will not be required based on the assumption that a mixing zone may be available to allow for compliance at the edge of the mixing zone and not at the end-of-pipe outfall. If however sufficient mixing is not available for one or more of the stations' discharges of cooling tower blowdown, then additional cooling of the blowdown will be required. The capital cost per station for this additional cooling, through the add-on installation and operation of a chiller, will be approximately an additional $3 million per station.

- Changes in the cooling tower location due to transmission line issues would increase the cost. S&L assumed that any interference with the siting of the cooling towers caused by third-party owned, existing transmission lines could be addressed through relocating of the transmission lines. It is not known whether this is a correct assumption.

- A change in cooling tower type, such as dry cooling, would increase cost.

- Additional work resulting from requirements imposed by the Illinois EPA, U.S. EPA Army Corp of Engineers or city or county governments during permitting reviews could increase costs. As an example, if the cooling towers are required to be relocated, the cost would increase.

- Interference from underground utilities could require design changes and impact cost. All of these generating units are on old sites and there may be abandoned, below-ground utilities discovered during the construction phase of the work that have to be removed. No costs for such unknown conditions were included in the S&L cost estimates.

- A constructability review by a general contractor could either identify cost savings or extra costs not included in the estimates. For example, a construction contractor may find that the lack of on-site construction storage area may increase the construction costs.

V. Conclusion

S&L's study of the applicable technology and estimated compliance costs relating to the Proposed UAA Thermal Standards involved an extensive amount of effort by several of its experienced and qualified personnel, as well as cost information generated by an outside cooling tower manufacturer. Based on the significant level of effort devoted to this study, it is clear that the IEPA's proposed re-designation of the aquatic life use of the Upper Dresden Island Pool and the CAWS and the accompanying Proposed UAA Thermal Standards would require new closed-cycle cooling systems for all five MWGen stations that have used these waterways for once-through cooling since they began operating. When the MWGen stations were designed several decades ago, they were not designed nor were their respective sites selected or arranged to attain thermal water quality standards as strict as those proposed in this rule-making. Due to the lack of sufficient land area at the MWGen stations on which to construct the necessary structures or equipment associated with cooling lakes and cooling ponds with sprays, these technologies are not technically feasible for the MWGen stations. Further, there are reasonably expected weather conditions in the vicinity of the MWGen stations which make the use of "helper" towers another option which is not technically feasible for these stations to employ to achieve compliance with the Proposed UAA Thermal Standards. Thus, the new cooling system required for each of the MWGen stations must be designed for closed-cycle operation.

Based on the results of S&L's study, plume abated (wet/dry) mechanical draft cooling towers are the lowest cost alternative for closed-cycle cooling that will achieve and maintain compliance with the Proposed UAA Thermal Standards. For all five MWGen stations, converting them to closed-cycle cooling systems would require an estimated total capital investment of nearly $1 billion, and would result in over $23,000,000 per year in operating and maintenance costs. In addition, the net electrical output and efficiency of all five stations would be reduced. However, as discussed above, because certain assumptions were made in the course of the S&L Study that may not be achieved in an actual implementation of the conceptual design, such as the relocation of high voltage transmission lines, as well as the existence of very few actual cases of converting open-cycle generating stations to closed-cycle operation with which to compare these estimated costs, the implementation of the conceptual design on which these cost estimates are based at each of the MWGen stations is not a technical certainty and is likely to result in actual costs that exceed these estimates.

Respectfully submitted,

Ray E. Henry

Ray E. Henry

EXHIBIT A

TO THE WRITTEN TESTIMONY OF RAY E. HENRY

Curriculum Vitae of Ray E. Henry

RAY E. HENRY
Principal Consultant
Sargent & Lundy Consulting

Sargent & Lundy

EDUCATION

Purdue University - B.S. Mechanical Engineering - 1971

REGISTRATIONS

Professional Engineer – Illinois, Indiana

PROFICIENCIES

Mechanical engineering

Project Management

Power plant design

Steam turbine design review

Boiler design review

Cycle optimization

Fan specialist

Plant betterment

Condition assessment and rehabilitation studies

Reliability and availability

Plant performance

Cooling Systems

Cycling conversion

Training and technology transfer

RESPONSIBILITIES

Mr. Henry is a principal consultant.

As a technical consultant, Mr. Henry provides technical support to the various project teams within Sargent & Lundy. His specialties include, system design, plant condition assessment, performance testing, heat balance studies, plant optimization studies, plant configuration, alternate technology assessment, cycling conversion, fuel switching, cooling system optimization, etc.

Mr. Henry also serves as a project manager for owner's engineer/consultant projects. The scope of these projects usually consists of conceptual design studies, feasibility studies and economic evaluations, preparation of engineering, procurement, and construction (EPC) specifications, evaluation of EPC bids, design review and construction technical support.

Mr. Henry is also Sargent & Lundy's specialist for power plant fans, condensers, and cooling towers.

EXPERIENCE

Mr. Henry has more than 35 years of experience in the mechanical engineering, design, and analysis of major steam-electric generating stations. Mr. Henry has participated in construction overviews, serving as the project lender's engineer.

Mr. Henry serves as a technical consultant on many of the combined cycle plants designed by S&L.

Mr. Henry is a member of the American Society of Mechanical Engineers (ASME) Performance Test Code Committee for fans, PTC II. He has participated in field tests and has provided performance evaluations of boilers, turbines, condensers, pumps, fans, steam generators, and feedwater heaters. He has participated in performance test for conventional and combined cycle plants, including preparation of test procedures, field testing, evaluation of test results and due diligence review of tests and test reports.

Mr. Henry is a member of the American Society of Mechanical Engineers (ASME) Performance Test Codes Standards Committee.

Mr. Henry currently serves as Sargent & Lundy's and fan specialist and one of several boiler and turbine specialists. He has been involved in fan evaluations and the development of specifications for replacement of fans.

Mr. Henry has also been involved in the preparation of and review of EPC and equipment specifications for unit sizes of 12 MW to 1000 MW. He has participated in EPC and equipment bid evaluations, design reviews, performance tests, unit assessments, and performance improvements.

Mr. Henry recently served as a technical consultant to the International Finance Corporation unit of the World Bank regarding its update, published in December 2008, of Environmental, Health, and Safety Guidelines for Thermal Power Plants. That is a key reference document for environmental evaluations of thermal power facilities worldwide.

Mr. Henry developed Sargent & Lundy's HTBAL program to model various steam turbine cycles.

Before assuming his position as consultant and project manger, Mr. Henry was the manager of Sargent & Lundy's Power System Engineering Division, consisting of consultants, technical specialists, senior engineers, and engineers who analyze units in design as well as units that are operating.

Prior to his position as a division manager, Mr. Henry was a senior mechanical project engineer. He performed preliminary design studies to determine general plant layout; sized and specified equipment; analyzed economic factors; prepared flow diagrams; and sized piping, which included analyzing flexibility and support systems. He maintained client contact and incorporated operating philosophies within design parameters. He also interfaced with suppliers in selecting equipment, materials, and labor packages; evaluated proposals; and recommended purchases.

Mr. Henry's specific experience includes the following:

INDEPENDENT ENGINEER / OWNER'S ENGINEER / CONSULTANT

- **Banco Itaú BBA S.A. MPX Energia (Brazil)**
  - Pecém II, 1x365 MW coal-fired. (2009 to present)

- **Fujian Electric Power Survey & Design Institute/Hebei Electric Power Design & Research Institute/Inner-Mongolia Power Exploration & Design Institute (China)**
  - Consulting services for design of 1000MW supercritical coal units (2008 to present)

- **Office National de l'Électricité (Morocco)**
  - Safi 2x660 MW coal fired plant (2008 to present)

- **Phu My 3 BOT Company (Vietnam)**
  - Phu My 3 2x2x1 natural gas combined cycle, 700 MW (2007-2008)

- **AES (Chile)**
  - Nueva Ventanas, 260 MW coal-fired.
    (2006 to 2007)
  - Guacolda, 150 MW coal-fired.
    (2006 to 2007)

- **Inter-American Development Bank/MPX Energia/Energias do Brasil (Brazil)**
  - Pecém I, 2x360 MW coal-fired. (2008 to present)
  - Itaqui, 1x360 MW coal-fired (2008 to 2009)

- **P.T. Tanjung Jati Power Company (Indonesia)**
  - Tanjung Jati "A", 2x600 MW coal-fired.
    (2005 to 2007)

- **Singapore Power International (Korea)**
  - Anyang and Buchon CHP, 2x475 MW LNG. (2000)
  - Bugok CC, 1x538 MW LNG-fired. (2000)

- **TotalFina/Tractebel (Abu Dhabi)**
  - 800 MW gas fired combined cycle
    Project Manager (1999-2000)

- **Shanghai Municipal Electric Power Company (China)**
  - Waigaoqiao Phase II, supercritical coal, 900 MW to 1000 MW.
    Project Manager. (1996-2002)

- **Wing Group (China)**
  - Dengfeng, 2x300 MW coal-fired.
    (1995 to 1998)

- **Sithe China Limited (China)**
  - Puqi, 2 x300 MW coal fired, IPP.
    (1997 to 1998)

- **Yellow Sea Company (China)**
  - Jinhua, 2x30 MW coal-fired cogeneration.
    (1995 to 1998)

- **Illinova (China)**
  - Zhuzhou, 2x12 MW coal-fired cogeneration.
    (1996 to 1997)

- **Electric Power of Henan (China)**
  - Qinbei, 2x600 MW coal-fired.
    (1995 to 1997)

CONCEPTUAL DESIGN STUDIES

- **Office National de l'Électricité (Morocco)**
  - Jorf Lasfer, Conceptual study for new coal fired generation, including site layout, evaluation of unit size and design, performance estimates and capital and O&M cost estimates. (2005 to 2007)

- **Shanghai Municipal Electric Power Company (China)**
  - Waigaoqiao, supercritical coal, 900 MW to 1000 MW.
    Project Manager. Phase II site evaluation for the potential addition of four supercritical coal-fired units. Stage 1 of the project, consists of conceptual design and bid document review and Stage 2 consists of interface. (1996 to 2002)

    Site study for extension units. (1993)

- **Central & South West Services, Inc.**
  - Technology assessment of new generation. (1993 to 1994)

PLANT DESIGN

- **Huaneng International Power Development Corporation**
  - Shidongkou 1 and 2, coal, 600 MW, supercritical.
    Performed pipe sizing and prepared heat balances. (1988)

- **PSI Energy**
  - Gibson 5, coal, 618 MW, supercritical.
    Performed preliminary design studies for plant layout; optimized cycle configuration; sized and specified equipment, including auxiliary boiler; analyzed economic factors; prepared flow diagrams; procured equipment and materials; and prepared labor packages, provided technical support for construction. (1979 to 1983)

For the following projects, Mr. Henry supervised equipment sizing, optimization of systems and components, performance evaluation of equipment from various manufacturers, and feasibility studies.

- **Central Power & Light Company**
  - Coleto Creek 1, coal, 570 MW.
    (1974 to 1977)

- **Commonwealth Edison Company**
  - Byron 1 and 2/Braidwood 1 and 2, nuclear, 1175 MW each.
    (1974 to 1977)

- **Northern Indiana Public Service Company**
  - Schahfer 14 and 15, coal, 550 MW each.
    (1971 to 1973, 1974 to 1977)

- **Illinois Power**
  - Clinton 1, nuclear, 985 MW;
  - Havana 6, coal, 439 MW.
    (1973 to 1977)

- **American Electric Power Service Corporation/Buckeye Power, Inc.**
  - Cardinal 3, coal, 615 MW, supercritical.
    (1973 to 1974)

BOILERS

- **Mitsui**
  - Point Aconi, 185 MW CFB.
    Boiler efficiency and plant heat rate tests. (1994 to 1995)

- **National Power**
  - Jiaxing 660 MW coal.
    Design review of boiler proposal. (1995)

- **PSI Energy**
  - Gibson 3, 668 MW, coal.
    Technical support for test burn of PRB coal. (1993 to 1995)

- **Carolina Power & Light Company**
  - Asheville Unit 2, coal 200 MW.
    Boiler capacity and HUT tests. (1995)

- **Carolina Power & Light Company**
  - Roxboro Unit 2, 600 MW coal.
    Retrofit of new pulverizers and coal pipe. (1995)

COOLING SYSTEM

- **PSI Energy**
  - Cayuga 1 and 2, coal, 531 MW each.
    Study to convert to closed cycle cooling. (1993)

- **PSEG Nuclear**
  - Salem 1 and 2, nuclear
    Evaluation of cooling tower retrofit (1994)

- **Genesis Energy**
  - Huntly Power Station Units 1 to 4
    Specification and evaluation of helper cooling tower (2004)
    Evaluation of alternative cooling systems (2010)

- **Enviro Power**
  - Various sites
    Cooling tower evaporation rates (2001)

- **Vattenfall**
  - Moorburg Units 1 and 2, coal, 840 MW each.
    Study of cooling system (2009)

PRECIPITATOR UPGRADES

- **Indianapolis Power & Light Company**

- Pritchard 6, coal, 69 MW.
  Fan testing, model flow testing, and precipitator procurement. (1992 to 1993)

CONDITION ASSESSMENT

- **ATCO Power**
  - Battle River Units 3 and 4
    Evaluated condition of steam turbine, boiler and other major equipment. (2006)

- **AES**
  - Ekibastuz units 1-5
    Review of steam turbine, boiler and other major equipment (2007)

- **The Cincinnati Gas & Electric Company**
  - Miami Fort 5, coal, 80 MW.
    Evaluated condition of fans, fluid drives, and condenser. (1987)

- **PSI Energy**
  - Gallagher 4, coal, 150 MW.
    Evaluated condition of fans, condenser, and feedwater heater. (1986)

- **Northern Indiana Public Service Company**
  - Mitchell 4, coal, 138 MW.
    Evaluated condition of fans, condenser boiler feed pumps, fluid drives, and feedwater heaters. (1985)

- **Boston Edison Company/Electric Power Research Institute**
  - Mystic, oil, 565 MW.
    Developed guidelines for fans and heat rate. (1984)

MISCELLANEOUS

- **Arizona Public Service Company**
  - Various stations.
    Developed turbine cycle and heat rate seminar for presentation to client's personnel. (1987)

- **Northern Indiana Public Service Company**
  - Provided engineering services to increase unit capacity. (1984)

- **Mitsui/Toshiba**
  - Performed survey of moisture separator reheaters. (1983 to 1984)

- **University of Wisconsin**
  - Performed balance-of-plant conceptual design for a fusion reactor. (1973 to 1974)

PLANT PERFORMANCE

- **TU Electric**
  - Mechanical Project Engineer. Subcontractor on EPRI heat rate improvement guideline project (RP2181). (1987 to 1989)

- **SEGS VIII and IX**
  - Plant performance improvement study. (1994)

- **Wisconsin Electric**
  - Pleasant Prairie, coal, 570 MW.
    Determined sources from plant to supply energy to industrial park. Identified sources and determined heat rate and power generation degradation caused by source. Also evaluated advantages and disadvantages and balance-of-plant impact. (1987)

- **Wisconsin Power & Light Company**
  - Rock River 2, coal, 75 MW.
    Conducted unit performance evaluation and developed a performance evaluation manual. (1987)

- **Boston Edison Company**
  - Mystic 4-7, oil, 1086 MW total;
  - New Boston 1 and 2, oil, 738 MW total.
    Performed unit availability study. (1985)

- **Interstate Power Company**
  - Lansing 4, coal, 252 MW.
    Performed unit performance evaluation. (1984)

- **Central Illinois Public Service Company**
  - Grand Tower 4, coal, 100 MW;
  - Newton 2, coal, 567 MW.
    Performed unit performance evaluation. (1983)

CYCLING CONVERSION

- **Houston Lighting & Power Company**
  - Sam Bertron 1 and 2/Deepwater 7/W. A. Parish 1 and 2; gas; 156 MW each. Development of system design for cycling modifications and determination of startup times for warm starts. (1986)

CLEAN AIR ACT AMENDMENT

- **PSI Energy**
  - All stations.
    Program Manager. Design, procurement, and installation design of continuous emission monitors. (1991 to 1992)

    Program Manager. Phase I Clean Air Act Amendment compliance study. (1991)

TRAINING AND TECHNOLOGY TRANSFER

- **Korea Electric Power Corporation/Korea Power Engineering Company**
  - Yonggwang 3 and 4, nuclear, 950 MW each.
    Conducted six-month transfer of technology course on heat exchangers. (1987 to 1988)

- **Arizona Public Service Company**
  - Conducted two-day course on heat balances. (1986)

- **Sargent & Lundy**
  - Instructor of a course in fans for Sargent & Lundy's Power Plant Fundamentals program.

FANS

- **Commonwealth Edison Company**
  - Kincaid 1 and 2, coal, 1160 MW total.
    Study for upgrading induced draft (ID) fans for the addition of an FGD system. (1991 to 1992)

    Provided engineering services for replacement of gas recirculation fan wheels. (1988)

  - Waukegan 8, coal and gas, 355 MW.
    Provided engineering services for replacement of ID fan wheel. (1988)

  - Joliet 7 and 8, coal and gas, 580 MW each.
    Performed engineering services in connection with ID fan wheel and fan rotor replacement. (1987)

- Powerton 5 and 6, coal, 828 MW each.
  Provided engineering services for replacement of forced draft (FD) fan wheel. (1987)

- Will County 1 and 2, coal, 280 MW total.
  Provided engineering services for ID fan hub replacement and prepared specifications for replacement of FD fan wheel. (1987)

- **Electric Power Research Institute**
  - Study manager for developing operating and maintenance guidelines (RP 2504-7) for draft fans. (1988 to 1992)

- **PSI Energy**
  - Gibson 4, coal, 668 MW.
    Study for upgrading ID fans for the addition of a flue gas desulfurization system. (1991)

  - Cayuga 1 and 2, coal, 1062 MW total.
    Provided engineering service for replacement of FD and ID fan wheels. (1988)

  - Wabash River 6, coal, 365 MW.
    Provided engineering services for replacement of ID fan wheels. (1988)

- **Florida Power & Light Company**
  - Various stations.
    Prepared generic FD fan specifications for several 400 MW units. (1987)

MEMBERSHIPS

American Society of Mechanical Engineers
- Performance Test Codes Standards Committee
- Committee PTC-11, Fans

PUBLICATIONS

"Emission Limits and Controls for Coal Fired Plants in the United States" (coauthor), Presented at the International Seminar on Energy Savings and Environmental Protection in Large Scale Thermal Power Companies, Shanghai, 2007

"Uncertainty Analysis in Fan Testing" (coauthor), ASME POWER2007, San Antonio, Texas, July 2007.

"Using Technology to Resolve Power Plant Design and Construction Disputes" (coauthor), ASME Joint International Power Generation Conference, Phoenix, Arizona, October 1994

"Economic and Operational Benefits from Retrofitting Variable-Speed Drives" (coauthor), American Power Conference, Chicago, Illinois, April 1994

"Fan Instability Associated with Variable-Frequency Drives" (coauthor), American Power Conference, Chicago, Illinois, April 1994

"Meeting CAA Demands on CEM Systems" (coauthor), Power Engineering, December 1992

"Heat Rate Study for the Base Case PC State-of-the-Art Power Plant Conceptual Design" (coauthor), EPRI Conference on Heat Rate Improvement, Birmingham, Alabama, October 1992

"Helping Operators Improve Plant Performance HEATXPRT: An On-Line Expert System" (coauthor), EPRI's Heat Rate Improvement Conference, Scottsdale, Arizona, May 1991

"Benefit from Lessons Learned in Replacing Centrifugal Fans," Power, January 1991

"Fan Replacement - Lessons Learned," American Power Conference, Chicago, Illinois, April 1990

"Development of an On-Line Expert System," HEATXPRT" (coauthor), EPRI Conference on Advanced Computer Technology for the Power Industry, Scottsdale, Arizona, December 1989

"Operating and Maintenance Guidelines for Draft Fans," EPRI Plant Maintenance Technology Conference, Houston, Texas, November 1989

"Heat Rate Improvement at TU Electric's North Lake Unit 2," EPRI Heat Rate Improvement Conference, Knoxville, Tennessee, September 1989

"Development of an On-Line Expert System: Heat Rate Degradation Expert System Advisor" (coauthor), EPRI Conference on Expert Systems Applications for the Electric Power Industry, Orlando, Florida, June 1989

"Performance Monitoring Systems" (coauthor), Instrument Society of America's Power Industry Division Conference, Phoenix, Arizona, May 1989

"Effective Use of Availability Data," (coauthor), Sargent & Lundy General Engineering Conference, Chicago, Illinois, Spring 1988

"Fossil-Fired Station Heat Rate Improvement," Sargent & Lundy General Engineering Conference, Chicago, Illinois, Spring 1987

"Performance-Related Monitoring and Diagnostics," Sargent & Lundy General Engineering Conference, Chicago, Illinois, Spring 1986, and JPGC 1987

"Integrated Power Plant Diagnostics" (coauthor), Pacific Coast Electrical Association's Engineering and Operating Conference, San Francisco, California, March 1986

"Heat Rate Improvement" (coauthor), Joint Power Conference, Toronto, Canada, September-October 1984

"Availability and Plant Betterment," 11th Annual Inter-RAM, Las Vegas, Nevada, April 1984

EXHIBIT W

PUBLIC RELEASE COPY

MIDWEST GENERATION EME, LLC
CHICAGO AREA WATERWAYS AND LOWER DES PLAINES RIVER
GENERATING UNITS

COOLING TOWER COST STUDY

REPORT NO. SL-009359

Date: February 1, 2011

S&L Project No. 10683-130

Sargent & Lundy

55 East Monroe Street
Chicago, IL 60603-5780 USA

Ex. B

MIDWEST GENERATION EME, LLC
CHICAGO AREA WATERWAYS AND LOWER DES PLAINES RIVER GENERATING UNITS

<u>COOLING TOWER COST STUDY</u>

REPORT NO. SL-009359

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MIDWEST GENERATION EME, LLC
CHICAGO AREA WATERWAYS AND
LOWER DES PLAINES RIVER GENERATING UNITS

COOLING TOWER COST STUDY

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I. EXECUTIVE SUMMARY

Proposed rules by the Illinois Environmental Protection Agency ("Illinois EPA" or "Agency") seek to change the use designation for the Upper Illinois Waterway ("UIW") from the existing "secondary contact and indigenous aquatic life" use (the "Proposed UAA Rules"). The Proposed UAA Rules include more stringent thermal water quality standards ("Proposed UAA Thermal Standards") for the UIW. Five electrical generating stations owned and operated by Midwest Generation EME, LLC ("MWGen") are located along and discharge to those portions of the UIW known as the South Branch of the Chicago River, Chicago Sanitary and Ship Canal ("CSSC") and the Upper Dresden Island Pool ("UDIP") of the Lower Des Plaines River. These stations are Fisk, Crawford, Will County and Joliet (2 stations) generating stations. Joliet 6 is located on the south side of the Des Plaines River, while Joliet 7&8 is located on the north side of the Des Plaines River. Will County Units 1&2 were retired effective December 31, 2010. Therefore, these two units were not included in this study. The MWGen generating stations operate based on a once-through, open-cycle circulating water system design. None of the MWGen generating stations are capable of achieving and consistently maintaining compliance with the proposed thermal standards at existing operating levels.

MWGen requested that Sargent & Lundy (S&L) evaluate the various technologies that are available for cooling the Fisk, Crawford, Will County and Joliet units. S&L has been designing power plants since its beginning in 1891. The original Fisk unit was designed by S&L in the early 1900's. Since that time, S&L has designed many power plants that incorporate different types of cooling tower designs.

This report addresses the potential cost and operational impacts associated with revised limits on thermal discharges from the subject MWGen generating stations. This particular study expands and updates earlier work prepared in 2005, that presented proposed cost estimates and other information developed by S&L for the installation of thermal control technology at the MWGen stations. In 2008, after this rule-making was initiated, S&L began work to review and update its prior 2005 study. The proposed thermal control technology evaluated consisted of multi-cell cooling towers designed for closed-cycle operation, with provisions to permit operation in open-cycle mode when conditions allow. The incremental capital costs for the provisions to permit open-cycle mode constitute a small percentage of the overall project cost. Those incremental costs are discussed further in Section 5.

At the time of the 2005 S&L study, it was not known what new thermal standards the Illinois EPA would propose for the UIW. Accordingly, in the absence of any suggested thermal standards on which to base the study, the 2005 S&L study used the existing Illinois General Use thermal standards as the design basis for evaluating the control options and associated costs for achieving compliance. In the 2005 study, the estimated capital costs for wet towers ranged from about $59,500,000 for Joliet 6 to about $170,000,000 for Joliet 7/8, and the costs for wet/dry (plume abated) towers ranged from about $84,500,000 for Joliet 6 to about $257,000,000 for Joliet 7/8. Annual Operation and Maintenance (O&M) costs were also estimated in the 2005 study. O&M costs are, to a great extent, proportional to a plant's electrical output, so it is to be expected that O&M costs for the largest plant, Joliet 7/8 at 1,138 MW, would be considerably higher than O&M costs for Fisk at 348 MW. The 2005 estimated O&M costs for wet/dry towers ranged from about $1,400,000 for Fisk to about $7,000,000 for Joliet 7/8.

In this study, the Proposed UAA Thermal Standards are used as the design basis for determining the feasibility of add-on thermal control technology and the associated costs of compliance for each of the MWGen stations. As part of the design basis, the proposed cooling systems were designed with the goal of allowing the stations to run at full capacity under the most demanding conditions. Under the Proposed UAA Thermal Standards, it is generally expected that the most demanding thermal conditions will occur during the hot summer months. However, because the Proposed UAA Thermal Standards include stringent seasonal thermal criteria throughout the year, the design also needed to address the need to operate without capacity restrictions during the cooler times of the year. The following information was developed in this study for cooling towers at Fisk, Crawford, Joliet and Will County:

- Evaluation of capability for meeting the proposed thermal standards;
- Review of regulatory and permitting issues and risks;
- Order-of-magnitude (-30%/+50%) capital and O&M cost estimates; and
- Review of schedule requirements and layout feasibility.

Several alternative types of closed loop cooling technologies were evaluated as part of this study, including radiator type towers (external water required), air cooled condensers (new condenser is located external to the turbine room), and hyperbolic natural draft cooling towers. These options have either not been proven on such large scale installations or are considerably more expensive than the conventional wet cooling tower design.

The advantage of the closed-cycle wet cooling tower approach is that it virtually eliminates thermal discharges to the adjacent river. There is still a small discharge that is required to control the water chemistry of the tower (referred to as "cooling tower blowdown"), but this is a fraction of a percent of the total open loop cooling compared to the current open-cycle operation of these stations. If a mixing zone is granted for discharging cooling tower blowdown, it is assumed that the cooling tower blowdown will meet the Proposed UAA Thermal Standards at the edge of the mixing zone. However, S&L recognizes that, if the ambient temperature of the river is above the Proposed UAA Thermal Standards, an allowed mixing zone may not be applicable under the existing mixing zone regulation in 35 IAC § 302.102. Accordingly, it is currently not known whether and to what extent each of the MWGen stations would be granted an allowed mixing zone. In any event, the estimated costs of the proposed cooling towers and associated circulating water system modifications discussed in this report are not significantly affected. If the stations' cooling tower blowdown discharge is not subject to an allowed mixing zone, the temperature of the cooling tower blowdown discharge must comply with the Proposed UAA Thermal Standards at the point of discharge to the river. In the absence of an allowed mixing zone, an additional cooling mechanism (likely a chiller totaling approximately $3 million per station) may be required to guarantee compliance at each of the MWGen stations under all operating and receiving water scenarios. However, for purposes of this report, we have not included any supplemental cooling of the cooling tower blowdown discharge for any of the stations in the study cost estimates.

Three different design scenarios were evaluated for the Joliet and Will County Stations. These are wet towers (which yield a visible, fog-like discharge plume), wet/dry towers (plume-abated towers), and wet towers with provisions to convert to wet/dry operation. The cooling tower design for Fisk and Crawford was based solely on the wet/dry (plume-abated) design, in order to prevent icing on the nearby interstate highway, high voltage power lines, and in nearby commercial and residential areas. The estimated compliance capital costs for all of the stations covered by this study range from $93,400,000 at Joliet 6 to $223,800,000 at Joliet 7/8 for wet towers to between $115,700,000 at Joliet 6 and $300,900,000 at Joliet 7/8 for the wet/dry options. Annual Operation and Maintenance (O&M) costs for wet/dry towers ranged from $2,127,000 at Fisk to $9,080,000 at Joliet 7/8.

The estimated capital costs for the various designs considered are summarized in Table ES-1. Table ES-1 also provides the capital cost per kilowatt for the wet/dry tower designs for each of the five MWGen stations, which ranges from $264/kW to $394/kW, with an average cost across all five stations of $301/kW. Annual O&M costs, based on 75 percent capacity factors, are summarized in Table ES-2. Table ES-3 summarizes the portion of each station's gross capacity which is lost due to the cooling tower systems' auxiliary power demand.

Table ES-1

Cost Summary of All Wet/Dry, Wet/Dry Convertible, and Wet Non-Convertible Towers

Unit	Station Total Gross MW	Capital Cost Wet/Dry Tower ($)	Capital Cost Wet Convertible to Wet/Dry ($)	Capital Cost Wet Only ($)	Wet/Dry Capital Cost ($ per kW)
Fisk 19	348	$137,100,000	N/A	N/A	$394
Crawford 7&8	585	$165,200,000	N/A	N/A	$282
Will County 3&4	832	$257,100,000	$230,200,000	$210,700,000	$309
Joliet 6	341	$115,700,000	$103,600,000	$93,400,000	$339
Joliet 7&8	1,138	$300,900,000	$257,900,000	$223,800,000	$264
Totals	**3,244**	**$976,000,000**	-	-	**$301 (average)**

Table ES-2
Estimated Annual Operating and Maintenance Costs

Unit	Station Total Gross MW	Wet/Dry Towers	Wet or Wet Convertible Towers
Fisk 19	348	$2,127,000	N/A
Crawford 7&8	585	$3,960,000	N/A
Will County 3&4	832	$5,750,000	$5,710,000
Joliet 6	341	$2,660,000	$2,350,000
Joliet 7&8	1,138	$9,080,000	$8,280,000
Totals	**3,244**	**$23,577,000**	N/A

Auxiliary power use increases for the cooling tower operation. Each cooling tower cell is provided with a fan, and additional pumps are required to move cooling water through the closed cooling loop. The power demands of the fans and additional pumps contribute to the additional auxiliary power requirements. The auxiliary power requirements for the MWGen plants are shown in Table ES-3.

Table ES-3
Cooling Tower Auxiliary Power Use (Annual-Average MW)

	Fisk 348 MW	Crawford 585 MW	Will County 3&4 832 MW	Joliet 6 341 MW	Joliet 7&8 1,138 MW
Cooling Tower Fan Power	3.24	6.08	9.32	4.28	16.20
Supply Pump Power	3.89	6.48	9.72	4.78	17.01
Discharge Pump Power	0.65	0.97	0.81	.0.81	1.94
Average Aux Power Use	**7.78**	**13.53**	**19.85**	**9.87**	**35.15**
Percentage of MW Output	**2.2**	**2.3**	**2.4**	**2.9**	**3.1**

From the data in Table ES-3, it can be seen that the cooling tower systems consume between 2.2 percent and 3.1 percent of the stations' gross output, which represents lost generating capacity for each affected station. The economic effects of station generating capacity loss are discussed in Section 5.

The costs presented above are based on the preliminary design criteria prepared by S&L for this report. For each of the MWGen stations, cooling tower design is based on a 7°F approach temperature and a 1% wet bulb occurrence. These numbers drive the performance and cost of the tower. Smaller approach temperatures require larger and more expensive towers to accommodate a given cooling water flow requirement. But, smaller (or lower) approach temperatures also increase the likelihood that the unit can remain running at its full rated load under all operating conditions. Conversely, higher approach temperatures would reduce the size of the tower required but would increase the risk that the unit would need to be operated at much less than its rated load on hot days when the demand for power is typically at its greatest. A higher approach temperature would also increase the temperature of the cooling tower blowdown, increasing the risk of not meeting the applicable temperature limits, especially if these apply at the end-of-pipe. The potential capital cost savings realized for designing to a 12°F approach temperature, instead of the 7°F approach temperature selected for this study, would be approximately 20 percent. Even with this potential cost savings, the overall cost of the cooling tower installation still represents a substantial capital expense. The use of a 7°F approach temperature yields the lowest practical cooling tower blowdown temperature, and thus minimizes the overall thermal impact on the river. Please refer to Section 2.C.2 for a more detailed discussion of cooling tower design and function.

There are several concerns associated with the proposed cooling tower installations. The feasibility of siting cooling towers poses significant constructability difficulties at many of the MWGen stations. "Constructability" is an industry term used to indicate both the economic feasibility and the ease with which equipment can actually be installed. Installation of cooling towers at Fisk, Crawford, and Will County stations will require relocation of ComEd high voltage lines to prevent ice buildup caused by the cooling towers' operation and potentially catastrophic snapping of these power lines during the winter months. Based on S&L's past professional experience, the estimated capital costs include an allowance for transmission line relocation where applicable, but there was no study performed to define the scope of this necessary modification. This study also assumes that if requested, ComEd would agree to and allow the relocation of the high voltage lines. If relocation of the ComEd high voltage lines is not possible, the towers would pose a safety concern at Fisk, Crawford, and Will County which may prevent their installation unless another alternative approach to their installation can be identified.

Many of the MWGen stations have very limited available space for locating new cooling towers. The limited availability of space can affect the towers' performance. These tight arrangements promote interference (when the hot air discharge of one tower enters the intake of a nearby tower, leading to poor performance). Another negative impact of the tight tower arrangement is recirculation (when the hot air discharge of a tower enters its own intake, leading to poor performance) when winds are blowing in an unfavorable direction.

Noise emissions from the cooling towers are expected to be below the regulatory limits for all of the units except for Joliet 7&8 due to the proximity of an existing office building west of the proposed Joliet 7&8 cooling tower location. The cost of noise abatement was not included in the Joliet 7&8 capital cost estimates.

Particulate emissions from the cooling tower are estimated to be greater than the 25 ton/year threshold for New Source Review (NSR) for overall particulate matter for the Joliet 7&8 and Will County 3&4 cooling towers. These emission levels would trigger requirements for Best Available Control Technology (BACT); however, drift eliminators (included in the design) meet the BACT standards.

Particulate emissions with an aerodynamic diameter less than 10 microns (PM_{10}) are estimated to fall below the NSR PM_{10} threshold of 15 tons/year at all stations except Joliet 7&8, based on use of published ratios of PM_{10}:PM emissions that have been accepted by the Illinois EPA in the past. Using this method, Joliet 7&8 have predicted combined PM_{10} emissions of approximately 15.06 tons/year, which is slightly above the threshold. Will County 3&4 have predicted combined emissions of approximately 10 tons/year, based on a conservative 100% capacity factor and 100% closed-cycle operation. If a methodology different from the ratio method is used to calculate PM_{10} emissions, the 15 tons/year threshold possibly could be exceeded at Will County, depending on the final calculation methods and assumptions. Fisk, Crawford and Joliet 6 should not have issues related to PM_{10} emissions.

Lastly, S&L estimates that a single tower installation will require a minimum of 29 months to complete after additional studies are completed and critical design criteria are finalized. This schedule is based on a single tower installation; the overall duration for a multiple station cooling tower installation will be longer. From a design standpoint, much of the required effort will be largely repetitive. For example, once a cooling tower specification is prepared for one station, it will take considerably less time to prepare a comparable specification for another station. However, it is likely that MWGen's ability to pursue multiple cooling tower projects in parallel will be limited by the time required to fabricate and deliver the cooling tower material and equipment and/or by the time required to construct the tower and other structures.

At present, there are few utility-size cooling tower projects underway nationally, and the construction labor market is favorable. With such conditions, assuming funding can be acquired when needed, one might be able to execute projects at Fisk and Crawford in parallel, and to start projects at the next stations in sequence with a 12- to 15-month lag. Assuming such "best case" scenario circumstances, after the time required to complete the final design criteria, the time required to implement closed-cycle cooling at the five MWGen stations is estimated to be a minimum of 60 months. However, as the economy improves, lead times will lengthen and construction labor will become less available. Therefore, it is not possible to predict accurately the overall time required to design, fabricate and install cooling towers at five power stations. Again, assuming that funding can be obtained when needed, for planning purposes, S&L recommends that at least 72 months should be allowed for that process.

The extent of transmission line relocation was not examined in any detail during this study. The time required to obtain permission for line relocation and to actually relocate the lines has not been considered in the schedule discussion above.

2. APPROACH AND SCOPE OF COOLING TOWER STUDY

This section addresses:

- The Proposed UAA Thermal Standards which will force installation of closed-cycle cooling at Crawford, Fisk, Joliet 6, Joliet 7/8 and Will County 3/4;
- A discussion of cooling tower design and performance considerations; and
- A description of the scope of this cooling tower cost study report.

A. PROPOSED UAA THERMAL WATER QUALITY STANDARDS

In October 2007, the Agency filed the Proposed UAA Rules with the Illinois Pollution Control Board. If adopted, the Proposed UAA Rules would reclassify the subject waters into which each of the MwGen stations discharge from their current "secondary contact" use designation and impose more stringent thermal standards for the associated waterways. The Proposed UAA Rules include thermal standards that are stricter than the existing General Use standards.

Table 2-1 below lists the Proposed UAA Thermal Standards, which would apply on a period average basis with a daily maximum limit. Under the Proposed UAA Rules, the CAWS Aquatic Life Use B ("ALU B") standards would apply to Fisk, Crawford, and Will County, while the Upper Dresden Island Pool ("UDIP") standards would apply to Joliet. The Proposed UAA Thermal Standards may be applied at the edge of an approved mixing zone pursuant to the requirements of 35 Ill. Adm. Code §302.102. However, a final determination of whether any mixing zone will be allowed, and, if so, how large, is not currently known because it would be determined by the Agency in future NPDES permitting if any revised thermal water quality standards are ultimately adopted. For the purpose of this study, it is assumed that the small (~650 to ~3000 gpm) cooling tower blowdown flows generated by a closed-cycle cooling system either will comply with the Proposed UAA Thermal Standards or will not contribute to any significant water temperature rise within the receiving stream, thus making any need for a mixing zone limited to a very small area of the receiving stream. However, based on existing receiving stream data, it is expected that there may be times when no mixing is available due to low river flow and/or ambient river temperatures which are higher than the Proposed UAA Thermal Standards. In the absence of an allowed mixing zone, an additional cooling mechanism (likely a chiller at a total approximate cost of $3 million per station) may be required to ensure compliance at each of the MWGen stations under all operating and receiving water scenarios. However, for purposes of this report, we have not included any supplemental cooling of the blowdown discharge for any of the stations in the study cost estimates.

Table 2-1
Proposed IEPA Water Temperature Limits

Month	October 2007 Final IEPA Average CAW Aquatic Life Use B Temp Limit	October 2007 Final IEPA Maximum CAW Aquatic Life Use B Temp Limit	October 2007 Final IEPA Average Upper Dresden Island Pool Temp Limit	October 2007 Final IEPA Maximum Upper Dresden Island Pool Temp Limit
Jan 1-31	54.3	90.3	54.3	88.7
Feb 1-29	53.6	90.3	53.6	88.7
Mar 1-15	57.2	90.3	57.2	88.7
Mar 16-31	57.2	90.3	57.2	88.7
Apr 1-15	60.8	90.3	60.8	88.7
Apr 16-30	62.1	90.3	62.1	88.7
May 1-15	69.2	90.3	69.2	88.7
May 16-31	71.4	90.3	71.4	88.7
Jun 1-15	74.2	90.3	74.2	88.7
Jun 16-30	86.7	90.3	85.1	88.7
Jul 1-15	86.7	90.3	85.1	88.7
Jul 16-31	86.7	90.3	85.1	88.7
Aug 1-15	86.7	90.3	85.1	88.7
Aug 16-31	86.7	90.3	85.1	88.7
Sep 1-15	86.7	90.3	85.1	88.7
Sep 16-30	77	90.3	77	88.7
Oct 1-15	73.2	90.3	73.2	88.7
Oct 16-31	69.6	90.3	69.6	88.7
Nov 1-30	66.2	90.3	66.2	88.7
Dec 1-31	59.9	90.3	59.9	88.7

The MWGen stations that are impacted by the Proposed UAA Rules are Fisk, Crawford, Will County and the two Joliet stations. Thermal discharges from the MWGen stations in their current once-through, open-cycle design do not meet the Proposed UAA Thermal Standards either for the CAWS Aquatic Life Use B or the UDIP. Based on the Proposed UAA Thermal Standards, as summarized in Table 2-1 above, it was determined that closed-cycle cooling tower control technology would be the most effective means of complying with the Proposed UAA Thermal Standards while maintaining the capability to operate at the design electrical output of each unit.

B. COOLING TOWER DESIGN AND PERFORMANCE

1) Cooling Tower Function and Physical Characteristics

Cooling towers are used to transfer the heat from the power plant circulating water into the atmosphere. Steam from the turbine-generator exhaust is cooled and condensed to water in one side of a large heat exchanger, called the condenser, and is pumped back (recycled) to the boiler. The other side of the condenser is cooled by the circulating water system, and the circulating water gains heat as it passes through the condenser. The circulating water is sprayed into the top of the cooling tower, where it comes into contact with air from the atmosphere which flows upward through the tower. Some of the warm circulating water is evaporated and absorbed by the cooler air. This evaporation of a portion of the circulating water is the primary mechanism for heat transfer between the water and the air. The air cools the circulating water so it can be pumped back to the condenser and the cycle is repeated. "Fill" is used to break up falling water droplets in the tower and promote interaction between the water and the ambient air.

Cooling towers of a type called "mechanical draft" were evaluated for installation at the MWGen stations. A mechanical-draft tower is typically 40 to 60 feet tall and anywhere from 40 to several hundred feet long, depending on the volume of circulating water flow the tower is designed to process. A cooling tower is actually comprised of several semi-independent modules referred to as "cells". Each cell consists of 1) a structural steel or fiberglass frame, 2) walls (to confine the air and water flow), 3) piping near the top of the framework to distribute the water evenly, 4) material called "fill" (installed within the tower framework) to improve heat transfer between the water flowing down and the air flowing up, 5) a large-diameter fan to pull air upward through the tower, and 6) an exhaust stack to help direct warm air upward and away from the sides of the tower. A group of cells is typically linked end-to-end to form a single cooling tower assembly. The group of cells is constructed inside a concrete basin which collects the cool water. The pumps which return the cool water to the condenser are installed on one end of the basin.

The number of individual cells in the cooling towers evaluated for this study ranged from a low of 16 at Fisk Station to a high of 64 at Joliet 7/8. The cooling tower equipment arrangement drawings presented in Exhibit A show that it was necessary to break the total number of cells required into two or more groups owing to space limitations at the stations.

2) Cooling Tower Performance Considerations

Sizing of wet and plume-abated (wet/dry) cooling towers depends primarily on two key parameters: wet bulb temperature, which is determined by weather conditions, and approach temperature, a value which is selected by the cooling system designer.

The amount of humidity in the atmosphere air determines the wet bulb temperature, which, in turn influences the effectiveness of cooling tower in removing heat from the circulating water. Higher humidity levels result in higher wet bulb temperatures, and lower humidity levels result in lower wet bulb temperatures. In general, the lower the wet bulb temperature, the lower the cold water temperature – the temperature of the circulating cooling water after it has passed through the cooling tower. Thus cooling towers are more effective on cool, dry days and less effective on warm, humid days.

Wet bulb temperature changes continually (hour to hour and day to day) as weather changes. Therefore, tower design for cooling performance and the ability to meet thermal discharge limits involves consideration of meteorology probabilities. A conservative approach that accounts for reasonably expected weather conditions was used in this study to ensure that the tower design will remove the heat from the generating station even during the most hot and humid days. The cooling towers were designed based on the "Summer

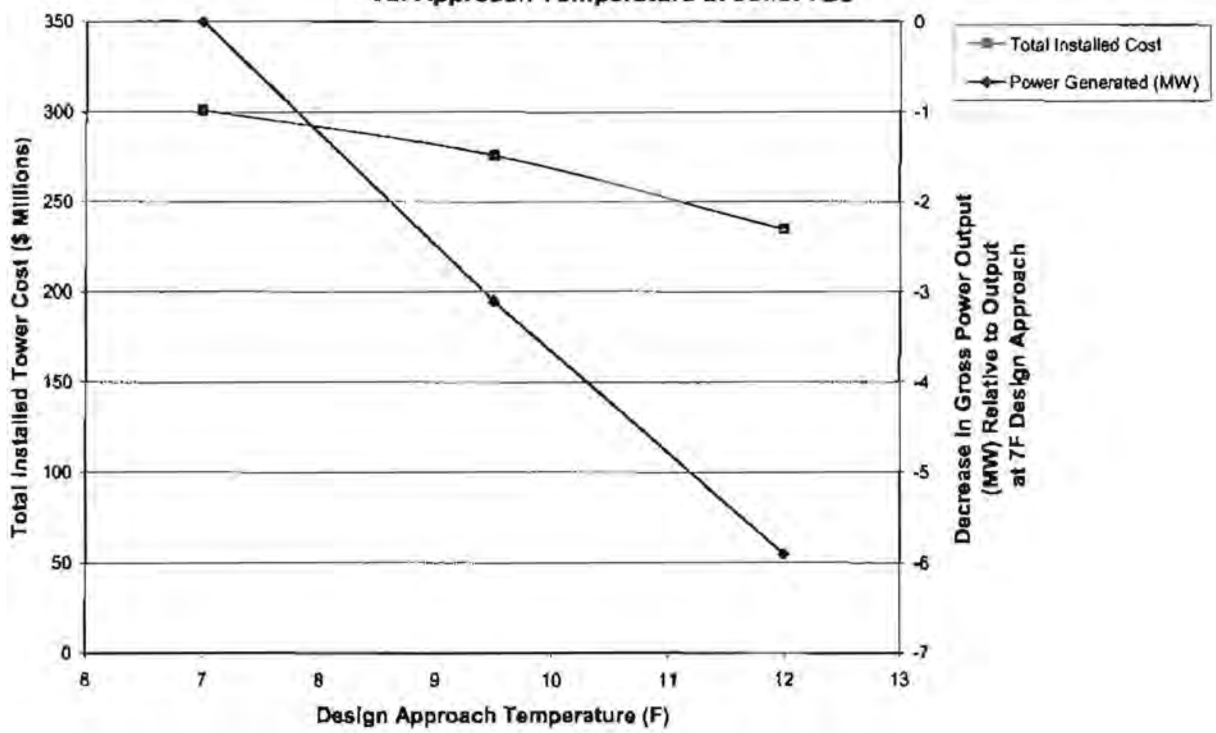
1%" wet bulb temperature which means that the historical wet bulb temperatures exceed this value only 1% of the time during the hottest months. Historical wet bulb data was obtained from a U.S. Air Force publication. (See paragraph 3.a.6 below for a complete reference to this publication.)

A second important parameter that defines the design of a cooling tower is "approach temperature." The approach temperature is defined as how close the water being cooled approaches the wet bulb temperature. Design for a lower approach temperature results in a larger tower, which is usually effected by increasing the number of cells in the tower. A larger tower will provide greater contact time between the circulating water and the airflow, which increases heat removal and lowers cold water temperature. A larger tower is more expensive for a given circulating water flow rate, but it will increase the likelihood that the generating station can remain running at full load during the most hot and humid days.

Figure 2-1 illustrates the capital costs for the Joliet 7&8 towers as a function of approach temperature. This same general relationship among cooling tower approach temperature, cooling tower cost, and auxiliary power demand is typical of the towers evaluated for the other generating stations considered in this study. Cooling tower cost decreases with higher approach temperatures although the cost is still in the order of hundreds of millions of dollars. With this decrease in cost, however, comes an increased risk that the unit will generate less electrical power during a time when demand is high and the cost for purchased power also is almost always relatively high. To minimize the risk that the cooling towers chosen would necessitate unit deratings to maintain compliance at the MWGen stations at times when demand for electricity is high, an approach temperature of 7°F was used as the basis for this study.

An additional benefit of designing the towers with a 7°F approach is that it minimizes the temperature of the cooling tower blowdown flow to the relevant waterway. Decreasing the tower size and cost by selecting a larger approach temperature such as 9°F or 12°F would increase the temperature of the cooling tower blowdown flow. An approach temperature increase of even 2-3 degrees would likely lead to an end-of-pipe cooling tower blowdown flow temperature that is warmer than the Proposed UAA Thermal Standards maximum value during the summer months.

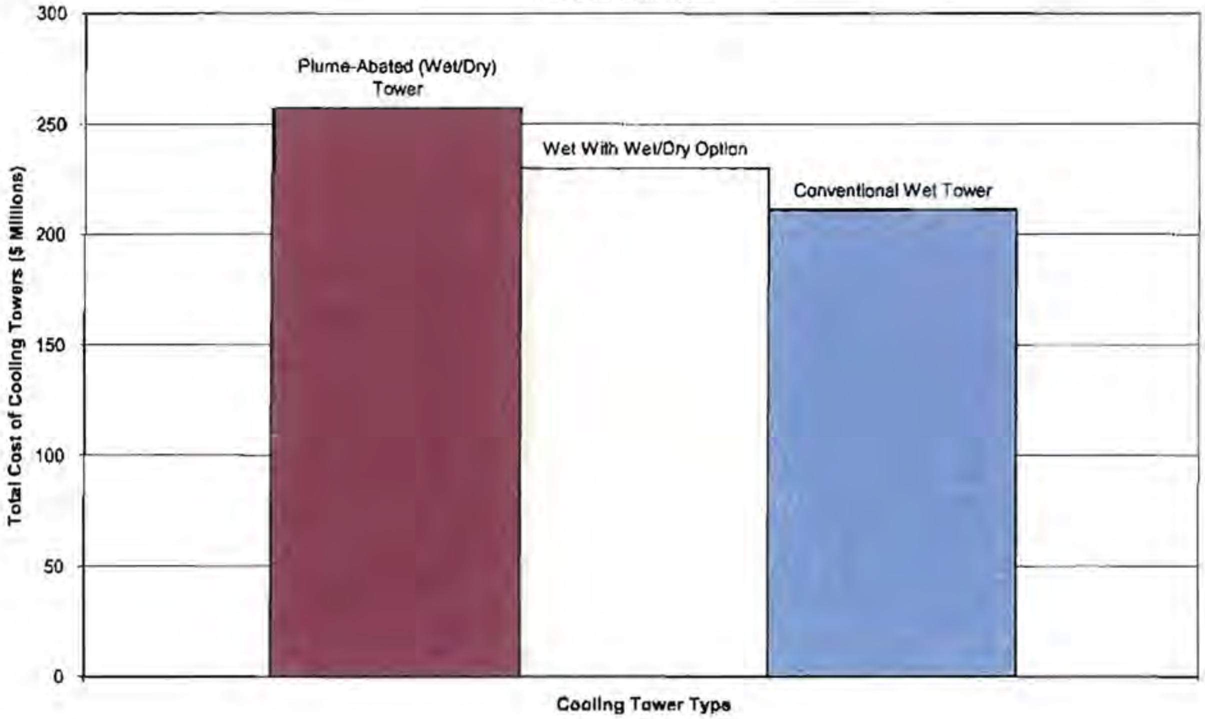
Figure 2-1
Total Installed Cost of Wet/Dry Cooling Towers and Power Generation Impact Vs. Approach Temperature at Joliet 7&8



A final design consideration is the treatment of the fog-like plume that normally rises from cooling towers. Towers with visible water vapor plumes are available at lower cost but can cause potential visibility problems and icing problems in freezing weather. Visibility and icing problems can create safety hazards on nearby streets and highways and for those who use them. Icing problems are particularly hazardous to power lines located in the vicinity of an electrical generating station because the icing can cause power lines to fail and interrupt power service to customers. Wet/dry or "plume-abated" towers minimize the risk of visibility and icing problems. Wet/dry towers have a dry reheating section above the wet section, which further warms the warm, moist air leaving the wet section of the tower. Such wet/dry towers make the plume essentially invisible and decreases the potential for visibility and icing problems. Hence, the reason they are called "plume-abated" towers. Plume-abated towers are designed so that the visible plume extends no farther than one tower height. It should be noted that there is still some icing concern with wet/dry towers, though the icing risk is lower than that associated with pure wet towers.

If it is uncertain whether plume abatement will ultimately be required for a given generating station, a wet-type tower can be designed with features which allow later conversion to plume-abated or wet/dry operation. The principal features required are design of the cooling tower basin and structural supports for the higher weight of the plume-abatement heat exchangers that are added to convert the tower to wet/dry operation. Although a wet-type tower that is not originally designed for conversion to plume abatement could subsequently be converted, the costs of doing so would be much higher than if provision for subsequent conversion were made in the original design. Figure 2-2 illustrates the relative costs of all three tower types based on the costs for Will County Station Units 3/4. As shown in more detail in Section 5, the cost relationship among the three types of towers at Will County is also typical for Joliet 6 and Joliet 7/8.

Figure 2-2
Installed Capital Cost of Will County Cooling Towers for Three Different Types



Wet/dry towers were selected as the base design for Crawford and Fisk, owing to those stations' proximity to a nearby interstate highway, electric transmission lines, and commercial and residential areas. Wet-type towers are believed to be acceptable for Joliet 6, Joliet 7/8 and Will County 3/4, but installed costs for all three types are provided in Section 5.

All of the MWGen stations were designed for and operate as open-cycle cooling stations. Cooling tower costs for retrofit applications to convert from open-cycle to closed-cycle cooling, such as is the case here for the MWGen stations, are generally higher than those for a tower provided at a generating unit initially designed for closed-cycle operation – estimated to be approximately 10 to 20 percent higher. Units designed for once-through (open-cycle) cooling typically have a smaller condenser than units originally designed for closed-cycle operation. A retrofit tower will typically be made larger to compensate for the smaller condenser. Increasing the size of the condenser during retrofit is a potential design option, but the costs of condenser modifications are higher than the incremental costs of larger cooling towers.

The cost estimates provided here for all wet/dry cooling tower options are based on cooling tower quotes obtained from SPX/Marley, a cooling tower supplier, in response to a brief specification and sizing table provided by S&L. Low-clog film fill was selected by SPX/Marley as suitable for the MWGen applications, based on the Total Suspended Solids levels in the make-up water. Make-up water quality data is presented in Exhibit F.

Exhibit C contains preliminary design specifications for the cooling tower designs. This design basis information was provided to SPX/Marley by S&L to use as the basis for its estimates of cooling tower costs.

3) Alternative Cooling Tower Technologies

The following alternative cooling technologies were also considered at the start of the study, but were eliminated from further consideration for the reasons stated below:

- Radiator-type towers (with no water cooling): Eliminated because these towers have never been applied to units of the size or approach temperature applicable here and they would require a prohibitive amount of land that is not available at the MWGen stations.
- Air-cooled condensers: Eliminated because existing unit condensers at the MWGen stations would have to be replaced and low-pressure steam would need to be ducted to the new air-cooled condenser (ACC). This option would not likely be technically feasible due to large amount of land area required for such installations, and the difficulty routing the very large duct required from the turbine exhaust to the ACC inlet. An ACC would increase turbine backpressure, which would further reduce the station's generating capacity, and it also would be prohibitively expensive.
- Hyperbolic natural draft cooling towers: Eliminated due to the extremely high cost (4 to 8 times the cost of a conventional wet tower), concerns about a) interference with the glide paths for nearby airports, b) the land area required, and c) overall permitting owing to negative public perception of the aesthetics of such tall structures.

C. COOLING TOWER COST STUDY SCOPE

The scope of this study is as follows:

- Obtain capital and O&M costs in current dollars for cooling towers sized for closed-cycle operation under summer conditions. The cooling tower equipment arrangement drawings and closed-cooling cycle diagrams that form the basis of the cost estimating criteria are provided in Exhibits A and B, respectively. Major equipment was sized based on maximum boiler heat input, maximum exhaust flows, and original condenser and circulating water design conditions.

- Develop "order-of-magnitude" (-30%/+50%) cost estimates for the following scenarios in this study:
  - ➢ Wet cooling tower with plume abatement (wet/dry tower) for all five stations.
  - ➢ Wet cooling towers for Joliet (both stations) and Will County Stations without the option to add plume abatement.
  - ➢ Wet cooling towers for Joliet (both stations) and Will County Stations without plume abatement but designed with additional structure to allow addition of plume abatement at a later date.

  Budgetary cost estimates from SPX/Marley, a prominent power plant cooling tower supplier, were solicited to obtain current costs for all cooling tower options. S&L calculated balance-of-plant costs using previous plant designs and our in-house cost database.
- Estimate O&M costs, including auxiliary power for tower fans and additional circulating water pump head requirements, plus chemical costs and tower maintenance.
- Compare estimated cooling tower blowdown temperatures and volumes to proposed thermal standards to determine whether further temperature dispersion study is required.
- Estimate particulate emissions due to cooling tower "drift", and determine whether these emissions could trigger additional air permit or compliance requirements.
- Perform a qualitative assessment of possible tower noise emissions and any regulatory or ordinance requirements that may require measures for noise mitigation.
- Evaluate the impact of cooling tower addition on plant thermal cycle. The ability of a cooling tower to produce cold water is limited by the outdoor wet bulb temperature. Generally, the cooler the return water to the condenser, the higher the efficiency of the turbine generator, and the more electricity which is generated. In addition, lower return water temperatures result in lower condenser discharge temperatures.
- Determine preliminary permitting requirements for installation of cooling towers.
- Prepare a preliminary construction schedule based on typical cooling tower installation duration.

3. CONCEPTUAL DESIGN BASIS FOR CLOSED LOOP COOLING TOWER STUDY

In order to design the cooling towers required at each of the MWGen stations, the current unit rating (in gross MW), which represents the current generating capacity of each station, was used. Major equipment was sized based on maximum boiler heat input, maximum exhaust flows, and original condenser and circulating water design conditions. Preliminary design specifications were developed for the towers needed at each station.

The following paragraphs describe the parameters common to all units at the MWGen stations which set the design of the cooling towers for this study. Design bases for individual units at each of the stations are provided in Exhibit D.

A. DESIGN ELEMENTS COMMON TO ALL UNITS

The following design bases were applied to cooling tower cost estimates and layouts for all of the electrical generating units located at each of the MWGen stations:

1) Cost estimates are "order-of-magnitude" accuracy, -30%/+50%.

2) The cooling systems for all stations were sized for closed-cycle operation at summer conditions. Cost estimates include towers sized to handle 100% of heat rejection duty. To maintain the flexibility to operate in open-cycle mode, when river temperature and meteorological conditions permit, gates were included in the estimates. As discussed in Section 5 below, the incremental increase in capital cost for these open-cycle provisions of the design are a small percentage of overall project cost. As noted above, when this study was originally prepared in 2005, the design considerations were based on General Use thermal standards. Under the General Use thermal water quality standards, the probability of being able to operate in open-cycle mode during parts of the year is greater than under the stricter Proposed UAA Rules. Hence, the design basis of the 2005 study included the capability to switch between open-cycle and closed-cycle cooling operation. Given the incremental increase in capital cost associated with including open-cycle capability in the design is a small percentage of overall estimated costs, for the purposes of updating the study, it was decided to retain this open-cycle capability in the design basis.

3) Estimates of O&M costs, particulate emissions, and cooling tower blowdown discharge are based on continuous closed-cycle operation, for conservatism and because it is not known to what extent open-cycle operation will be compliant with applicable thermal standards.

4) Cost estimates for plume-abated (wet/dry) towers were developed for all stations. Consideration of wet only and wet/convertible to plume-abated was given to Joliet 6, Joliet 7/8 and Will County 3/4.

The following is a comparison of plume-abated (wet/dry) tower characteristics compared to conventional wet towers:

- Wet/dry towers use 7-13% less total makeup water than wet towers
- Extent of drift/level of particulate matter emissions will be the same for wet/dry and wet towers operations
- Icing still occurs with wet/dry towers, but will be less than with wet towers, due to the increased saturation temperature of the air. Moisture will still condense on cold surfaces, however.
- Visible plume will be negligible for wet/dry towers at the design point. A small amount of visible plume occurs at lower temperatures and/or at high relative humidity conditions.
- The wet/dry tower uses approximately 10-25% more electrical power than a wet tower.
- Noise emissions are similar for both types of towers.

5) The cooling tower site arrangement drawings (provided in Exhibit A) are based on the wet/dry tower layouts. SPX/Marley was consulted to determine the cooling tower arrangements that are technically feasible based on the type of cooling tower to be installed. SPX/Marley advised that back-to-back cooling towers are not available for wet/dry cooling tower types due to the need for the dry section to receive air from both sides. Therefore, the design for all of the wet/dry cooling towers consists of a single row of cells. Pure wet towers were not considered as the base design due to all of the previously mentioned reasons, including creation of poor visibility near the stations, icing of roads, and icing of overhead power lines. Cost estimates for both wet-only and wet/convertible to plume-abated were developed, however, and are provided in Section 5.

6) The cooling towers at all of the stations were designed for a summer season wet bulb temperature of 78°F. This is the 1% summer season wet bulb temperature for all of the stations.[1] This is a conservative approach used to avoid derating the units during the summer months when the demand for power is highest.

7) The cooling towers at all of the stations were designed for an 85°F cold water temperature, which is a reasonable choice based on the 1% summer wet bulb temperature in the Chicago area, and the choice of a 7°F approach temperature. This is a conservative approach selected to minimize the potential for unit derating (reduction in generating capacity) on hot, humid days.

[1] Departments of the Air Force (USAF), the Army, and the Navy, "Facility Design and Planning Engineering Weather Data", AFM 88-29, TM 5-785, NAVFAC P-89, Washington D.C., 1978.

8) All of the cooling towers were designed for a minimum achievable drift rate of 0.0005% (*i.e.*, with drift eliminators). This minimizes the water particulate emissions of the towers. Exhibit E contains the results of the particulate calculations. Exhibit F contains the water quality data input used.

9) Under closed-cycle operation, each station was assumed to operate at five cycles of concentration. The phrase "five cycles of concentration" means the cooling water is recirculated until the total dissolved solids (TDS) level reaches a value five times the TDS concentration in the make-up water. Further build-up is limited by cooling tower blowdown. A value of five cycles is most often chosen for design purposes because it minimizes the need for make-up water and limits TDS concentrations to levels which do not create corrosion problems for cooling system materials.

10) All of the towers are priced with fiberglass construction. Fire protection costs have not been incorporated into the cooling tower estimates but could increase the cost of the towers substantially dependent upon the requirements of the agency having jurisdiction and the extent to which they require installation of fire protection equipment.

11) Single speed non-reversing motors were assumed for all of the cooling towers.

12) Chlorination, sulfuric acid addition, and dechlorination equipment were included in the system design and cost estimates for closed-cycle operation at all of the stations.

13) From its professional experience, S&L estimates the annual water treatment chemical cost to be $1,000/MW for a station with closed-cycle cooling towers. This cost is based on the gross load of the station unit(s) in all cases, and is based on Sargent & Lundy's 120 years of power plant design experience.

14) Cooling tower blowdown from the closed-cycle mode of operation was assumed to be by a bleed stream from the cooling tower water supply pumps. No separate cooling tower blowdown pumps were included in the design or cost estimate, though a small (up to 12" diameter) pipe was included. The cooling tower blowdown, evaporation, and makeup water data are contained in Exhibit G.

15) The following methodology was used to estimate the potential impact on turbine MW output (*i.e.*, capacity loss) resulting from operation in a closed cooling configuration:

- The cold water temperatures of the towers corresponding to the 1% wet bulb during each month of the year were used as condenser circulating water input values. These cold water temperatures, which are identical to the cooling tower blowdown temperatures, are based on cooling tower industry (*i.e.*, Cooling Tower Institute) data.
- Condenser backpressures at 70% assumed cleanliness were estimated, and the percent heat rate adjustment was read from the original heat rate adjustment vs. backpressure curves at valves wide open flow.

- The variations in generator output between the design output value and the output during closed loop cooling operation at the maximum wet bulb temperature were calculated ("closed-cycle gain/loss"). Then the variations in generator output between the design output value and the output during open-cycle cooling operation with the Proposed UAA Thermal Standards Period Average temperature as the condenser circulating water inlet temperature were calculated ("open-cycle gain/loss"). The difference between the closed-cycle gain/loss and the open-cycle gain/loss is the MW output gain or loss for each time period during the year. Note that the Period Average values are tabulated on a partial month basis where so specified in the Proposed UAA Thermal Standards, while the closed-cycle 1% wet bulb values derive from the monthly ASHRAE[2] values. A separate partial month wet bulb distribution was not developed for this current study.

16) Isolating the stations' intake and discharge channels from the river typically involves a combination of fixed walls and moveable gates. Where the term "gate" alone is used in this report, the installation may also involve some fixed walls at that location. The actual configurations used in the design are documented in the capital cost estimates for each station that are presented in Exhibit I. It was assumed that the existing circulating water inlet channel would be partially left open to the river in closed-cycle operation so that makeup water to the cycle can be drawn in as needed. No separate makeup pumps or piping were included in the design or cost estimate.

17) No special noise abatement equipment was included in the base cost estimates. SPX/Marley indicates that the predicted noise level is about 90 dBA at 3 meters from the tower. Rough noise abatement options and costs were provided by SPX/Marley, but the predicted noise reduction is not guaranteed without a full noise study. A simple comparison of noise levels (inverse square method) was performed (see Section 4 of this report) by locating approximate distances of nearest residential and industrial/ commercial sites, using satellite photographs and the survey drawing for each site.

18) All electrical power costs are based on a price of electricity of $36.71/MWh, which is based on the weighted average price of peak and off-peak pricing over a five-year period beginning in 2011 as calculated by MWGen.

B. STATION OR UNIT-SPECIFIC ASSUMPTIONS

The design and layout of the cooling tower system must be customized at each station due to differences in plant size and layouts. The unit specific design inputs for cooling tower design provided to SPX/Marley are presented in Exhibit C. Exhibit D contains the detailed balance-of-project design inputs used for each station.

[2] American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), "The Handbook 2005 of Fundamentals", published by ASHRAE, Atlanta, Georgia, 2005.

4. REGULATORY AND PERMITTING ISSUES

The construction and operation of cooling towers at the five MWGen stations will be subject to a number of environmental and local construction permitting requirements. The S&L study included determining the expected permit requirements for the proposed closed-cycle cooling systems, which are presented in the discussion below, but further detailed review is recommended if any of the projects are slated to proceed. Regulatory and permitting standards potentially applicable to a cooling tower installation project include: (1) air permitting for particulate matter emissions; (2) modifications to the facility's National Pollutant Discharge Elimination System (NPDES) permit for changes associated with cooling water intake and wastewater treatment and discharge characteristics; (3) U.S. Army Corps of Engineer permits to allow construction activities within a waterway or activities that impact wetlands; (4) local building permit requirements; and (5) noise emission regulations. Due to the conceptual nature of the design basis included in this study, a cost estimate for preparing and obtaining the necessary permits for construction and operation of the closed-cycle cooling systems for each of the MWGen stations was beyond the scope of this study. Accordingly, costs associated with obtaining permits have not been included in the capital cost estimates presented in this report.

A. AIR PERMITTING

Particulate matter emissions occur from cooling towers as a result of cooling water being entrained in the air stream. Particulate matter in the drift water sent into the air by the tower is primarily composed of the same impurities as in the tower cooling water.[3] The magnitude of the drift loss is influenced by the number and size of droplets produced within the tower, which are a function of tower design, air and water flow patterns, and design of the drift eliminators. The most effective way to reduce drift from cooling towers is by installing drift eliminators. Drift eliminators, included in the design basis for all towers in this study, are designed to remove entrained droplets before the droplets leave the tower.

Particulate emissions from a new cooling tower can trigger the need for New Source Review (NSR) air quality review and permitting. NSR is a federal regulatory program (implemented in Illinois by the Illinois EPA) that applies to major new sources of air pollution and major modifications of existing major sources of air pollution. An existing major source of emissions (such as the Crawford, Fisk, Joliet, and Will County Generating Stations) can become subject to NSR if modifications are made to the existing source, and the modification results in a significant increase in the annual emissions of a regulated NSR pollutant.

Regulated NSR pollutants include total particulate matter (PM), PM with an aerodynamic diameter less than 10 microns (μm) or less (PM_{10}) , and PM with an aerodynamic diameter of 2.5 μm or less ($PM_{2.5}$). With respect to particulate matter emissions, a significant emissions increase is defined as being above 25 tons per year (tpy) PM, 15 tpy PM_{10}, or 10 tpy PM2.5. (See 35 IAC §203.209).

[3] Cooling Tower Drift, it Measurement, Control and Environmental Effect. Cooling Tower Institute Paper No: TP73-01

Emission calculations were prepared for each MWGen cooling tower configuration to quantify potential particulate emissions. Total PM emissions were estimated based on: (1) the circulating water flow rate at full load; (2) projected drift eliminator efficiency; (3) total dissolved solids (TDS) in the circulating water; and (4) the assumption that 100% of the TDS in the drift would be emitted as PM, using the following equation:[4]

$$E_{PM} = Q * \rho_w * (60 \text{ min/hr}) * \%DL * (TDS/10^6)$$

Where:

E_{PM} = PM emission rate (lb/hr)
Q = circulating water flow rate (gpm)
ρ_w = density of water (8.34 lb/gal)
%DL = Drift Loss Efficiency (0.0005%)
TDS = Total Dissolved Solids in the liquid drift (ppmw)

The methodology given in EPA's AP-42 Chapter 13.4 calculates total PM emissions, but does not account for particle size distribution. Therefore, to determine PM10 and PM2.5 emissions, S&L used the methodology described by Reisman and Frisbie to calculate the particle size distribution of solids emitted after evaporation of the liquid drift.[5] Particle size is determined based on representative drift droplet size distribution data, TDS in the drift droplets, and the assumption that the total mass of dissolved solids in the drift condenses into a spherical particle after all the water evaporates. The percentage of drift droplets containing particles small enough to produce PM10 or PM2.5 emissions can be calculated using the following equation:

$$D_p = D_d \left[(TDS)(\rho_w / \rho_{TDS})\right]^{1/3}$$

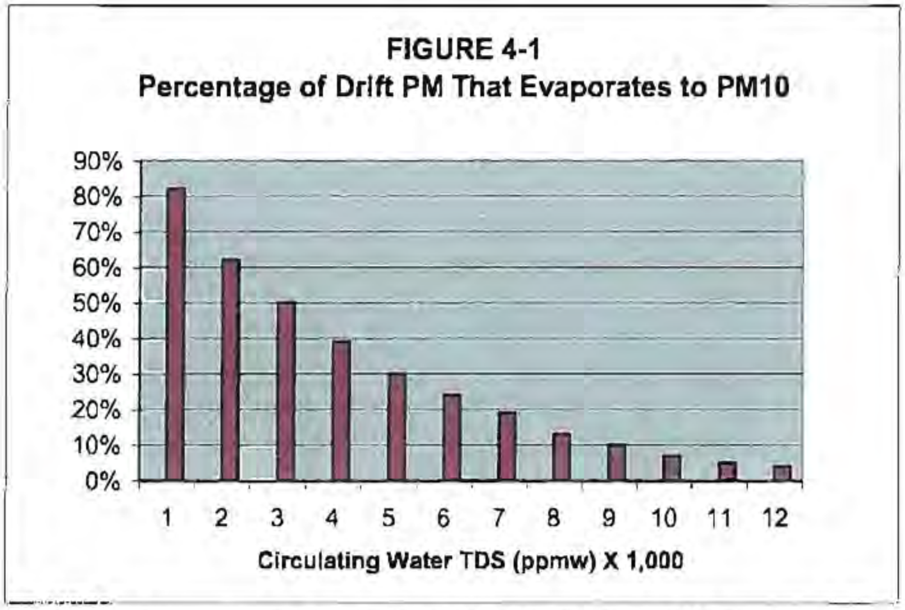
Where:

D_p = diameter of the solid particle (μm)
D_d = diameter of the drift droplet (μm)
ρ_w = density of water (1.0 g/cm^3)
ρ_{TDS} = density of the solid particles (assumed to be equal to sodium chloride, 2.2 g/cm^3)
TDS = Total Dissolved Solids in the liquid drift (ppmw)

Using this approach, drift from cooling towers with higher TDS values tend to form larger solid particles as the liquid drift evaporates. In other words, PM10-to-PM and PM2.5-to-PM ratios are inversely related to circulating water TDS, as shown in Figure 4-1.

[4] The methodology described herein for calculating cooling tower particulate emissions is taken from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42 Fifth Edition, Volume I: Stationary Point and Area Sources, Chapter 13.4 Wet Cooling Towers, available at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s04.pdf.

[5] Reisman, J., and Frisbie, G., *Calculating Realistic PM10 Emissions from Cooling Towers*, Greystone Environmental Consultants, Inc., Sacramento, CA. See also, Hennon, D., *Cooling Tower Emissions Quantification Using the Cooling Technology Institute Test Code ATC-140*, Cooling Tower Institute, Paper No. TP03-08.



Taken from: Reisman, J., and Frisbie, G., "Calculating Realistic PM10 Emissions from Cooling Towers," Greystone Environmental Consultants, Inc., Sacramento, CA.

Particle size distribution was calculated for each MWGen generating station using the methodology described above and the circulating water TDS values summarized in Table 4-1. Cooling water TDS values were obtained from water quality data collected by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC).[6] Results of the particle size distribution calculations for three different maximum TDS concentrations (*i.e.*, 3,680 ppmw, 4,220 ppmw and 2,935 ppmw) are shown in Tables 4-2 through 4-4, respectively.

[6] Cooling water TDS values were obtained from the 2007 Annual Summary Report Water Quality within the Waterways System of the Metropolitan Water Reclamation District of Greater Chicago, September 2008.

Table 4-1
Generating Station TDS Values

CASE	Makeup Water TDS	Cycles of Concentration	Maximum TDS
	(ppm)	#	(ppm)
Fisk 19	736	5	3,680
Crawford 7&8	736	5	3,680
Will County 3&4	844	5	4,220
Joliet 6	587	5	2,935
Joliet 7&8	587	5	2,935

Table 4-2
Solid Particle Size Distribution (TDS = 3,680 ppmw)

TDS	3,680					
Liquid Droplet Diameter	**Liquid Droplet Volume**	**EPRI Droplet Size Distribution**	**Liquid Droplet Mass**	**Solid Particle Mass**	**Solid Particle Volume**	**Particle Size Diameter**
um	um^3	% smaller	ug	ug	um^3	um
10	524	0.000	5.24E-04	1.93E-06	0.9	1.187
20	4,189	0.196	4.19E-03	1.54E-05	7.0	2.374
30	14,137	0.226	1.41E-02	5.20E-05	23.7	3.561
40	33,510	0.514	3.35E-02	1.23E-04	56.1	4.748
50	65,450	1.816	6.55E-02	2.41E-04	109.5	5.935
60	113,097	5.702	1.13E-01	4.16E-04	189.2	7.122
70	179,594	21.348	1.80E-01	6.61E-04	300.4	8.309
90	381,704	49.812	3.82E-01	1.40E-03	638.5	10.684
110	696,910	70.509	6.97E-01	2.56E-03	1,165.7	13.058
130	1,150,347	82.023	1.15E+00	4.23E-03	1,924.2	15.432
150	1,767,146	88.012	1.77E+00	6.50E-03	2,956.0	17.806
180	3,053,628	91.032	3.05E+00	1.12E-02	5,107.9	21.367
210	4,849,048	92.468	4.85E+00	1.78E-02	8,111.1	24.928
240	7,238,229	94.091	7.24E+00	2.66E-02	12,107.6	28.490
270	10,305,995	94.689	1.03E+01	3.79E-02	17,239.1	32.051
300	14,137,167	96.288	1.41E+01	5.20E-02	23,647.6	35.612
350	22,449,298	97.011	2.24E+01	8.26E-02	37,551.6	41.547
400	33,510,322	98.340	3.35E+01	1.23E-01	56,053.6	47.483
450	47,712,938	99.071	4.77E+01	1.76E-01	79,810.7	53.418
500	65,449,847	99.071	6.54E+01	2.41E-01	109,479.7	59.353
600	113,097,336	100.0	1.13E+02	4.16E-01	189,181.0	71.224

Table 4-3
Solid Particle Size Distribution (TDS = 4,220 ppmw)

TDS	4,220					
Liquid Droplet Diameter	**Liquid Droplet Volume**	**EPRI Droplet Size Distribution**	**Liquid Droplet Mass**	**Solid Particle Mass**	**Solid Particle Volume**	**Particle Size Diameter**
um	**um^3**	**% smaller**	**ug**	**ug**	**um^3**	**um**
10	524	0.000	5.24E-04	2.21E-06	1.0	1.243
20	4,189	0.196	4.19E-03	1.77E-05	8.0	2.485
30	14,137	0.226	1.41E-02	5.97E-05	27.1	3.728
40	33,510	0.514	3.35E-02	1.41E-04	64.3	4.970
50	65,450	1.816	6.55E-02	2.76E-04	125.6	6.213
60	113,097	5.702	1.13E-01	4.77E-04	216.9	7.455
70	179,594	21.348	1.80E-01	7.58E-04	344.5	8.698
90	381,704	49.812	3.82E-01	1.61E-03	732.2	11.183
110	696,910	70.509	6.97E-01	2.94E-03	1,336.8	13.668
130	1,150,347	82.023	1.15E+00	4.85E-03	2,206.6	16.153
150	1,767,146	88.012	1.77E+00	7.46E-03	3,389.7	18.638
180	3,053,628	91.032	3.05E+00	1.29E-02	5,857.4	22.365
210	4,849,048	92.468	4.85E+00	2.05E-02	9,301.4	26.093
240	7,238,229	94.091	7.24E+00	3.05E-02	13,884.2	29.820
270	10,305,995	94.689	1.03E+01	4.35E-02	19,768.8	33.548
300	14,137,167	96.288	1.41E+01	5.97E-02	27,117.7	37.275
350	22,449,298	97.011	2.24E+01	9.47E-02	43,061.8	43.488
400	33,510,322	98.340	3.35E+01	1.41E-01	64,278.9	49.700
450	47,712,938	99.071	4.77E+01	2.01E-01	91,522.1	55.913
500	65,449,847	99.071	6.54E+01	2.76E-01	125,544.7	62.125
600	113,097,336	100.0	1.13E+02	4.77E-01	216,941.3	74.550

Table 4-4
Solid Particle Size Distribution (TDS = 2,935 ppmw)

TDS	2,935					
Liquid Droplet Diameter	**Liquid Droplet Volume**	**EPRI Droplet Size Distribution**	**Liquid Droplet Mass**	**Solid Particle Mass**	**Solid Particle Volume**	**Particle Size Diameter**
um	**um^3**	**% smaller**	**ug**	**ug**	**um^3**	**um**
10	524	0.000	5.24E-04	1.54E-06	0.7	1.101
20	4,189	0.196	4.19E-03	1.23E-05	5.6	2.202
30	14,137	0.226	1.41E-02	4.15E-05	18.9	3.303
40	33,510	0.514	3.35E-02	9.84E-05	44.7	4.403
50	65,450	1.816	6.55E-02	1.92E-04	87.3	5.504
60	113,097	5.702	1.13E-01	3.32E-04	150.9	6.605
70	179,594	21.348	1.80E-01	5.27E-04	239.6	7.706
90	381,704	49.812	3.82E-01	1.12E-03	509.2	9.908
110	696,910	70.509	6.97E-01	2.05E-03	929.7	12.109
130	1,150,347	82.023	1.15E+00	3.38E-03	1,534.7	14.311
150	1,767,146	88.012	1.77E+00	5.19E-03	2,357.5	16.513
180	3,053,628	91.032	3.05E+00	8.96E-03	4,073.8	19.815
210	4,849,048	92.468	4.85E+00	1.42E-02	6,469.1	23.118
240	7,238,229	94.091	7.24E+00	2.12E-02	9,656.5	26.420
270	10,305,995	94.689	1.03E+01	3.02E-02	13,749.1	29.723
300	14,137,167	96.288	1.41E+01	4.15E-02	18,860.3	33.026
350	22,449,298	97.011	2.24E+01	6.59E-02	29,949.4	38.530
400	33,510,322	98.340	3.35E+01	9.84E-02	44,705.8	44.034
450	47,712,938	99.071	4.77E+01	1.40E-01	63,653.4	49.538
500	65,449,847	99.071	6.54E+01	1.92E-01	87,316.1	55.043
600	113,097,336	100.0	1.13E+02	3.32E-01	150,882.1	66.051

Using straight-line interpolation for solid particle sizes of 2.5 and 10 µm diameter, the PM_{10}-to-PM and $PM_{2.5}$-to-PM ratios for each station are summarized in Table 4-5. Potential PM_{10} and $PM_{2.5}$ emissions for each cooling tower configuration are summarized in Table 4-6.

Table 4-5
PM_{10}-to-PM and $PM_{2.5}$-to-PM Ratios for Each Station

CASE	Maximum TDS	% of PM that Evaporates to PM10	% of PM that Evaporates to PM2.5
	(ppm)	(%)	(%)
Fisk 19	3,680	41.6	0.20
Crawford 7&8	3,680	41.6	0.20
Will County 3&4	4,220	36.3	0.20
Joliet 6	2,935	50.7	0.20
Joliet 7&8	2,935	50.7	0.20

Table 4-6
Potential PM/$PM_{2.5}$ Emission Calculation Summary

Station	Total Number of Cells	Circulating Water Flow per Cell	Calculated Total Drift Loss	Estimated Maximum TDS	Calculated Potential Total PM Emissions	Calculated Potential PM10 Emissions	Calculated Potential PM2.5 Emissions
	(#)	(gpm)	(gpm)	(ppm)	(tpy)	(tpy)	(tpy)
Fisk 19	16	13,125	1.0	3,680	8.5	3.53	0.017
Crawford 7&8	30	12,747	1.9	3,680	15.4	6.40	0.031
W/C 3&4	40	15,000	3.0	4,220	27.7	10.0	0.055
Joliet 6	18	14,500	1.3	2,935	8.5	4.29	0.017
Joliet 7&8	64	14,375	4.6	2,935	29.7	15.06	0.059

The following should be noted regarding interpretation of this calculation:

- Circulating water flows are the original station design values.
- Total Dissolved Solids (TDS) concentrations in the cooling water were obtained from water quality data collected by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC): 2007 Annual Summary Report, "Water Quality Within the Waterways System of the Metropolitan Water Reclamation District of Greater Chicago", September 2008. The 2007 data are given in Exhibit F. The 2009 Annual Summary Report No. 10-36, July 2010, was reviewed and the 2007 report data were found to be representative. Estimated maximum TDS values in Table 4-1 were based on the 90^{th} percentile TDS values of water quality given in Exhibit F and on the assumption of 5 cycles of concentration. (See discussion in Section 3.A.9, above.)

- The calculations above are based on 100% capacity factor and operation in closed-cycle 100% of the time, which are both conservative assumptions.
- The NSR threshold for overall PM emissions is 25 tpy. Calculated total PM emissions from the Will County and Joliet 7&8 cooling towers exceed these thresholds, triggering NSR review for the control of PM emissions. Potential NSR considerations are discussed in more detail below.
- The NSR threshold for PM_{10} emissions is 15 tpy. Calculated PM_{10} emissions from cooling towers at Joliet 7&8 are slightly above this threshold, and could trigger NSR review for the control of PM_{10}. PM_{10} emissions from cooling towers at the other MWGen stations fall below this threshold and should not trigger NSR permitting. Annual PM_{10} emissions were calculated using the PM_{10}-to-PM ratios calculated in Tables 4-2 thru 4-4, and the conservative assumption regarding capacity factors. The methodology used to calculate the PM_{10}-to-PM ratio has been accepted by Illinois EPA in the past for permitting of new units, but acceptance is not guaranteed for all future cases. If this calculated ratio method is not accepted and a higher PM_{10}:PM ratio is required. Joliet 7&8, Will County 3&4 and Crawford 7&8 could be at some risk of exceeding the PM_{10} NSR threshold, triggering NSR review and permitting.
- The NSR threshold for $PM_{2.5}$ emissions is 10 tpy. Calculated $PM_{2.5}$ emissions from cooling towers at all MWGen stations fall below this threshold and should not trigger NSR permitting. Annual $PM_{2.5}$ emissions were calculated using the $PM_{2.5}$-to-PM ratios calculated in Tables 4-2 thru 4-4, and the conservative assumption regarding capacity factors. The methodology used to calculate the $PM_{2.5}$-to-PM ratio results in very low $PM_{2.5}$ emissions because of the diameter of the drift droplets and the cooling water TDS. Using the methodology described above, a large majority of PM emitted from the cooling towers will have an aerodynamic diameter greater than 2.5 μm. If this methodology is not accepted by Illinois EPA, $PM_{2.5}$ emissions would need to be calculated using an alternative methodology, and, depending on the $PM_{2.5}$-to-PM ratio used, could result in higher annual $PM_{2.5}$ emissions. However, a significant change in the ratio would be needed to result in $PM_{2.5}$ emissions above the NSR significance level.

More detail on potential NSR considerations is provided below to give an idea of the upper bounds of this risk for Joliet and Will County Stations.

Project specific NSR permitting requirements depend upon the location of the emission source. Sources located in an area meeting the National Ambient Air Quality Standards (NAAQS) are subject to the Prevention of Significant Deterioration (PSD) regulations, while sources located in areas that do not meet the NAAQS are subject to the nonattainment area (NAA) regulations in 35 IAC Part 203. A summary of the current PM NAAQS is provided in Table 4-7.

Table 4-7
Current Particulate Matter National Ambient Air Quality Standards

Pollutant	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Time
PM_{10}	150 $\mu g/m^3$	24-hour	Same as Primary	
$PM_{2.5}$	15.0 $\mu g/m^3$	Annual (Arithmetic Average)	Same as Primary	
	35 $\mu g/m^3$	24-hour	Same as Primary	

All areas in Illinois are currently designated as attainment/unclassifiable with respect to the PM_{10} NAAQS. Thus, cooling tower projects that result in a significant net increase in annual emissions of PM or PM_{10} would be subject to the PSD preconstruction permitting and review regulations. Among other things, the PSD regulations require air pollutants to be controlled using best available control technology (BACT).

BACT is defined as an emission limitation based on the maximum degree of reduction which, on a case-by-case basis, is determined to be achievable taking into account energy, environmental, and economic impacts and other costs. U.S. EPA maintains a database of recently issued NSR permits, including a description of the control technology required to meet the LAER or BACT (the "RBLC Database"). The RBLC Database lists several BACT determinations for industrial process cooling towers (process code 99.009). All recently permitted industrial process cooling towers have been permitted with "drift eliminators" as BACT for PM_{10} control. For example an NSR permit recently issued to the City Utilities of Springfield – Southwest Power Station in Missouri identified "high efficiency drift eliminator – 0.001% drift" as BACT to control particulate emissions from the facility's cooling tower.

Based on a review of BACT determinations listed in the RBLC Database, high efficiency drift eliminators should represent BACT for large industrial process cooling towers, and would likely represent LAER. Based on information from Marley, drift eliminators can be designed to reduce drift to 0.0005% of the circulating water flow. There are no other technically feasible drift control technologies available for wet cooling towers. Emission calculations in Table 4-6 are based on a drift eliminator efficiency of 0.0005%, and all of the cooling tower capital costs in this study include drift eliminators.

Crawford, Fisk, Will County, and Joliet generating stations are located in Cook and Will Counties, respectively. U.S.EPA has designated both Cook and Will Counties as nonattainment areas with respect to annual $PM_{2.5}$ NAAQS. Because all of the generating stations are located within areas designated as nonattainment for $PM_{2.5}$, the cooling tower projects will be subject to the NAA permitting regulations in 35 IAC Part 203 if their emissions exceed the NSR significant emissions threshold. Under the Part 203 air regulations, a construction permit is required prior to actual construction of a major new source or major modification (35 IAC 203.203). In addition, the owner or operator of a major modification must demonstrate that the control equipment and process measures applied to the modification will produce the lowest achievable emission rate (LAER). This requirement applies to each emissions unit at which a net increase in emissions of the pollutant will occur as a result of the modification (e.g., the cooling towers). LAER is defined as the more stringent rate of emissions based on the following:

a. The most stringent emission limitation which is contained in the implementation plan of any state for such class or category of stationary source, unless it is demonstrated that such limitation is not achievable; or

b. The most stringent emission limitation which is achieved in practice by such a class or category of stationary sources.

As discussed above, EPA's RBLC Database lists several BACT determinations for industrial process cooling towers (process code 99.009), but does not include any recent projects that required LAER. Based on a review of the RBLC Database, and a review of cooling tower particulate control technologies, high efficiency drift eliminators should represent BACT for large industrial process cooling towers, and would likely represent LAER.

High efficiency drift eliminators would likely represent LAER for large industrial process cooling towers. However, because LAER does not include an evaluation of economic impacts, and because the Illinois NAA regulations require an evaluation of alternative environmental control techniques, it is possible that Illinois EPA would require MWGen to evaluate the feasibility of dry cooling tower configurations (*e.g.*, air cooled condensers) to minimize particulate matter emissions in the $PM_{2.5}$ nonattainment areas. As noted previously, dry cooling towers were not investigated in the study since this technology is generally more expensive and requires significantly more land than the equivalent wet cooling tower. If dry cooling towers were required to be installed in order to meet LAER requirements, the estimated costs of compliance presented in this study would significantly increase, and overall feasibility issues would need to be considered.

In addition to the requirement to achieve LAER, 35 IAC Section 203.302 requires the owner or operator of a new major modification to provide emission offsets equal to or greater than the net increase in emissions from the modification. Offsets must be sufficient to allow Illinois EPA to determine that the modification will not interfere with reasonable further progress toward meeting the applicable NAAQS. Owners/operators of a new major modification are also required to demonstrate that benefits of the modification significantly outweigh the environmental and social costs based upon an analysis of alternative sites, sizes, production processes, and environmental control techniques for such proposed source. (35 IAC Section 203.306).

Because LAER may require an evaluation of dry cooling, and because Illinois NAA regulations require emissions off-sets, MWGen may need to investigate options to reduce further particulate emissions to provide internal emission offsets and "net-out" of NSR review. NSR significant thresholds are based on the "net" emissions increase at an existing source. Net emissions increase is defined as the amount by which the sum of any increase in actual emissions from a particular modification and any other increases or decreases in actual emissions at the source that are contemporaneous with the particular change and are otherwise creditable, exceeds zero.

(See, 35 IAC 203.208: Net Emission Determination). In other words, if a generating station can reduce existing actual particulate matter emissions by a quantity equal to or greater than the increase from the cooling tower project, the station should net-out of NSR review and eliminate the need for a LAER evaluation and emission offsets.

B. NPDES PERMITTING

Modifications to the cooling water systems that alter the characteristics of the cooling water discharge or the location of the cooling water discharge are subject to NPDES permitting requirements. NPDES permitting procedures require any person proposing modifications to an existing discharge to submit an application to the appropriate agency at least 180 days before the date on which the discharge is to begin.

1. Wastewater Discharges

All facilities that discharge pollutants from any point source into waters of the United States are required to obtain a NPDES permit. The term "pollutant" is defined very broadly by the NPDES regulations and includes any type of industrial waste discharged into water, including cooling tower blowdown. Depending on the design of the cooling tower, including any water recycling/reuse systems, operating a cooling tower could result in a new wastewater stream requiring treatment and discharge. MWGen would be required to modify its existing NPDES permits to allow treatment and discharge of any wastewater streams associated with the cooling towers investigated in this study.

The cooling tower blowdown flows to the river in closed-cycle operation were calculated using the evaporation flow rates provided by Marley and the assumed five cycles of concentration. The temperature of cooling tower blowdown was assumed to be the same as the cold water temperature of the tower. The 1% wet bulb temperature at O'Hare, according to the ASHRAE 2005 handbook, was used as the wet bulb temperature during each month of the year.

The maximum temperatures of the cooling tower blowdown from each station were calculated month-by-month, and the results were compared with the Proposed UAA Thermal Standards. The results are presented in Exhibit H. Average monthly blowdown temperatures are much more difficult to predict, as those estimates require a detailed study of the meteorological data as a function of time of day for each day of the month. Such a detailed evaluation was beyond the scope of this study.

In general, the maximum monthly end-of-pipe cooling tower blowdown temperatures exceed the corresponding Proposed UAA Thermal Standards' monthly allowable discharge temperature. However, in closed-cycle operation, the cooling tower blowdown would be routed to the existing station discharge canal at a point just beyond the barrier walls/gates which would isolate the circulating water systems from the river. (Refer to Exhibits A and B.) Some mixing will occur in the discharge canal, and, as mentioned previously, the cooling tower blowdown flow rates are negligible compared to the overall volumetric flow of the waterways, therefore any temperature rise in the receiving water would be expected to be negligible.

If compliance is to be determined based on end-of-pipe temperature and the Proposed UAA Thermal Standards would be exceeded at times, the cooling tower blowdown can be routed through a chiller package to cool it prior to discharge. The installed cost of a chiller package is estimated to be about $3,000,000 for Joliet 7/8, the station which has the highest cooling tower blowdown flow rate and therefore, the highest likelihood and frequency of exceeding the Proposed UAA Thermal Standards if a mixing zone is not allowed for the cooling tower blowdown discharge. The costs of chiller packages for the other stations are expected to be proportionally lower.

2. Wastewater Treatment Facility Construction Permits

In Illinois, a water pollution control construction permit is required for industrial activities with the potential to cause water pollution. This construction permit is required prior to constructing or modifying any wastewater treatment facility as specified in the Illinois water pollution regulations.

A construction permit is required prior to commencing construction of a regulated wastewater management system. The treatment of cooling tower blowdown prior to discharge from any MWGen generating station would require a construction permit. The construction permit application can be submitted concurrently with the NPDES permit modification, if required. Cost estimates for obtaining permits were not included in this analysis.

C. U.S. ARMY CORPS OF ENGINEERS PERMITTING

Section 404 of the CWA requires a permit before discharging or placing any dredged or fill material into navigable waters of the United States. The CWA delegates dredged or fill material discharge permit approval authority to the U.S. Army Corps of Engineers. The definition of "navigable water" for a section 404 permit is very broad, and includes waters that are, or could be, used for interstate commerce, as well as lakes, impoundments, and wetlands. The subject CSSC and UDIP surface waters meet the definition of a "navigable water" under CWA Section 404.

Activities, including modifications to the cooling water intake/discharge structures and construction activities impacting existing wetlands, will require a permit from the U.S. Army Corps of Engineers. In general, if a wetland is located on a site proposed for development, the developer must apply for a Corp of Engineers permit to place fill into the wetland. For projects that impact over 0.25 acre of wetlands, the applicant will be required to provide compensatory wetland mitigation. It is important to note that the Corp of Engineers will require the applicant to avoid and/or minimize wetland destruction before compensatory wetland mitigation will be considered.[7]

[7] None of the cooling tower arrangements studies here for the MWGen generating stations are believed to impact existing wetland areas.

The construction of the cooling towers at each of the MWGen stations may require the issuance of a CWA section 404 permit due to excavation and fill activities adjacent to or in the waterway necessary to complete their construction. In order to expedite the permitting and review process, the Corps of Engineers has developed a limited number of nationwide permits (NWPs) for activities the Corps has identified as being substantially similar in nature and causing only minimal environmental impacts. Construction activities within a waterway that are not covered by a NWP require the Corps to issue an individual permit for the activity. Issuance of an individual construction permit may also trigger the need for a formal Environmental Impact Statement (EIS).

The Corps of Engineers cannot issue a permit for any activity that may result in a discharge into navigable waters unless the State of Illinois, through the Illinois EPA, first provides a CWA Section 401 Certification. The Section 401 Certification includes a statement that the State has reasonable assurance that the activity will be conducted in a manner which will not violate applicable water quality standards. For purposes of this study, it was assumed that both the CWA section 401 Certification and a section 404 permit would be issued for the proposed cooling towers construction projects necessary to attain compliance with the Proposed UAA Thermal Standards. Cost estimates for obtaining permits were not included in this analysis.

D. NOISE REGULATIONS

Generally speaking, the falling water within a cooling tower results in locally high noise levels. To meet county noise regulations, the sound levels must be reduced approximately to that of a normal conversation at nearby site boundaries. Under current regulations, only Joliet 7&8 appears to have the potential to violate noise limits.

Table 4-8 below shows approximate costs and abatement reduction options for Joliet Units 7 and 8 that were proposed by SPX/Marley. The most expensive option, on the order of $12.5 million, would most likely be necessary to achieve the required sound level reduction.

Table 4-8
Joliet 7&8 Noise Abatement Cost Options

Attenuation Method	dBA Reduction	Approximate Cost For 80 Cells
SA	-2.4	$3,000,000
GBW	-3.7	$4,450,000
SA + GBW	-4.8	$7,450,000
FDBW	-0.7	$5,110,000
SA + FDBW	-3.6	$8,110,000
GBW+FDBW	-5.4	$9,560,000
SA+GBW+FDBW	-7.1	$12,560,000
SA = Splash Attenuation		
GBW = Grade Barrier Wall		
FDBW = Fan Deck Barrier Wall		

Splash attenuation (SA) consists of installing a thin layer of film at the bottom of the air inlet to the tower to help break up the noise generated by the falling water.

A grade barrier wall (GBW) is a wall installed at the ground elevation along the side of the tower which is more noise-sensitive to further attenuate the noise of falling water. It is as high as the tower air inlet, and is three air inlet heights away from the tower structure.

A fan deck barrier wall (FDBW) is a wall installed along the tower fan deck along the more noise-sensitive side to screen the noise from the fans, motors and gearboxes. The barrier wall extends to a height about one foot above the tops of the fan stacks.

5. STUDY RESULTS

There are three primary elements of cost associated with conversion of an existing electrical generating station from open-cycle operation to closed-cycle operation. These are:

- The engineering, material and equipment purchase, and construction of modifications to the plant's circulating water system, including
  - Cooling towers,
  - Pumps and piping,
  - Electrical and control equipment,
  - Barrier walls and/or gates (to isolate the open-cycle intake and discharge).
- Operating and maintenance costs, including
  - Electricity to run the new pumps and cooling tower fans,
  - Costs of chemicals needed to control water quality in closed-cycle operation, and
  - Mechanical and electrical maintenance of the new equipment.
- Loss of plant generating capacity. As discussed in Section 2, the circulating water inlet temperature to the condenser is higher in closed-cycle mode than in open-cycle mode, because it is not possible to reduce (with cooling towers) the cold-water temperature of the circulating water system to the temperature of the body of water previously used for open-cycle cooling. This higher condenser inlet temperature reduces turbine-generator efficiency and results in a loss of plant generating capacity, and a corresponding loss of revenue from electricity sales.

All three elements of the costs of closed-cycle conversion and operation are discussed individually for each station in the paragraphs below. The methodologies that were used to develop the costs in this section were discussed in Section 3 above. All O&M and lost capacity costs are based on a 75 percent capacity factor.

A. FISK STATION TECHNOLOGY OPTIONS AND COST ESTIMATE RESULTS

A1. FISK COOLING TOWER ARRANGEMENT

Exhibit A1 shows the arrangement of the cooling tower proposed for Fisk. The "tower" actually consists of two physically separate sections – two groups of cells – as there is not enough room at the station property for one long tower section. Installation of the northern tower would require the demolition of existing old Switch House No. 1 to make room for the cooling tower. The cost estimate includes this demolition and replacement of active electrical equipment in this switch house in the electrical costs. The demolition costs do not include asbestos removal or lead paint abatement which may be necessary given the age of the Switch House.

The northern tower is not ideally oriented to the prevailing winds and may be subject to increased recirculation which would lower the cooling ability of the towers, leading to increased risk of violating the thermal discharge limits, as well as requiring derates to the unit. The adjacent building to the east may interfere with air flow into that side of the tower which could also decrease tower cooling ability. A ComEd switchyard is located immediately to the west of the tower and would be subject to icing risk, although it is generally upwind of the tower. Wet/dry (plume-abated) cooling towers reduce the potential for icing downwind of the tower but do not eliminate it. Any such buildup of ice would lead to extra weight loading the live power lines, potentially resulting in line collapse. The consequences of this would be power outages and the risk of injury to persons in the immediate area. The southern tower section is more suitably oriented but would require demolition of the existing metal cleaning tank and demolition/ replacement of the plant makeup water treatment facility. The existing boiler building to the north of this tower may interfere with air flow into that side of the tower, adversely impacting tower performance.

Exhibit B1 shows the closed loop cooling tower flow diagram for the Fisk Station. A gate would be installed in the existing discharge flume in order to allow for the option of switching between open and closed-cycle cooling modes. Under closed-cycle operation, this gate would be closed and two 50% cooling tower supply pumps would pump the water from the flume upstream of the gate to the cooling towers. The cooled water would be pumped by four 25% cooling tower discharge pumps (two per tower) through above ground steel-lined concrete piping to the existing circulating water (CW) intake, and discharged there between the existing trash rakes and traveling screens to re-enter the existing CW pumps and condenser.

A2. FISK COOLING TOWER CAPITAL COST ESTIMATES

The capital costs (including the quoted pricing from Marley) for the wet/dry tower are shown in Exhibit I1. Below in Table 5-1, the cost for the 100% closed loop tower is broken into the key components. For the wet/dry tower option, the total estimated capital cost is approximately $137 million, which translates to a normalized capital cost of $394 per kilowatt of generating capacity. This value is derived by dividing the total installed cost of closed-cycle conversion in dollars by the plant's gross electrical capacity in kilowatts. Normalizing capital costs on a "per kW" basis is common practice in the power industry, similar to comparing costs on a "per square foot" basis in the construction industry.

Table 5-1
Fisk Capital Costs

Unit	Marley Wet/Dry CT Cost ($)	BOP Equipment and Material Cost ($)	Installation Cost ($)	Indirect Costs ($)	Contingency ($)	Total Cost ($)	Total Cost ($/kW)
Fisk 19	$13,300,000	$23,600,000	$60,500,000	$18,500,000	$21,400,000	$137,100,000	$394

A3. FISK COOLING TOWER O&M COST ESTIMATES

The operation and maintenance cost for a wet/dry (plume-abated) cooling tower at Fisk includes cooling tower fan and pump power (46,831 MWh at $36.71/MWh), tower maintenance costs such as gear oil replacement, and chemical costs for chlorination and anti-scaling additives. The total annual O&M cost is approximately $2,127,000. A detailed breakdown of these O&M costs is shown in Exhibit J. The breakdown of the costs is shown in Table 5-2.

Table 5-2
Fisk O&M Costs

Unit	Annual CT Fan Power Cost ($)	Annual Pump Power Cost ($)	Annual Maintenance Cost ($)	Annual Chemical Cost ($)	Total Annual O&M Cost ($)
Fisk 19	$781,000	$938,000	$60,000	$348,000	$2,127,000

A4. FISK DERATING IMPACTS WITH CLOSED-CYCLE COOLING TOWER

Table 5-3 below summarizes the month-by-month loss of plant capacity in closed-cycle operation compared to open-cycle operation weather and water temperature conditions.

Table 5-3
Fisk 19 Megawatt Loss Due to Closed v. Open-Cycle Operation

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
January	-1.37	0.26	-1.63
February	-1.75	0.35	-2.11
March 1-15	-3.70	-0.15	-3.55
March 16-31	-3.70	-0.15	-3.55
April 1-15	-4.98	-0.75	-4.23
April 16-30	-4.98	-1.00	-3.98
May 1-15	-7.18	-2.68	-4.50
May 16-31	-7.18	-3.34	-3.84
June 1-15	-8.75	-4.29	-4.46
June 16-30	-8.75	-10.56	1.81
July 1-15	-10.10	-10.56	0.46
July 16-31	-10.10	-10.56	0.46
August 1-15	-9.78	-10.56	0.78
August 16-31	-9.78	-10.56	0.78
Sep. 1-15	-8.02	-10.56	2.54
Sep. 16-30	-8.02	-5.39	-2.64
October 1-15	-5.18	-3.94	-1.24
Oct. 16-31	-5.18	-2.80	-2.38

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
November	-3.70	-1.90	-1.80
December	-2.77	-0.59	-2.18
		Annual Average	**-1.79**

Nominal plant output: 348 MW gross
Annual-average capacity loss: 1.79 MW
Annual revenue loss: $432,000 (75% capacity, $36.71/MWh)

B. CRAWFORD STATION TECHNOLOGY OPTIONS AND COST ESTIMATE RESULTS

B1. CRAWFORD COOLING TOWER ARRANGEMENT

Exhibit A2 shows the layout for the two Crawford cooling tower sections. A ComEd switchyard is located to the east of the southern tower, with potential icing concerns. 138 kV transmission line crosses the tower location, and would need to be relocated, and a 345 kV line would need to be raised and more insulators added. Costs for relocation and insulation of ComEd transmission lines are included in the estimate, but because the lines are not owned by MWGen, it is not known whether permission will be granted to relocate these lines. If permission to relocate the ComEd transmission lines is not granted, an alternate location may not be available or feasible. The northern tower is not ideally oriented to the prevailing winds and may be subject to increased recirculation. The northern tower location requires routing of 10 ft diameter circulating water lines across the site.

See Exhibit B2 for the closed loop cycle diagram at Crawford. A wall with a gate would be constructed across the existing CW discharge channel. In closed-cycle operation, this gate would be closed and four 25% cooling tower supply pumps would pump the water from the discharge channel upstream of the wall to the cooling towers. The cooled water would be pumped by two 25% cooling tower discharge pumps from the northern tower and would flow by gravity from the southern tower to the existing CW intake channel, and would be discharged there to re-enter the existing crib house and condenser.

B2. CRAWFORD COOLING TOWER CAPITAL COST ESTIMATES

The capital costs (including the quoted pricing from Marley) for the wet/dry towers are shown in Exhibit I2. Below in Table 5-4, the cost for the 100% closed loop tower is broken into the key components. For the wet/dry tower option, the total estimated capital cost is approximately $165 million. This translates to a normalized capital cost of about $282 per kilowatt of generating capacity.

Table 5-4
Crawford Capital Costs

Unit	Marley Wet/Dry CT Cost w/Delivery ($)	BOP Equipment Material Cost ($)	Labor ($)	Indirect Costs ($)	Contingency ($)	Total Cost ($)	Total Cost ($/ kW)
Crawford 7&8	$24,900,000	$28,400,000	$61,300,000	$24,800,000	$25,800,000	$165,200,000	$282

B3. CRAWFORD COOLING TOWER O&M COST ESTIMATES

The operation and maintenance cost for the Crawford plume-abated (wet/dry) cooling tower consists of cooling tower fan and pump power (88,872 MWh at $36.71/MWh), tower maintenance costs such as gear oil replacement, and chemical costs for chlorination and anti-scaling additives. The total annual O&M cost is approximately $3,960,000. A detailed breakdown of these O&M costs is shown in Exhibit J. The breakdown of the costs is shown in Table 5-5.

Table 5-5
Crawford O&M Costs

Unit	Annual CT Fan Power Cost ($)	Annual Pump Power Cost ($)	Annual Maintenance Cost ($)	Annual Chemical Cost ($)	Total Annual O&M Cost ($)
Crawford 7&8	$1,460,000	$1,800,000	$112,500	$585,000	$3,957,500

B4. CRAWFORD DERATING IMPACTS WITH CLOSED-CYCLE COOLING TOWER

Tables 5-6 and 5-7 below summarize the month-by-month loss of plant capacity in closed-cycle operation for Crawford 7 and Crawford 8, respectively, compared to open-cycle operation weather and water temperature conditions.

Table 5-6
Crawford 7 Megawatt Loss Due to Closed v. Open-Cycle Operation

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
January	-1.33	-0.24	-1.10
February	-1.60	-0 18	-1.43
March 1-15	-3.09	-0.51	-2.58
March 16-31	-3.09	-0.51	-2.58
April 1-15	-3.92	-0.92	-3.00
April 16-30	-3.92	-1.09	-2.83
May 1-15	-5.54	-2.28	-3.26
May 16-31	-5.54	-2.75	-2.78
June 1-15	-6.71	-3.45	-3.26
June 16-30	-6.71	-8.11	1.40
July 1-15	-7.81	-8.11	0.30
July 16-31	-7.81	-8.11	0.30
August 1-15	-7.52	-8.11	0.58
August 16-31	-7.52	-8.11	0.58
Sep. 1-15	-6.12	-8.11	1.98
Sep. 16-30	-6.12	-4.25	-1.88
October 1-15	-3.98	-3.19	-0.79
Oct. 16-31	-3.98	-2.36	-1.61
November	-3.09	-1.72	-1.37
December	-2.40	-0.81	-1.60
		Annual Average	**-1.27**

Nominal unit output:	237 MW gross
Annual-average capacity loss:	1.27 MW
Annual revenue loss:	$306,000 (75% capacity, $36.71/MWh)

Table 5-7
Crawford 8 Megawatt Loss Due to Closed v. Open-Cycle Operation

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
January	-2.08	0.71	-2.79
February	-2.66	0.89	-3.55
March 1-15	-5.44	-0.07	-5.37
March 16-31	-5.44	-0.07	-5.37
April 1-15	-6.78	-1.13	-5.66
April 16-30	-6.78	-1.53	-5.25
May 1-15	-9.11	-4.01	-5.10
May 16-31	-9.11	-4.87	-4.24
June 1-15	-10.61	-6.04	-4.58
June 16-30	-10.61	-12.27	1.66
July 1-15	-11.93	-12.27	0.34
July 16-31	-11.93	-12.27	0.34
August 1-15	-11.60	-12.27	0.68
August 16-31	-11.60	-12.27	0.68
Sep. 1-15	-9.87	-12.27	2.40
Sep. 16-30	-9.87	-7.28	-2.59
October 1-15	-6.87	-5.61	-1.26
Oct. 16-31	-6.87	-4.16	-2.71
November	-5.44	-2.91	-2.54
December	-4.24	-0.85	-3.39
		Annual Average	-2.50

Nominal unit output: 348 MW gross
Annual-average capacity loss: 2.5 MW
Annual revenue loss: $603,000 (75% capacity, $36.71/MWh)

C. WILL COUNTY STATION TECHNOLOGY OPTIONS AND COST ESTIMATE RESULTS

C1. WILL COUNTY COOLING TOWER ARRANGEMENT

Exhibit A3 represents the arrangement drawing for the Will County towers. Two transmission lines (including two river crossings) run parallel with the towers and would need to be relocated to prevent icing problems. As at Crawford and Fisk, denial of a request to ComEd to relocate these transmission lines may not leave any other feasible locations open. One pond would need to be partially filled under the area where towers would be installed. Costs for these site modifications are included in the estimate. Some interference between the towers is likely under prevailing wind conditions. It proved necessary to separate the tower into three tower sections in order to provide the number of cells required to accommodate the combined cooling water flow for both Unit 3 and Unit 4. There is not enough space for one long tower due to the roads and railroad tracks that cross the tower location.

See Exhibit B3 for the closed loop diagram at Will County. A wall with a gate would be installed in the existing discharge channel. Under closed-cycle operation, this gate would be closed and four 25% cooling tower supply pumps would pump the water from the channel upstream of the wall to the cooling towers. The cooled water would be pumped by two 20% and four 15% cooling tower discharge pumps through above ground steel-lined concrete piping to the existing screen houses, to re-enter the CW pumps and condensers.

C2. WILL COUNTY COOLING TOWER CAPITAL COST ESTIMATES

The capital costs (including the quoted pricing from Marley) for the wet/dry tower are shown in Exhibit I3. Below in Table 5-8, the cost for the 100% closed loop tower is broken into the key components. For the wet/dry tower option, the total estimated capital cost is approximately $257 million. This translates to a normalized capital cost of $307 per kilowatt.

Table 5-8
Will County Capital Costs

Unit	Marley Wet/Dry CT Cost w/Delivery ($)	BOP Equipment Material Cost ($)	Labor ($)	Indirect Costs ($)	Contingency ($)	Total Cost ($)	Total Cost ($/kW)
Will County 3&4	$33,200,000	$47,300,000	$108,300,000	$28,200,000	$40,100,000	$257,100,000	$309

Below in Table 5-9, the cost of plume-abated (wet/dry) towers is compared to the cost for a wet tower with and without the provisions for later conversion to a wet/dry configuration. (See Section 2 for a discussion of the provisions required for a wet convertible to wet/dry tower.)

Table 5-9
Will County Capital Costs for Three Tower Styles

Unit	Wet/Dry Total Installed Cost ($)	Wet With Dry Option Total Installed Cost ($)	Wet Without Dry Option Total Installed Cost ($)
Will County 3&4	$257,100,000	$230,200,000	$210,700,000

C3. WILL COUNTY COOLING TOWER O&M COST ESTIMATES

The operation and maintenance cost for the Will County plume-abated (wet/dry) cooling tower consists of cooling tower fan and pump power (137,832 MWh at $36,71/MWh), tower maintenance costs such as gear oil replacement, and chemical costs for chlorination and anti-scaling additives. The total annual O&M cost is approximately $5,750,000. A detailed breakdown of these O&M costs is shown in Exhibit J. The breakdown of the costs is shown in Table 5-10.

Table 5-10
Will County O&M Costs

Unit	Annual CT Fan Power Cost ($)	Annual Pump Power Cost ($)	Annual Maintenance Cost ($)	Annual Chemical Cost ($)	Total Annual O&M Cost ($)
Will County 3&4	$1,950,000	$2,820,000	$150,000	$832,000	$5,752,000

C4. WILL COUNTY DERATING IMPACTS WITH CLOSED-CYCLE COOLING TOWER

Tables 5-11 and 5-12 below summarize the month-by-month loss of plant capacity in closed-cycle operation for Will County 3 and Will County 4, respectively, compared to open-cycle operation weather and water temperature conditions.

Table 5-11
Will County 3 Megawatt Loss Due to Closed v. Open-Cycle Operation

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
January	-1.37	0.41	-1.77
February	-1.67	0.50	-2.17
March 1-15	-4.64	-0.03	-4.61
March 16-31	-4.64	-0.03	-4.61
April 1-15	-6.26	-0.72	-5.54
April 16-30	-6.26	-1.02	-5.24
May 1-15	-9.49	-3.19	-6.30
May 16-31	-9.49	-4.10	-5.39
June 1-15	-11.95	-5.44	-6.51
June 16-30	-11.95	-14.93	2.98
July 1-15	-14.32	-14.93	0.62
July 16-31	-14.32	-14.93	0.62
August 1-15	-13.72	-14.93	1.21
August 16-31	-13.72	-14.93	1.21
Sep. 1-15	-11.00	-14.93	3.93
Sep. 16-30	-11.0	-7.03	-3.97
October 1-15	-6.67	-4.93	-1.73
Oct. 16-31	-6.67	-3.35	-3.32
November	-4.60	-2.15	-2.45
December	-1.93	-0.53	-1.40
		Annual Average	**-2.18**

Nominal unit output: 281 MW gross
Annual-average capacity loss: 2.18 MW
Annual revenue loss: $526,000 (75% capacity, $36.71/MWh)

Table 5-12
Will County 4 Megawatt Loss Due to Closed v. Open-Cycle Operation

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
January	-0.57	1.06	-1.63
February	-0.85	1.14	-1.99
March 1-15	-3.63	0.66	-4.29
March 16-31	-3.63	0.66	-4.29
April 1-15	-5.16	0.03	-5.19
April 16-30	-5.16	-0.25	-4.91
May 1-15	-8.25	-2.27	-5.98
May 16-31	-8.25	-3.12	-5.14
June 1-15	-10.64	-4.38	-6.25
June 16-30	-10.64	-13.57	2.93
July 1-15	-12.96	-13.57	0.61
July 16-31	-12.96	-13.57	0.61
August 1-15	-12.37	-13.57	1.19
August 16-31	-12.37	-13.57	1.19
Sep. 1-15	-9.71	-13.57	3.85
Sep. 16-30	-9.71	-5.89	-3.82
October 1-15	-5.55	-3.91	-1.64
Oct. 16-31	-5.55	-2.41	-3.13
November	-3.59	-1.29	-2.29
December	-1.09	0.20	-1.29
		Annual Average	**-2.03**

Nominal unit output: 551 MW gross
Annual-average capacity loss: 2.03
Annual revenue loss: $490,000 (75% capacity, $36.71/MWh)

D. JOLIET 6 STATION TECHNOLOGY OPTIONS AND COST ESTIMATE RESULTS

D1. JOLIET 6 COOLING TOWER ARRANGEMENT

Exhibit A4 represents the arrangement drawing developed for the Joliet 6 cooling tower sections. The arrangement of the cooling towers is favorable, considering the space constraints. The towers are oriented to minimize recirculation and interference under prevailing wind conditions. The site would need to be filled to raise the elevation suitably above the canal. There is a microwave easement that crosses the tower location. It is assumed for purposes of this analysis that this easement is sufficiently elevated that the towers do not interfere with it.

Exhibit B4 is the closed loop cycle diagram for at Joliet 6. A wall with a gate would be installed across the existing discharge channel. Under closed-cycle operation, this gate would be closed and four 25% cooling tower supply pumps would pump the water from the channel upstream of the wall to the cooling towers. The cooled water would be pumped by four 25% cooling tower discharge pumps (two per tower section) through steel-lined concrete piping to the intake of the existing crib house, to re-enter the CW pumps and condensers. The crib house intake would be enclosed with gates on the north and west sides to prevent the circulating water from entering the canal.

D2. JOLIET 6 COOLING TOWER CAPITAL COST ESTIMATES

The capital costs (including the quoted pricing from Marley) for the wet/dry tower are shown in Exhibit I4. Below in Table 5-13, the cost for the 100% closed loop tower is broken into the key components. For the wet/dry tower option, the total estimated capital cost is approximately $116 million. This translates to a normalized capital cost of $339 per kilowatt.

Table 5-13
Joliet 6 Capital Cost

Joliet 6 Capital Costs Unit	Marley Wet/Dry CT Cost w/Delivery ($)	BOP Equipment Material Cost ($)	Labor ($)	Indirect Costs ($)	Contingency ($)	Total Cost ($)	Total Cost ($/kW)
Joliet 6	$14,900,000	$21,000,000	$42,600,000	$19,100,000	$18,100,000	$115,700,000	$339

Below in Table 5-14, the cost of plume-abated (wet/dry) towers is compared to the cost for a wet tower with and without provisions to convert to wet/dry. (See Section 2 for a discussion of the provisions required for a wet convertible to wet/dry tower.)

Table 5-14
Joliet 6 Capital Costs for Three Tower Styles

Unit	Wet/Dry Total Installed Cost ($)	Wet With Dry Option Total Installed Cost ($)	Wet Without Dry Option Total Installed Cost ($)
Joliet 6	$115,700,000	$103,600,000	$93,400,000

D3. JOLIET 6 COOLING TOWER O&M COST ESTIMATES

Operation and maintenance costs for plume-abated (wet/dry) cooling towers at Joliet 6 wet/dry consists of cooling tower fan and pump power (65,350 MWh at $36.71/MWh), tower maintenance costs such as gear oil replacement, and chemical costs for chlorination and anti-scaling additives. The total annual O&M cost is approximately $2,660,000. A detailed breakdown of these O&M costs is shown in Exhibit J. The breakdown of the costs is shown in Table 5-15.

Table 5-15
Joliet 6 O&M Costs

Unit	Annual CT Fan Power Cost ($)	Annual Pump Power Cost ($)	Annual Maintenance Cost ($)	Annual Chemical Cost ($)	Total Annual O&M Cost ($)
Joliet 6	$880,000	$1,370,000	$67,500	$341,000	$2,660,000

D4. JOLIET 6 DERATING IMPACTS WITH CLOSED-CYCLE COOLING TOWER

Table 5-16
Joliet 6 Megawatt Loss Due to Closed v. Open-Cycle Operation

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
January	-1.26	0.47	-1.73
February	-1.71	0.58	-2.29
March 1-15	-3.85	-0.04	-3.81
March 16-31	-3.85	-0.04	-3.81
April 1-15	-5.14	-0.76	-4.38
April 16-30	-5.14	-1.05	-4.09
May 1-15	-7.35	-2.94	-4.41
May 16-31	-7.35	-3.64	-3.71
June 1-15	-9.08	-4.64	-4.43
June 16-30	-9.08	-9.82	0.75
July 1-15	-10.36	-9.82	-0.54
July 16-31	-10.36	-9.82	-0.54
August 1-15	-10.06	-9.82	-0.24

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
August 16-31	-10.06	-9.82	-0.24
Sep. 1-15	-8.26	-9.82	1.56
Sep. 16-30	-8.26	-5.76	-2.50
October 1-15	-5.39	-4.27	-1.11
Oct. 16-31	-5.39	-3.06	-2.32
November	-3.85	-2.07	-1.77
December	-2.88	-0.57	-2.30
		Annual Average	**-2.08**

Nominal plant output:	341 MW gross
Annual-average capacity loss:	2.08
Annual revenue loss:	$502,000 (75% capacity, $36.71/MWh)

E. JOLIET 7&8 STATION TECHNOLOGY OPTIONS AND COST ESTIMATE RESULTS

E1. JOLIET 7&8 COOLING TOWER ARRANGEMENT

Exhibit A4 represents the arrangement drawing developed for the Joliet 7&8 towers. Interference between the towers is likely under prevailing wind conditions, as the spacing between the towers is less than desired. Recirculation may also be a problem with westerly winds.

See Exhibit B5 for the closed loop diagram corresponding to Joliet 7&8 case. A dividing wall would be installed down the center of the existing discharge channel, and a wall with a gate would be installed at the southwestern end of the channel formed north of this wall. Under closed-cycle operation, this gate would be closed and six 17% cooling tower supply pumps would pump the water from this channel to the cooling towers. The cooled water would be pumped by six cooling tower discharge pumps (two per tower) through buried steel-lined concrete piping to the channel south of the dividing wall. This channel would be isolated from the canal by a new wall and gate. The flow in the southern section of the divided discharge channel would be reversed and a new flume with a gate would connect this channel with the existing inlet channel. From the inlet channel, the circulating water would re-enter the CW pumps and condensers.

E2. JOLIET 7&8 COOLING TOWER CAPITAL COST ESTIMATES

The capital costs (including the quoted pricing from Marley) for the wet/dry tower are shown in Exhibit I5. Below in Table 5-17, the cost for the closed loop tower is broken into the key components. For the wet/dry tower option, the total estimated capital cost is approximately $301 million. This translates to a normalized capital cost of $264 per kilowatt.

Table 5-17
Joliet 7&8 Capital Costs

Unit	Marley Wet/Dry CT Cost w/Delivery ($)	BOP Equipment Material Cost ($)	Labor ($)	Indirect Costs ($)	Contingency ($)	Total Cost ($)	Total Cost ($/kW)
Joliet 7&8	$53,100,000	$58,800,000	$115,400,000	$26,600,000	$47,000,000	$300,900,000	$264

Table 5-18 presents a comparison of the cost of plume-abated (wet/dry) towers is compared to the cost for a wet tower with or without the option to convert to wet/dry.

Table 5-18
Joliet 7&8 Tower Capital Cost for Three Tower Styles

Unit	Wet/Dry Total Installed Cost ($)	Wet With Dry Option Total Installed Cost ($)	Wet Without Dry Option Total Installed Cost ($)
Joliet 7&8 100%	$300,900,000	$257,900,000	$223,800,000

E3. JOLIET 7&8 COOLING TOWER O&M COST ESTIMATES

The operation and maintenance cost for the Joliet 7&8 plums-abated (wet/dry) cooling tower consists of cooling tower fan and pump power (230,962 MWh at $36.71/MWh), tower maintenance costs such as gear oil replacement, and chemical costs for chlorination and anti-scaling additives. The total annual O&M cost is approximately $9,080,000. A detailed breakdown of these O&M costs is shown in Exhibit J. The breakdown of the costs is shown in Table 5-19.

Table 5-19
Joliet 7&8 O&M Costs

Unit	Annual CT Fan Power Cost ($)	Annual Pump Power Cost ($)	Annual Maintenance Cost ($)	Annual Chemical Cost ($)	Total Annual O&M Cost ($)
Joliet 7&8	$3,100,000	$4,570,000	$240,000	$1,138,000	$9,050,000

Total O&M costs for Joliet 7&8 are markedly higher than the O&M costs for other MWGen station units for two reasons: 1) Most O&M costs are related to plant generating capacity, and Joliet 7&8 is the largest station of the five stations considered in this study, and 2) Joliet 7&8 have three cooling tower sections, which requires one additional set of large pumps than is required for the other stations.

E4. JOLIET 7&8 DERATING IMPACTS WITH CLOSED-CYCLE COOLING TOWER

Table 5-20
Joliet 7&8 Megawatt Loss Due to Closed v. Open-Cycle Operation

Period	Closed-Cycle MW Loss	Open-Cycle MW Gain/Loss	Total MW Gain/Loss Running Closed vs. Open-Cycle
January	-2.19	-0.71	-1.48
February	-2.91	-0.71	-2.20
March 1-15	-7.31	-0.28	-7.02
March 16-31	-7.31	-0.28	-7.02
April 1-15	-9.53	-0.64	-8.89
April 16-30	-9.53	-1.30	-8.23
May 1-15	-13.36	-5.32	-8.04
May 16-31	-13.36	-6.71	-6.64
June 1-15	-16.13	-8.61	-7.53
June 16-30	-16.13	-17.29	1.15
July 1-15	-18.20	-17.29	-0.91
July 16-31	-18.20	-17.29	-0.91
August 1-15	-17.65	-17.29	-0.36
August 16-31	-17.65	-17.29	-0.36
Sep. 1-15	-15.02	-17.29	2.27
Sep. 16-30	-15.02	-10.63	-4.38
October 1-15	-10.26	-7.92	-2.34
Oct. 16-31	-10.26	-5.56	-4.70
November	-7.24	-3.53	-3.71
December	-5.50	-0.20	-5.30
		Annual Average	**-3.72**

Nominal plant output: 569 MW gross (each unit)
Annual-average capacity loss: 3.72
Annual revenue loss: $897,000 (75% capacity, $36.71/MWh)

F. CAPITAL COSTS ASSOCIATED WITH OPEN-CYCLE CAPABILITY

Conversion of Crawford 7/8, Fisk, Joliet 6, Joliet 7/8 and Will County 3/4 to closed-cycle cooling requires isolation of the existing cooling water intake and discharge canals from the river. For cost estimating purposes, S&L assumed this isolation would be accomplished by installing a combination of fixed barrier walls with moveable gates at the points of isolation from the river. Although there are many other systems and structures required to convert these stations to closed-cycle cooling, conversion does not require any changes to existing plant equipment which would prevent the plant from operating in open-cycle mode if access to the river were maintained. Thus, the only additional equipment included in the capital cost estimates to allow the stations to maintain their current open-cycle capability is the inclusion of moveable gates as part of the fixed barrier walls.

Table 5-21 provides a comparison of the capital costs of conversion from open-cycle to closed-cycle cooling with and without moveable gates. For the estimates without gates, S&L substituted continuous fixed barrier walls for walls with moveable gates.

Table 5-21
Capital Costs With and Without Moveable Gates (2007 $)

	Crawford	Fisk	Joliet 6	Joliet 7/8	Will County
Open-Cycle Capability Costs	$144,652,125	$119,952,645	$109,045,489	$296,100,668	$225,485,626
Closed-Cycle Costs	$141,995,107	$118,832,840	$107,185,075	$292,252,428	$224,095,727
Difference	$2,657,018	$1,119,805	$1,860,414	$3,846,240	$1,389,899
Percentage Difference	1.9	0.9	1.7	1.3	0.6

6. TYPICAL COOLING TOWER PROJECT SCHEDULE

A typical schedule for the design, procurement, fabrication and erection of a cooling tower and other closed-cycle conversion activities for a single station is shown in Figure 6-1. If all of the towers at each of the MWGen stations had to be installed to meet a single compliance deadline and therefore, schedules for the work to install the cooling towers would need to overlap, the overall schedule duration would be considerably longer than that shown for a single station.

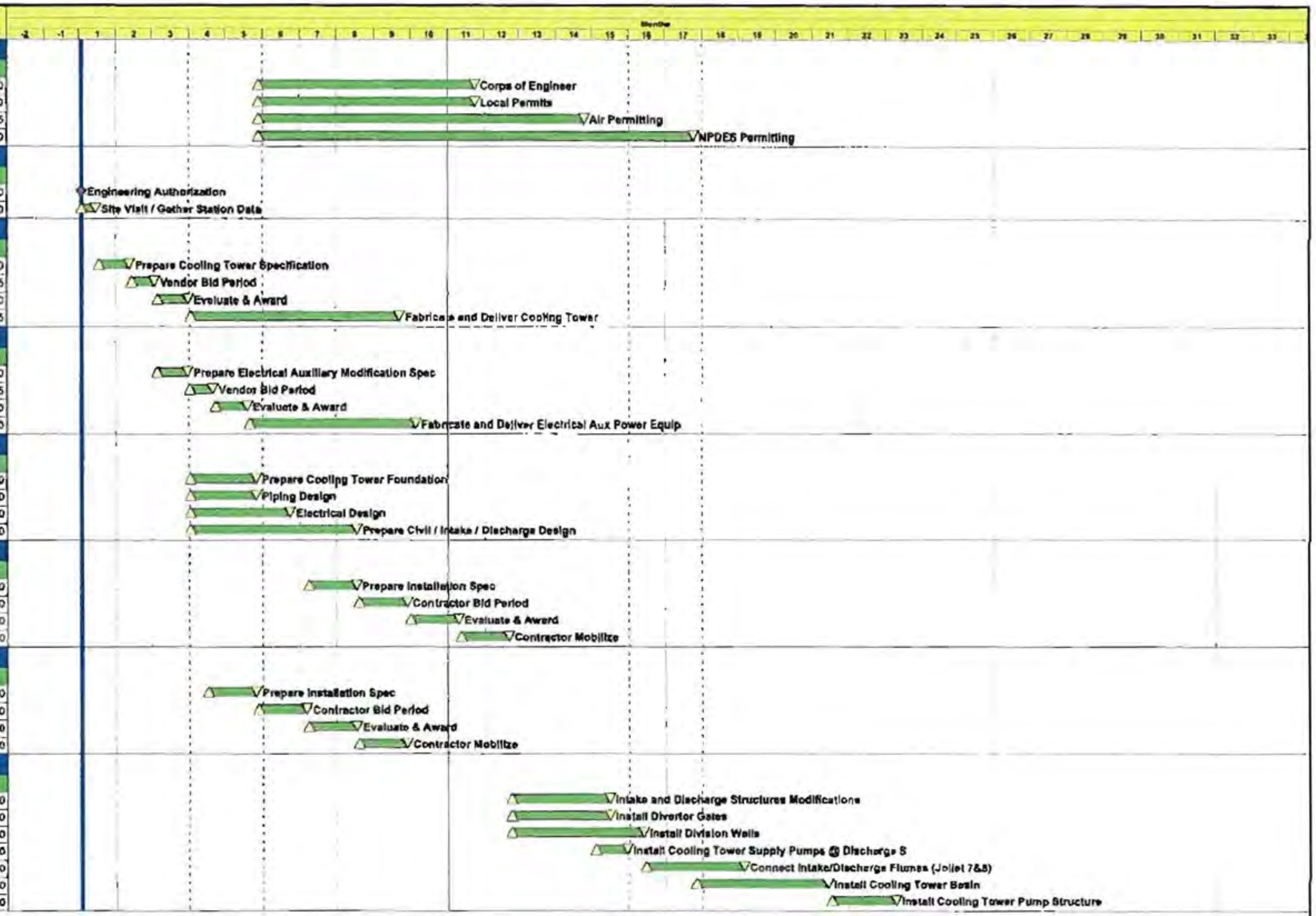
As shown on Figure 6-1, S&L estimates that a typical single-station installation will require about 29 months to complete, not including the time needed both to conduct necessary design studies and to complete critical design criteria. The 29-month duration is applicable to Fisk, Crawford and Joliet 6; the overall durations for closed-cycle conversion at Will County 3/4 and Joliet 7/8 are estimated to be 31 months and 33 months, respectively.

The overall duration for a multiple station cooling tower installation will require over twice as much time as a single-station installation. From a design standpoint, much of the required effort will be largely repetitive. For example, once a cooling tower specification is prepared for one station, it will take considerably less time to prepare a comparable specification for another station. However, it is likely that MWGen's ability to pursue multiple cooling tower projects in parallel will be limited by the time required to fabricate and deliver the cooling tower material and equipment and/or by the time required to construct the tower and other structures. At present, there are few utility-size cooling tower projects underway nationally and the construction labor market is favorable. With such conditions, and assuming the necessary funds are available, one might be able to execute projects at Fisk and Crawford stations in parallel, and to start projects at the next stations in sequence with a 12- to 15-month lag. Assuming such "best case" scenario circumstances, after the time required to complete the final design criteria, the overall time required to implement closed-cycle cooling at the five MWGen stations is estimated to be a minimum of 60 months. However, as the economy improves, lead times will lengthen and construction labor will become less available. Therefore it is not possible to predict accurately the overall time required to design, fabricate and install cooling towers at five power stations. Again, assuming that funding can be obtained when needed, for planning purposes, S&L recommends that at least 72 months should be allowed for that process.

There are several permits required to install cooling towers at the MWGen stations. S&L believes the time frames we have indicated in Figure 6-1 for acquisition of those permits for a single tower installation is reasonable, but any delay in preparation, agency review or agency issue of those permits will result in a commensurate delay in the overall project schedule. If all of the towers at each of the MWGen stations had to be installed to meet a single compliance deadline and therefore, multiple permit applications were submitted to the Agency simultaneously or close in time, it is expected that the time frames indicated in Figure 6-1 for agency review and issuance of permits for a single cooling tower installation would increase significantly due to the additional permit applications review burden this would place on the Agency.

The extent of transmission line relocation was not examined in any detail during this study. The time required to obtain permission for line relocation and to actually relocate the lines has not been considered in the schedule discussion above.

Activity ID	Activity Description	Days
Permitting		
30	Corps of Engineer	130
40	Local Permits	130
10	Air Permitting	195
20	NPDES Permitting	260
Engineering Study		
100	Engineering Authorization	0
110	Site Visit / Gather Station Data	10
Cooling Tower Procurement		
160	Prepare Cooling Tower Specification	20
170	Vendor Bid Period	15
180	Evaluate & Award	20
190	Fabricate and Deliver Cooling Tower	125
Electical Aux. Power Modification Procurement		
240	Prepare Electrical Auxiliary Modification Spec	20
250	Vendor Bid Period	15
260	Evaluate & Award	20
270	Fabricate and Deliver Electrical Aux Power Equip	100
Engineering / Design		
280	Prepare Cooling Tower Foundation	40
300	Piping Design	40
310	Electrical Design	60
290	Prepare Civil / Intake / Discharge Design	100
Civil Contractor Procurement		
312	Prepare Installation Spec	30
313	Contractor Bid Period	30
314	Evaluate & Award	30
315	Contractor Mobilize	30
Construction Contractor Procurement		
320	Prepare Installation Spec	30
330	Contractor Bid Period	30
340	Evaluate & Award	30
350	Contractor Mobilize	30
Construction / Startup		
Structural		
365	Intake and Discharge Structures Modifications	60
375	Install Divertor Gates	60
385	Install Division Walls	80
367	Install Cooling Tower Supply Pumps @ Discharge S	20
410	Connect Intake/Discharge Flumes (Joliet 7&8)	60
360	Install Cooling Tower Basin	80
395	Install Cooling Tower Pump Structure	40



Run Date 27JAN11 10:23 CT03

Typical Single Station
Project Schedule
Cooling Tower Addition
Design-Fabrication-Installation

Sheet 1 of 2

Sargent & Lundy LLC

Activity ID	Activity Description	Days
400	Install Cooling Tower Structure Pumps	20
Cooling Tower/Mechanical		
C5CWGVC000	Erect Cooling Tower	85*
405	Install Chemical Bldg	30
C5CWGVC016	Erect Cooling Tower-Framing	75
C5CWGVC017	Erect Cooling Tower-Install Partition Walls	75
C5CWGVC018	Erect Cooling Tower -Install Wind Walls	75
C5CWGVC019	Erect Cooling Tower -Inst Immediate Fill Support	75
C5CWGVC020	Erect Cooling Tower -Inst. Header and Lat. Sppts	75
C5CWGVC022	Erect Cooling Tower -Set Distribution Systems	75
C5CWGVC023	Erect Cooling Tower -Receive and Stock Fill	75
C5CWGVC024	Erect Cooling Tower -Install Fill	75
C5CWGVC025	Erect Cooling Tower -Lay Top Decking	75
C5CWGVC026	Erect Cooling Tower -Fiberglass Riser Pipes	75
C5CWGVC027	Erect Cooling Tower -Install Lateral Pipes	75
C5CWGVC030	Erect Cooling Tower -Stand Stacks	75
C5CWGVC031	Erect Cooling Tower -Install Drift Eliminators	75
C5CWGVC032	Erect Cooling Tower -Inst. Water Divert. & Seals	75
C5CWGVC033	Erect Cooling Tower -Hang Siding	75
C5CWGVC034	Erect Cooling Tower -Stand Stairway	75
C5CWGVC035	Erect Cooling Tower -Hand Escape Ladder	75
C5CWGVC036	Erect Cooling Tower-Install Lightning Protection	75
C5CWGVC028	Erect Cooling Tower -Set Mech Fan Motors & Drvs	75
C5CWGVC029	Erect Cooling Twr-Instl Hubs,Fan Blades,Set Ptch	85
C5CWPEW000	Install Conduit/Cable Tray Cooling Tower	40
Piping/Fire Protection		
380	Install Piping	125
C5FPGVF010	Install Fire Protection - Cooling Tower	65
Electrical		
420	Electrical Installation	185*
455	Erect Cooling Tower Transformers	25
450	Erect Cooling Tower Electrical Bldgs/PDCs	40
460	Install Conduit - Plnt Pwr to Cooling Twr MCCs	30
465	Pull Wire & Cable - Plnt Pwr to Cooling Twr MCCs	40
470	Term Wire & Cable - Plnt Pwr to Cooling Twr MCCs	10
475	Install Cond/Cbl Try - Cooling Twr MCCs to Fans	20
480	Pull Wire & Cable - Cooling Twr MCCs to Fans	20
490	Install Cooling Tower Area Lighting	60
485	Term Wire & Cable - Cooling Twr MCCs to Fans	10
I&C		
495	Instrument & Control Installation	120*
C5CWPND010	Install Instruments	40
500	Install - DCS Cabinets	20
505	Install Cond/Cbl Tray - Pwr to DCS Cabinets	20
510	Pull Wire & Cable-DCS Cabs to Mn Ctrl Rm DCS	20
C5CWPEW020	Term Wire & Cable-DCS Cabs to Mn Ctrl Rm DCS	15
545	Install Cond/Cbl Tray-DCS Cabinets to Fan MCCs	20
550	Pull Wire & Cable - DCS Cabinets to Fan MCCs	30
555	Term Wire & Cable - DCS Cabinets to Fan MCCs	30
580	Load Cooling Tower Software - DCS	10
Start-Up & Commissioning		
C514-820	Checkout - COOLING TOWER	0
565	Verify DCS Control Loops	50
430	System Startup	60
440	Cooling Tower In-service	0

EXHIBITS

A. COOLING TOWER EQUIPMENT ARRANGEMENTS

B. CLOSED-CYCLE COOLING TOWER FLOW DIAGRAMS

C. COOLING TOWER SIZING AND SPECIFICATION DATA

D. DESIGN BASIS FOR COOLING TOWER SELECTION

E. PARTICULATE EMISSIONS CALCULATIONS

F. METROPOLITAN WATER RECLAMATION DISTRICT WATER QUALITY DATA

G. COOLING TOWER BLOWDOWN, EVAPORATION, AND MAKE-UP WATER DATA

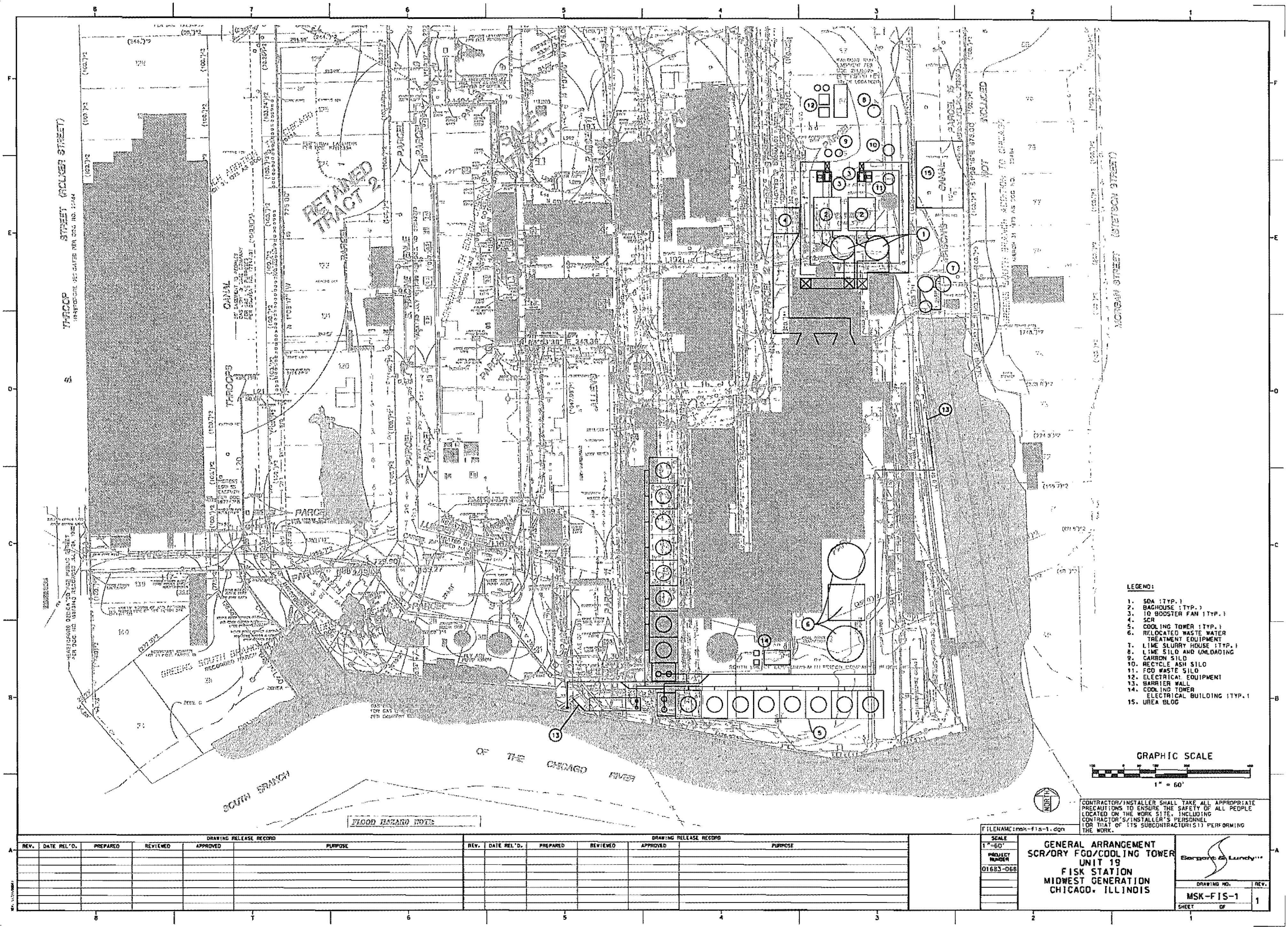
H. COOLING TOWER BLOWDOWN TEMPERATURE DATA

I. CAPITAL COST ESTIMATES

J. OPERATION AND MAINTENANCE COST ESTIMATES

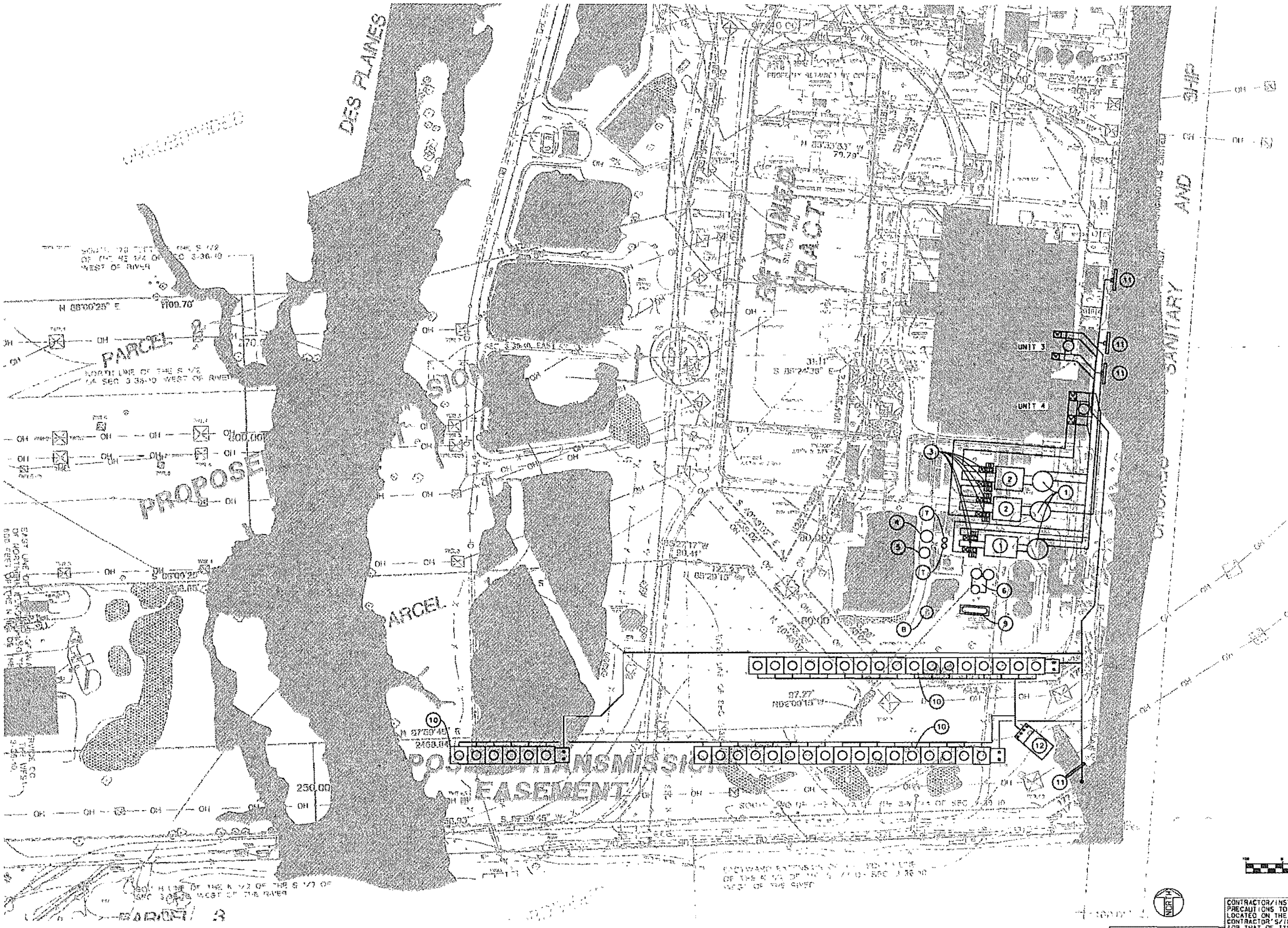
EXHIBIT A

Cooling Tower Equipment Arrangements



RETAINED TRACT 2
THROOP STREET
MORGAN STREET
SOUTH BRANCH OF THE CHICAGO RIVER
FLOOD HAZARD NOTE:
LEGEND:
1. SDA (TYP.)
2. BAGHOUSE (TYP.)
3. ID BOOSTER FAN (TYP.)
4. SCR
5. COOLING TOWER (TYP.)
6. RELOCATED WASTE WATER TREATMENT EQUIPMENT
7. LIME SLURRY HOUSE (TYP.)
8. LIME SILO AND UNLOADING
9. CARBON SILO
10. RECYCLE ASH SILO
11. FGD WASTE SILO
12. ELECTRICAL EQUIPMENT
13. BARRIER WALL
14. COOLING TOWER ELECTRICAL BUILDING (TYP.)
15. UREA BLDG
GRAPHIC SCALE
1" = 60'
NORTH
CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.
FILENAME: msk-fis-1.dgn
DRAWING RELEASE RECORD
REV. | DATE REL'D. | PREPARED | REVIEWED | APPROVED | PURPOSE
SCALE 1"=60'
PROJECT NUMBER 01683-068
GENERAL ARRANGEMENT
SCR/DRY FGD/COOLING TOWER
UNIT 19
FISK STATION
MIDWEST GENERATION
CHICAGO, ILLINOIS
Sargent & Lundy
DRAWING NO. MSK-FIS-1
REV. 1
SHEET OF

Electronic Filing: Received, Clerk's Office 6/27/2018



LEGEND:

1. SDA
2. BAGHOUSE
3. ID BOOSTER FANS
* 4. RECYCLE ASH SILO
* 5. FGD WASTE SILO
* 6. SLURRY HOUSE
7. CARBON SILOS
* 8. LIME SILO
* 9. AMMONIA STORAGE
* 10. COOLING TOWER
* 11. BARRIER WALL
* 12. INTAKE STRUCTURE

* - COMMON WITH UNIT 3&4

GRAPHIC SCALE

1" = 100'

NORTH

CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.

FILENAME: msk-wil-1.dgn

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE

SCALE: 1"=100'

PROJECT NUMBER

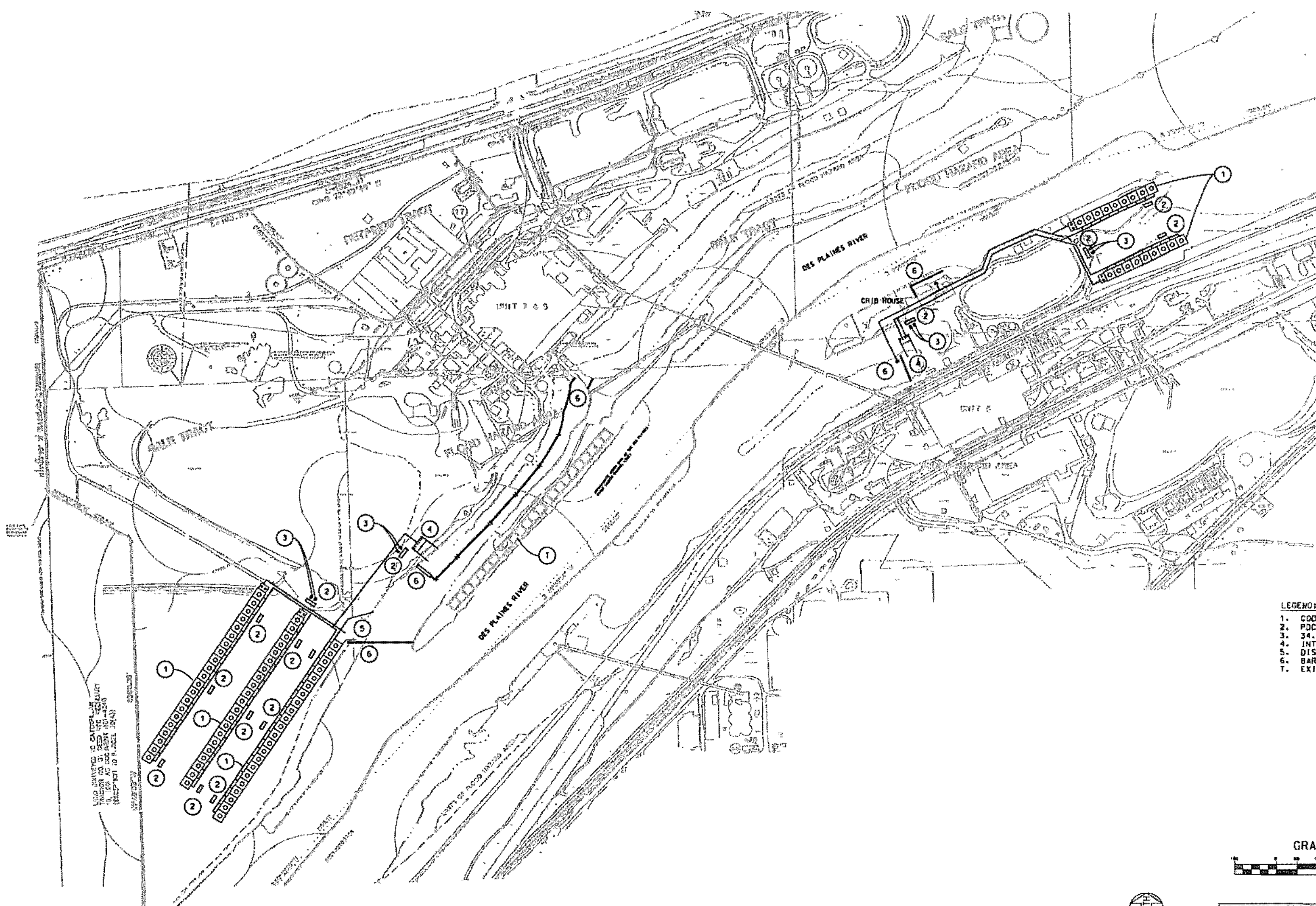
GENERAL ARRANGEMENT
DRY FGD COOLING TOWER
STATION 8 - UNIT 3&4
WILL COUNTY STATION
MIDWEST GENERATION
CHICAGO, ILLINOIS

Sargent & Lundy

DRAWING NO.: MSK-WIL-1

REV.: 3

SHEET OF



LEGEND:
1. COOLING TOWER
2. PDC
3. 34.5 - 4.16 KV TRANSFORMER
4. INTAKE STRUCTURE
5. DISCHARGE STRUCTURE
6. BARRIER WALL
T. EXISTING PSI HELPER TOWER

GRAPHIC SCALE

1" = 200'

NORTH

CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE

FILENAME: msk-jol-8.dgn

SCALE 1"=200'

PROJECT NUMBER 01683-068

GENERAL ARRANGEMENT
COOLING TOWERS
STATION 9 & 29
JOLIET STATION
MIDWEST GENERATION
CHICAGO, ILLINOIS

Sargent & Lundy

DRAWING NO. MSK-JOL-8

REV. 2

SHEET OF

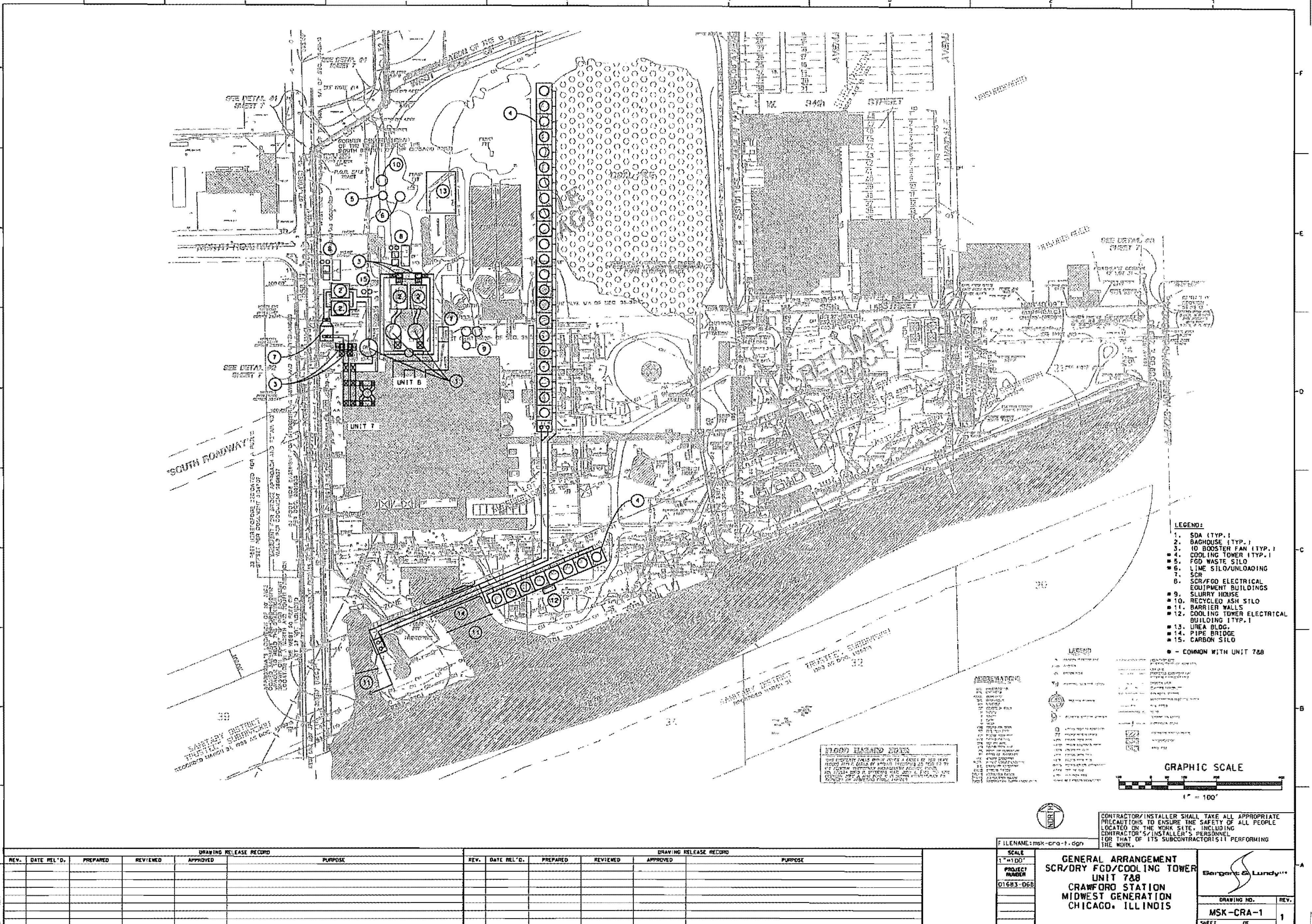
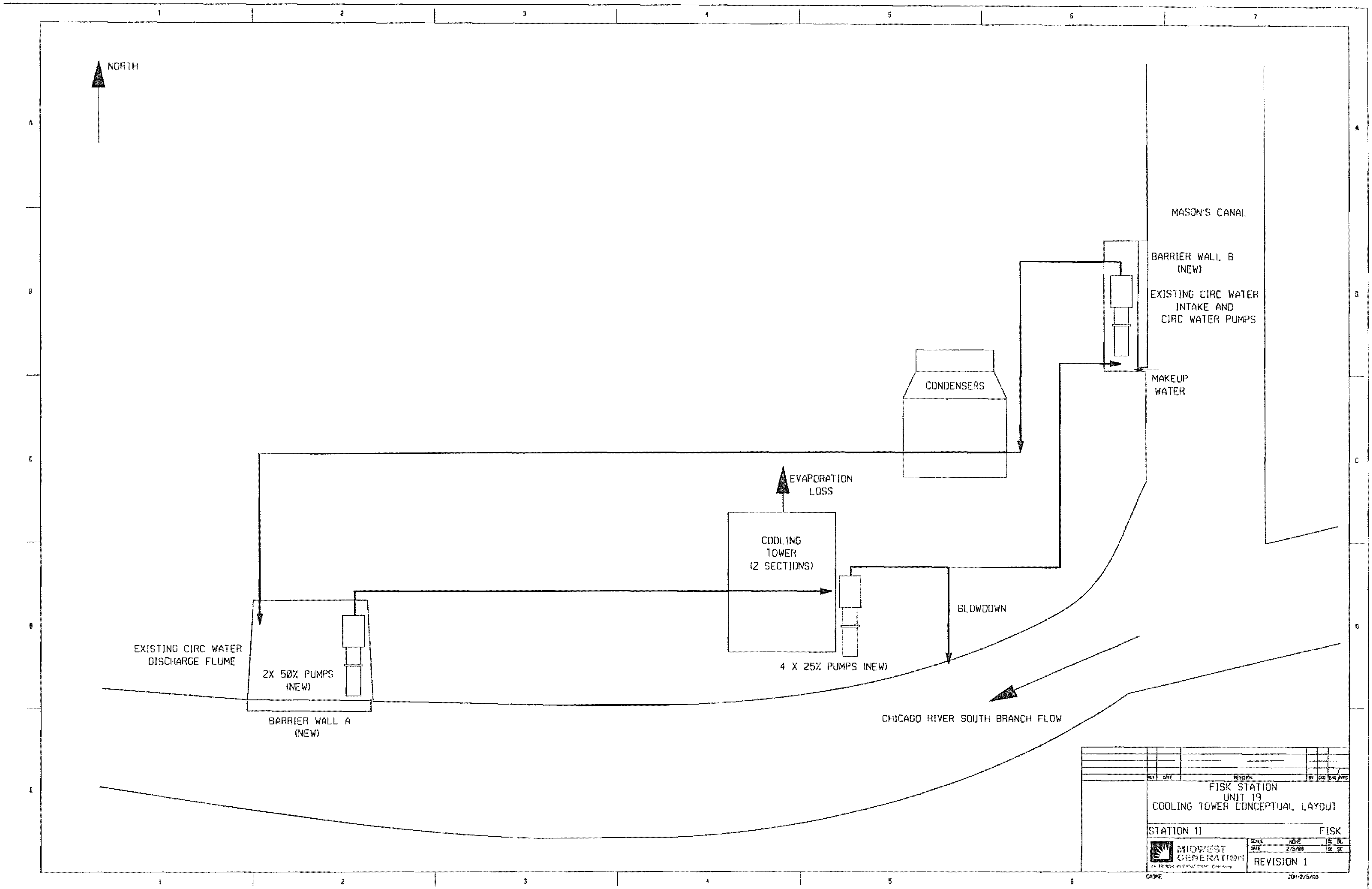
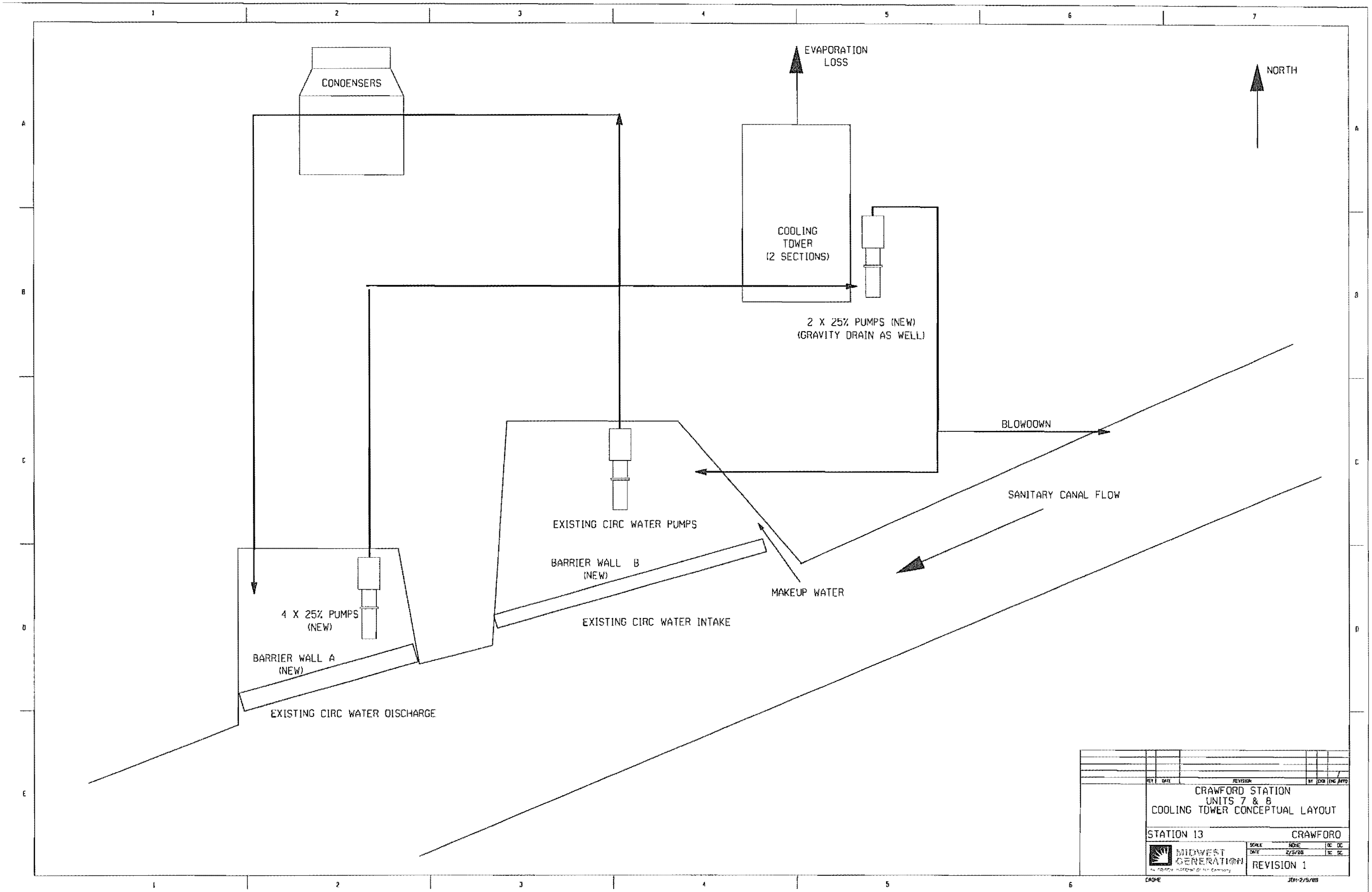
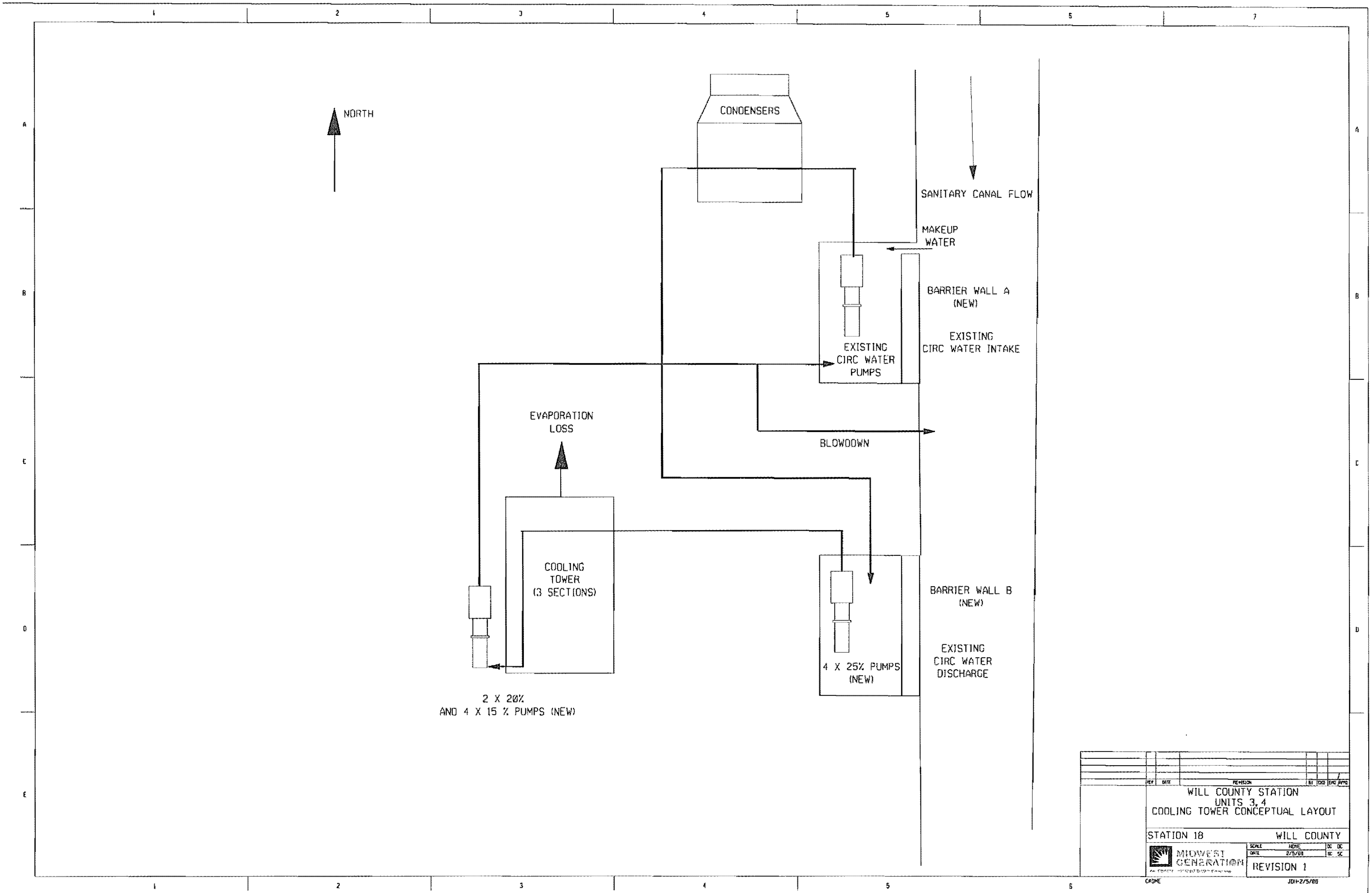

UNIT 7
UNIT 8
SOUTH ROADWAY
RETAINED TRACT
LEGEND:
1. SDA (TYP.)
2. BAGHOUSE (TYP.)
3. ID BOOSTER FAN (TYP.)
* 4. COOLING TOWER (TYP.)
* 5. FGD WASTE SILO
* 6. LIME SILO/UNLOADING
7. SCR
8. SCR/FGD ELECTRICAL EQUIPMENT BUILDINGS
* 9. SLURRY HOUSE
* 10. RECYCLED ASH SILO
* 11. BARRIER WALLS
* 12. COOLING TOWER ELECTRICAL BUILDING (TYP.)
* 13. UREA BLDG.
* 14. PIPE BRIDGE
* 15. CARBON SILO
* - COMMON WITH UNIT 7&8
GRAPHIC SCALE
1" = 100'
NORTH
CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.
FILENAME: msk-cra-1.dgn
DRAWING RELEASE RECORD
REV. | DATE REL'D. | PREPARED | REVIEWED | APPROVED | PURPOSE
SCALE
1"=100'
PROJECT NUMBER
01683-068
GENERAL ARRANGEMENT
SCR/DRY FGD/COOLING TOWER
UNIT 7&8
CRAWFORD STATION
MIDWEST GENERATION
CHICAGO, ILLINOIS
Sargent & Lundy
DRAWING NO.
MSK-CRA-1
REV.
1
SHEET OF

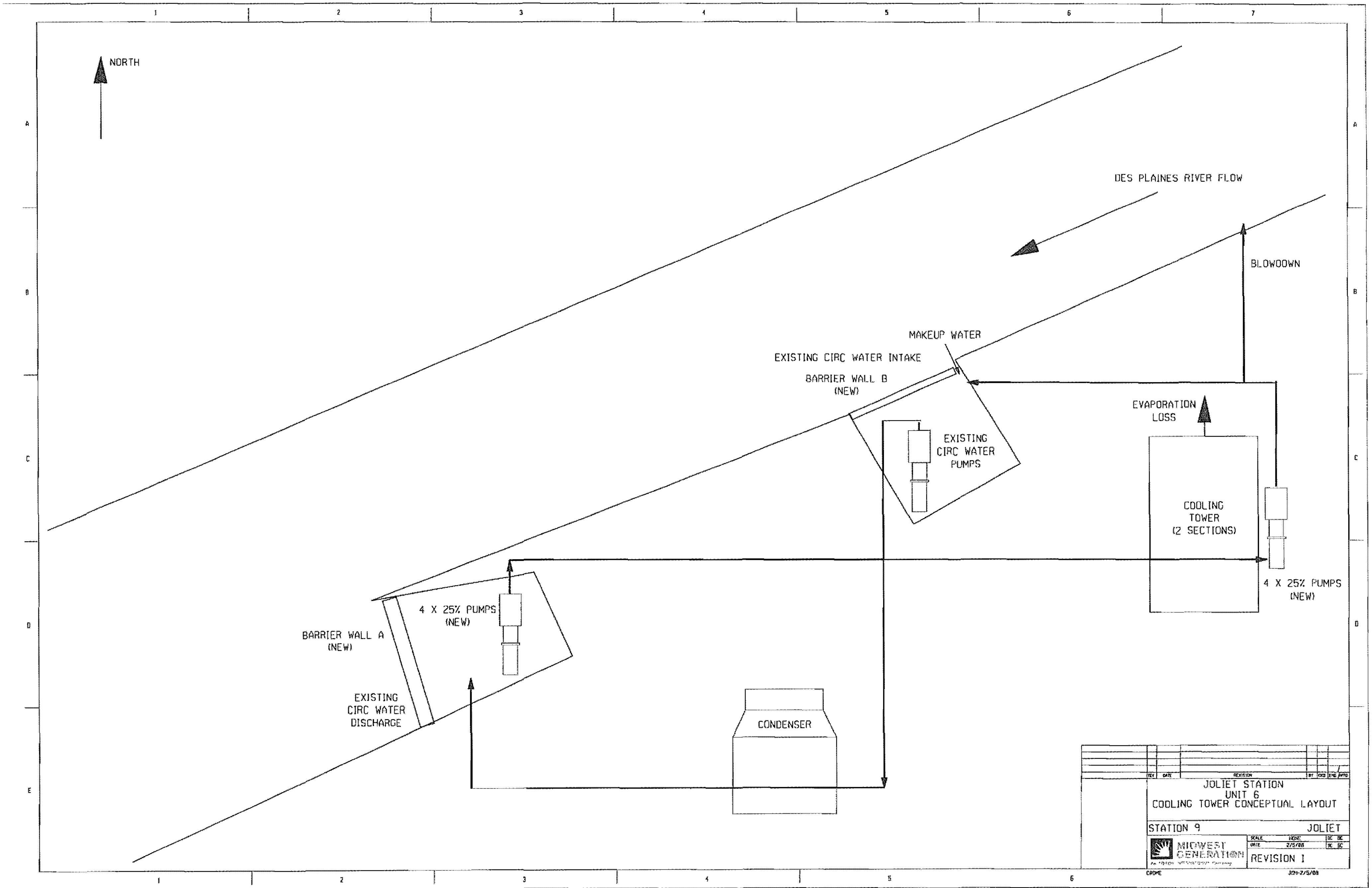
EXHIBIT B

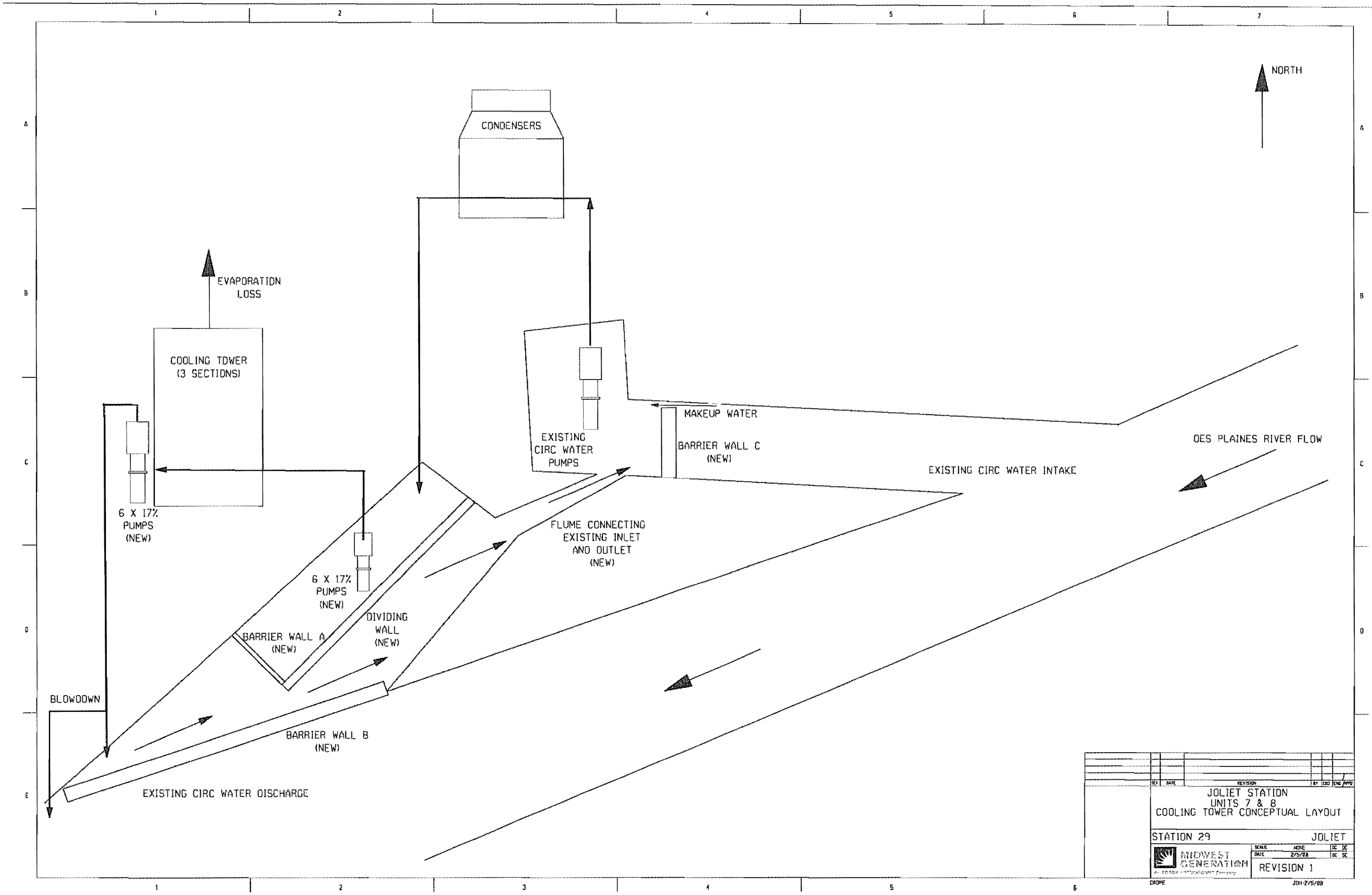
Closed-Cycle Cooling Tower Flow Diagrams


NORTH
MASON'S CANAL
BARRIER WALL B
(NEW)
EXISTING CIRC WATER
INTAKE AND
CIRC WATER PUMPS
CONDENSERS
MAKEUP
WATER
EVAPORATION
LOSS
COOLING
TOWER
(2 SECTIONS)
BLOWDOWN
4 X 25% PUMPS (NEW)
EXISTING CIRC WATER
DISCHARGE FLUME
2X 50% PUMPS
(NEW)
BARRIER WALL A
(NEW)
CHICAGO RIVER SOUTH BRANCH FLOW
FISK STATION
UNIT 19
COOLING TOWER CONCEPTUAL LAYOUT
STATION 11
FISK
MIDWEST
GENERATION
REVISION 1


EVAPORATION LOSS
NORTH
CONDENSERS
COOLING TOWER (2 SECTIONS)
2 X 25% PUMPS (NEW) (GRAVITY DRAIN AS WELL)
BLOWDOWN
SANITARY CANAL FLOW
EXISTING CIRC WATER PUMPS
BARRIER WALL B (NEW)
MAKEUP WATER
EXISTING CIRC WATER INTAKE
4 X 25% PUMPS (NEW)
BARRIER WALL A (NEW)
EXISTING CIRC WATER DISCHARGE
CRAWFORD STATION
UNITS 7 & 8
COOLING TOWER CONCEPTUAL LAYOUT
STATION 13
CRAWFORO
MIDWEST GENERATION
REVISION 1


NORTH
CONDENSERS
SANITARY CANAL FLOW
MAKEUP WATER
BARRIER WALL A (NEW)
EXISTING CIRC WATER PUMPS
EXISTING CIRC WATER INTAKE
EVAPORATION LOSS
BLOWDOWN
COOLING TOWER (3 SECTIONS)
BARRIER WALL B (NEW)
4 X 25% PUMPS (NEW)
EXISTING CIRC WATER DISCHARGE
2 X 20% AND 4 X 15 % PUMPS (NEW)
WILL COUNTY STATION
UNITS 3, 4
COOLING TOWER CONCEPTUAL LAYOUT
STATION 18
WILL COUNTY
MIDWEST GENERATION
REVISION 1


NORTH
DES PLAINES RIVER FLOW
BLOWDOWN
MAKEUP WATER
EXISTING CIRC WATER INTAKE
BARRIER WALL B
(NEW)
EVAPORATION
LOSS
EXISTING
CIRC WATER
PUMPS
COOLING
TOWER
(2 SECTIONS)
4 X 25% PUMPS
(NEW)
4 X 25% PUMPS
(NEW)
BARRIER WALL A
(NEW)
EXISTING
CIRC WATER
DISCHARGE
CONDENSER
REV
DATE
REVISION
BY
CKD
ENG
APPD
JOLIET STATION
UNIT 6
COOLING TOWER CONCEPTUAL LAYOUT
STATION 9
JOLIET
MIDWEST
GENERATION
SCALE
NONE
DATE
REVISION I



NORTH
CONDENSERS
EVAPORATION
LOSS
COOLING TOWER
(3 SECTIONS)
6 X 17%
PUMPS
(NEW)
EXISTING
CIRC WATER
PUMPS
MAKEUP WATER
BARRIER WALL C
(NEW)
DES PLAINES RIVER FLOW
EXISTING CIRC WATER INTAKE
FLUME CONNECTING
EXISTING INLET
AND OUTLET
(NEW)
6 X 17%
PUMPS
(NEW)
DIVIDING
WALL
(NEW)
BARRIER WALL A
(NEW)
BLOWDOWN
BARRIER WALL B
(NEW)
EXISTING CIRC WATER DISCHARGE
JOLIET STATION
UNITS 7 & 8
COOLING TOWER CONCEPTUAL LAYOUT
STATION 29
JOLIET
MIDWEST
GENERATION
REVISION 1

EXHIBIT C

Cooling Tower Sizing and Specification Data

Cooling Tower Design Data - Fisk Unit 19
Cooling Tower Design Data

Case	Units	Wet/Dry
Total Number of Tower Sections		2
Water Flow to be Cooled	gpm	210,000 total
Ambient Wet Bulb Temperature	°F	78
Ambient Dry Bulb Temperature	°F	94
Cooling Tower Approach	°F	7
Cooling Tower Range	°F	12.72
Cooling Tower Drift	%	0.0005
Cycles of Concentration		5
Makeup Source		South Branch of Chicago River
Makeup Total Suspended Solids*	mg/l	17.1
Makeup Total Dissolved Solids*	mg/l	736
Makeup BOD*	mg/l	6
Cooling Tower Cell Arrangement		Single Row

Cooling Tower Design Data - Crawford Units 7&8
Cooling Tower Design Data

Case	Units	Wet/Dry
Total Number of Tower Sections		2
Water Flow to be Cooled	gpm	382,400 total
Ambient Wet Bulb Temperature	°F	78
Ambient Dry Bulb Temperature	°F	94
Cooling Tower Approach	°F	7
Cooling Tower Range	°F	12.61
Cooling Tower Drift	%	0.0005
Cycles of Concentration		5
Makeup Source		Chicago Sanitary and Ship Canal
Makeup Total Suspended Solids*	mg/l	17.1
Makeup Total Dissolved Solids*	mg/l	736
Makeup BOD*	mg/l	6
Cooling Tower Cell Arrangement		Single Row

Cooling Tower Design Data - Will County Units 3&4
Cooling Tower Design Data

Case	Units	Wet/Dry
Total Number of Tower Sections		3
Water Flow to be Cooled	gpm	600,000 total
Ambient Wet Bulb Temperature	°F	78
Ambient Dry Bulb Temperature	°F	94
Cooling Tower Approach	°F	7
Cooling Tower Range	°F	11.12
Cooling Tower Drift	%	0.0005
Cycles of Concentration		5
Makeup Source		Chicago Sanitary and Ship Canal
Makeup Total Suspended Solids*	mg/l	18.7
Makeup Total Dissolved Solids*	mg/l	844
Makeup BOD*	mg/l	6.4
Cooling Tower Cell Arrangement		Single Row

Cooling Tower Design Data - Joliet Unit 6
Cooling Tower Design Data

Case	Units	Wet/Dry
Total Number of Tower Sections		2
Water Flow to be Cooled	gpm	261,000 total
Ambient Wet Bulb Temperature	°F	78
Ambient Dry Bulb Temperature	°F	94
Cooling Tower Approach	°F	7
Cooling Tower Range	°F	10.69
Cooling Tower Drift	%	0.0005
Cycles of Concentration		5
Makeup Source		Lower Des Plaines River
Makeup Total Suspended Solids*	mg/l	21.7
Makeup Total Dissolved Solids*	mg/l	587
Makeup BOD*	mg/l	3
Cooling Tower Cell Arrangement		Single Row

Cooling Tower Design Data - Joliet Units 7&8
Cooling Tower Design Data

Case	Units	Wet/Dry
Total Number of Tower Sections		3
Water Flow to be Cooled	gpm	920,000 total
Ambient Wet Bulb Temperature	°F	78
Ambient Dry Bulb Temperature	°F	94
Cooling Tower Approach	°F	7
Cooling Tower Range	°F	12.44
Cooling Tower Drift	%	0.0005
Cycles of Concentration		5
Makeup Source		Lower Des Plaines River
Makeup Total Suspended Solids*	mg/l	21.7
Makeup Total Dissolved Solids*	mg/l	587
Makeup BOD*	mg/l	3
Cooling Tower Cell Arrangement		Single Row

* Total Suspended Solids, Total Dissolved Solids and BOD data are 90th percentile values for locations adjacent to each station. Water quality information was obtained from the Metropolitan Water Reclamation District. Refer to Exhibit F.

EXHIBIT D

Design Basis for Cooling Tower Selection

The following are unit specific design criteria that were used for developing the cooling tower options for each station. All O&M and lost capacity costs were developed using an annual-average plant capacity factor of 75 percent.

A. Design Features for Fisk Station:

1) The cooling system design and cost estimate are for cooling towers for Fisk Unit 19. Tower design data is shown in Exhibit C.

2) The heat rejection at the current unit gross rating of 348 MW was calculated to be 1,335 mmBtu/hr based on condenser heat balance calculations using the original heat balance diagrams.

3) The CW flow rate through the condenser was assumed to be 210,000 gpm, the original design value. This results in a calculated condenser temperature rise of 12.72°F. However, plant personnel indicate that the temperature rise can be as high as 20°F. It is not known if this is due to deteriorated CW pump performance or operation with a CW pump offline. The calculated rise and original flow rate were used in the tower design and cost estimate, resulting in a larger tower and higher cost estimate.

4) At the summer design wet bulb temperature, an 85°F condenser inlet temperature would occur under closed-cycle operation. This is calculated to result in a turbine backpressure of 2.29 in HgA at a 70% cleanliness factor.

5) Based on station data and Metropolitan Water Reclamation District data provided by Midwest Generation, the cooling tower was designed for river water makeup with a total suspended solids level of 17.1 ppm, a total dissolved solids level of 736 ppm, and a BOD of 6 ppm. Based on the relatively low total suspended solids levels in the make-up, Marley designed the cooling towers to use anti-clog film fill.

6) The cooling system design includes two cooling towers of 8 cells each. Each cell is 48 ft x 48 ft and has a 250 hp fan that is 30 ft in diameter.

B. Design Features for Crawford Station:

1) The cooling system design and cost estimate are for cooling towers shared by Crawford Units 7&8. Tower design data is shown in Exhibit C.

2) The heat rejection for the cooling towers at the current unit gross rating was calculated based on condenser heat balance calculations using the original heat balance diagrams. For Unit 7 the heat rejection was calculated to be 992 mmBtu/hr at 237 MW. For Unit 8 the heat rejection was calculated to be 1,417 mmBtu/hr at 348 MW.

3) The combined CW flow rate through the Units 7 and 8 condensers was assumed to be 382,400 gpm, the original design value. This results in a calculated combined Unit 7 and 8 CW temperature rise of 12.61°F. However, plant personnel indicate that the temperature rise can be as high as 16°F for Unit 7 and 15°F for Unit 8. It is not known if this is due to deteriorated CW pump performance or operation with a CW pump offline. The calculated rise and original flow rate were used in the tower design and cost estimate, resulting in a larger tower and higher cost estimate.

4) At the summer design wet bulb temperature, an 85°F condenser inlet temperature would occur under closed-cycle operation. This is calculated to result in turbine backpressure of 2.94 and 2.41 in HgA the Units 7 and 8, respectively, at a 70% cleanliness factor.

5) Based on station data and Metropolitan Water Reclamation District data provided by Midwest Generation, the cooling tower was designed for river water makeup with a total suspended solids level of 17.1 ppm, a total dissolved solids level of 736 ppm, and a BOD of 6 ppm. Based on this data, Marley designed the cooling towers to use anti-clog film fill.

6) The cooling system design includes two cooling tower sections with a total of 30 cells. Each cell is 48 ft x 48 ft and has a 250 hp fan that is 28 ft in diameter.

C. Design Features for Will County Station:

1) The cooling system design and cost estimate are for cooling towers shared by Will County Units 3 and 4. Tower design data is shown in Exhibit C.

2) The heat rejection for the cooling towers at the current unit gross rating was calculated based on condenser heat balance calculations using the original heat balance diagrams. For Unit 3 the heat rejection was calculated to be 1,099 mmBtu/hr at 281 MW. For Unit 4 the heat rejection was calculated to be 2,235 mmBtu/hr at 551 MW.

3) The combined CW flow rate through the Units 3 and 4 condensers was assumed to be 600,000 gpm, the original design value. This results in a calculated combined Unit 3 and 4 CW temperature rise of 11.12°F.

4) At the summer design wet bulb temperature, an 85°F condenser inlet temperature would occur under closed-cycle operation. This is calculated to result in turbine backpressures of 2.34 for Unit 3, and 2.17 HgA for Unit 4, at a 70% cleanliness factor.

5) Based on station data and Metropolitan Water Reclamation District data provided by Midwest Generation, the cooling tower was designed for river water makeup with a total suspended solids level of 18.7 ppm, a total dissolved solids level of 844 ppm, and a BOD of 6.4 ppm. Based on this data, Marley designed the cooling towers to use anti-clog film fill.

6) The cooling system design includes three cooling tower sections with a total of 40 cells. Each cell is 48 ft long x 48 ft wide and has a 250 hp fan that is 28 ft in diameter.

D. Design features for Joliet Unit 6:

1) The cooling system design for the Joliet 6 cooling towers are shown in Exhibit C.

2) The heat rejection at the current unit gross rating of 341 MW was calculated to be 1,395 mmBtu/hr based on condenser heat balance calculations using the original heat balance diagrams.

3) The CW flow rate through the Unit 6 condenser was assumed to be 261,000 gpm, the original design value. This results in a calculated CW temperature rise of 10.69°F.

4) At the summer design wet bulb temperature, an 85°F condenser inlet temperature would occur under closed-cycle operation. This results in a turbine backpressure of 2.30 in HgA at a 70% cleanliness factor.

5) Based on station data and Metropolitan Water Reclamation District data provided by Midwest Generation, the cooling tower was designed for river water makeup with a total suspended solids level of 21.7 ppm, a total dissolved solids level of 587 ppm, and a BOD of 3 ppm. Based on this data, Marley designed the cooling towers to use anti-clog film fill.

6) The cooling system design includes two cooling towers with a total of 18 cells. Each cell is 48 ft long x 48 ft wide and has a 240 hp fan that is 30 ft in diameter.

E. Design Features for Joliet Unit 7&8:

1) The cooling system design and cost estimate are for cooling towers shared by Joliet Units 7&8. This is shown in Exhibit C.

2) The heat rejection at the current unit gross rating of 569 MW was calculated to be 2,861 mmBtu/hr based on condenser heat balance calculations using the original heat balance diagrams.

3) The CW flow rate through the Units 7&8 condensers was assumed to be 920,000 gpm, the original design value. This results in a calculated CW temperature rise of 12.44°F.

4) At the summer design wet bulb temperature, an 85°F condenser inlet temperature would occur under closed-cycle operation. This results in a calculated turbine backpressure of 2.32 in HgA for Unit 7 or 8.

5) Based on station data and Metropolitan Water Reclamation District data provided by Midwest Generation, the cooling tower was designed for river water makeup with a total suspended solids level of 21.7 ppm, a total dissolved solids level of 587 ppm, and a BOD of 3 ppm. Based on this data, Marley designed the cooling towers to use anti-clog film fill.

6) The cooling system design includes three cooling tower sections with a total of 64 cells. Each cell is 48 ft long x 48 ft wide and has a 250 hp fan that is 30 ft in diameter.

7) The existing Psychometric System Inc (PSI) helper cooling tower was assumed to be abandoned in place. The high drift rate of this tower would make permitting more difficult, and the tower would be difficult to incorporate into a closed-cycle operating scenario.

EXHIBIT E

Particulate Emissions Calculations

PROJECT: MidWest Gen Cooling Tower Evaluation

		Wet Cooling Towers				
Case Description		Fisk 19	Crawford 7&8	W/C 3&4	Joliet 6	Joliet 7&8
Number of Total Cells		16	30	40	18	64
Number of Cooling Towers (Marley info is all in terms of 2 towers)		2	2	2	2	2
Water						
Makeup Water TDS	ppm	736	736	844	587	587
Maximum Cycles of Concentration		5	5	5	5	5
TDS of Circ. Water	ppm (mg/L)	3,680	3,680	4,220	2,935	2,935
Cooling Tower						
Hours of Operation per Year	hours/year	8,760	8,760	8,760	8,760	8,760
Total Circulating Water Flow per Cell	gpm	**13,125**	**12,747**	**15,000**	**14,500**	**14,375**
Total Circulating Water Flow per Cell	gal/hr	787,500	764,800	900,000	870,000	862,500
Total Circulating Water Flow per Cell	lb/hr	6,567,750	6,378,432	7,506,000	7,255,800	7,193,250
Total Circulating Water Flow per Cell	L/hr	2,981,003	2,895,074	3,406,860	3,293,298	3,264,908
Approximate Cooling Water Make-up Flow	%	1.575%	1.575%	1.575%	1.575%	1.575%
Approximate Cooling Water Make-up Flow per Cell	gpm	207	201	236	228	226
Approximate Cooling Water Make-up Flow per Cell	MGD	0.30	0.29	0.34	0.33	0.33
Approximate Cooling Water Make-up Flow (Total)	MGD	4.80	8.70	13.60	5.94	21.12
Mist Eliminator/Drift Rate	%	0.0005%	0.0005%	0.0005%	0.0005%	0.0005%
Calculated Drift Loss per Cell	lb/hr	32.8	31.9	37.5	36.3	36.0
Calculated Drift Loss per Cell	gpm	0.066	0.064	0.075	0.073	0.072
Calculated Drift Loss (Total)	gpm	1.0	1.9	3.0	1.3	4.6
PM10:PM Ratio	ratio	41.6%	41.6%	36.3%	50.7%	50.7%
PM2.5:PM Ratio	ratio	0.20%	0.20%	0.20%	0.20%	0.20%
EMISSIONS						
PER CELL						
PM Emissions per Cell (TDS x Drift Loss)	lb/hr	0.121	0.117	0.158	0.107	0.106
PM Emission per Cell	tons/year	0.53	0.51	0.69	0.47	0.46
PM-10 Emissions per Cell	lb/hr	0.05	0.05	0.06	0.05	0.05
PM-10 Emissions per Cell	tons/year	0.22	0.21	0.25	0.24	0.23
PM2.5 Emissions per Cell	lb/hr	0.00024	0.00023	0.00032	0.00021	0.00021
PM2.5 Emissions per Cell	tons/year	0.0011	0.0010	0.0014	0.0009	0.0009
COOLING TOWER EMISSIONS RESULTS						
Total PM Emissions (Total emissions per cell x # of cells)	lb/hr	1.94	3.51	6.32	1.93	6.78
Total PM Emissions (Total emissions per cell x # of cells)	tons/year	8.5	15.4	27.7	8.5	29.7
PM10 Emissions (Total Cooling Tower)	lb/hr	0.81	1.46	2.29	0.98	3.44
PM10 Emissions (Total Cooling Tower)	tons/year	3.53	6.40	10.05	4.29	15.06
PM2.5 Emissions (Total Cooling Tower)	lb/hr	0.0039	0.0070	0.0126	0.0039	0.0136
PM2.5 Emissions (Total Cooling Tower)	tons/year	0.017	0.031	0.055	0.017	0.059

Conversion Factors

Typical density of water	lb/gal	8.34
Conversion from gallons to liters	L/gal	3.7854
conversion from lbs. to grams	grams/lb	453.59

EXHIBIT F

Metropolitan Water Reclamation District Water Quality Data

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

WATER QUALITY DATA FOR SELECTED PARAMETERS AND LOCATIONS AT THE CHICAGO RIVER SYSTEM IN 2004

Location Code	Location	Date	BOD_5 (mg/L)[1]	TSS (mg/L)[2]	TDS (mg/L)[3]
	Fisk/Crawford Input:				
40	Damen Avenue, Chicago Sanitary & Ship Canal	01/20/04	3.000	11.0	658
40	Damen Avenue, Chicago Sanitary & Ship Canal	02/17/04	3.000	24.0	756
40	Damen Avenue, Chicago Sanitary & Ship Canal	03/15/04	6.000	14.0	644
40	Damen Avenue, Chicago Sanitary & Ship Canal	04/19/04	7.000	13.0	620
40	Damen Avenue, Chicago Sanitary & Ship Canal	05/17/04	3.000	11.0	414
40	Damen Avenue, Chicago Sanitary & Ship Canal	06/21/04	0.000	18.0	340
40	Damen Avenue, Chicago Sanitary & Ship Canal	07/19/04	3.000	11.0	296
40	Damen Avenue, Chicago Sanitary & Ship Canal	08/16/04	0.000	9.0	262
40	Damen Avenue, Chicago Sanitary & Ship Canal	09/20/04	0.000	11.0	342
40	Damen Avenue, Chicago Sanitary & Ship Canal	10/18/04	0.000	23.0	344
40	Damen Avenue, Chicago Sanitary & Ship Canal	11/15/04	0.000	15.0	424
40	Damen Avenue, Chicago Sanitary & Ship Canal	12/20/04	4.000	15.0	566
41	Harlem Avenue, Chicago Sanitary & Ship Canal	01/20/04	5.000	6.0	776
41	Harlem Avenue, Chicago Sanitary & Ship Canal	02/17/04	6.000	9.0	750
41	Harlem Avenue, Chicago Sanitary & Ship Canal	03/15/04	4.000	8.0	704
41	Harlem Avenue, Chicago Sanitary & Ship Canal	04/19/04	9.000	12.0	662
41	Harlem Avenue, Chicago Sanitary & Ship Canal	05/17/04	3.000	5.0	512
41	Harlem Avenue, Chicago Sanitary & Ship Canal	06/21/04	0.000	12.0	442
41	Harlem Avenue, Chicago Sanitary & Ship Canal	07/19/04	3.000	7.0	404
41	Harlem Avenue, Chicago Sanitary & Ship Canal	08/16/04	5.000	12.0	360
41	Harlem Avenue, Chicago Sanitary & Ship Canal	09/20/04	0.000	8.0	420
41	Harlem Avenue, Chicago Sanitary & Ship Canal	10/18/04	0.000	13.0	418
41	Harlem Avenue, Chicago Sanitary & Ship Canal	11/15/04	0.000	10.0	434
41	Harlem Avenue, Chicago Sanitary & Ship Canal	12/20/04	3.000	0.0	610
	Average Fisk/Crawford Values		2.792	11.5	507
	Max Fisk/Crawford Values		9.000	24.0	776
	Min Fisk/Crawford Values		0.000	0.0	262
	90% value		6.000	17.1	736
	95% value		6.850	22.3	755
	Will County Input:				
42	Route 83, Chicago Sanitary & Ship Canal	01/20/04	4.000	7.0	1124
42	Route 83, Chicago Sanitary & Ship Canal	02/17/04	3.000	7.0	866
42	Route 83, Chicago Sanitary & Ship Canal	03/15/04	3.000	6.0	520
42	Route 83, Chicago Sanitary & Ship Canal	04/19/04	8.000	9.0	728
42	Route 83, Chicago Sanitary & Ship Canal	05/17/04	7.000	5.0	504
42	Route 83, Chicago Sanitary & Ship Canal	06/21/04	0.000	10.0	498
42	Route 83, Chicago Sanitary & Ship Canal	07/19/04	5.000	9.0	476
42	Route 83, Chicago Sanitary & Ship Canal	08/16/04	0.000	10.0	364
42	Route 83, Chicago Sanitary & Ship Canal	09/20/04	4.000	10.0	460
42	Route 83, Chicago Sanitary & Ship Canal	10/18/04	0.000	21.0	430
42	Route 83, Chicago Sanitary & Ship Canal	11/15/04	0.000	14.0	466
42	Route 83, Chicago Sanitary & Ship Canal	12/20/04	0.000	0.0	622

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

WATER QUALITY DATA FOR SELECTED PARAMETERS AND LOCATIONS
AT THE CHICAGO RIVER SYSTEM IN 2004

Location Code	Location	Date	BOD_5 (mg/L)[1]	TSS (mg/L)[2]	TDS (mg/L)[3]
48	Stephen Street, Chicago Sanitary & Ship Canal	01/20/04	3.000	10.0	794
48	Stephen Street, Chicago Sanitary & Ship Canal	02/17/04	3.000	9.0	1094
48	Stephen Street, Chicago Sanitary & Ship Canal	03/15/04	3.000	16.0	754
48	Stephen Street, Chicago Sanitary & Ship Canal	04/19/04	10.000	12.0	758
48	Stephen Street, Chicago Sanitary & Ship Canal	05/17/04	0.000	15.0	508
48	Stephen Street, Chicago Sanitary & Ship Canal	06/21/04	0.000	14.0	516
48	Stephen Street, Chicago Sanitary & Ship Canal	07/19/04	0.000	10.0	492
48	Stephen Street, Chicago Sanitary & Ship Canal	08/16/04	0.000	18.0	386
48	Stephen Street, Chicago Sanitary & Ship Canal	09/20/04	0.000	10.0	384
48	Stephen Street, Chicago Sanitary & Ship Canal	10/18/04	0.000	19.0	450
48	Stephen Street, Chicago Sanitary & Ship Canal	11/15/04	0.000	41.0	530
48	Stephen Street, Chicago Sanitary & Ship Canal	12/20/04	3.000	15.0	428
	Average Will County Values		2.333	12.4	590
	Max Will County Values		10.000	41.0	1124
	Min Will County Values		0.000	0.0	364
	90% value		6.400	18.7	844
	95% value		7.850	20.7	1060
	Joliet Input:				
92	Lockport Forebay, Chicago Sanitary & Ship Canal	01/05/04	0.000	11.0	590
92	Lockport Forebay, Chicago Sanitary & Ship Canal	01/12/04	3.000	10.0	1320
92	Lockport Forebay, Chicago Sanitary & Ship Canal	01/20/04	0.000	11.0	840
92	Lockport Forebay, Chicago Sanitary & Ship Canal	01/26/04	6.000	7.0	684
92	Lockport Forebay, Chicago Sanitary & Ship Canal	02/02/04	0.000	7.0	1150
92	Lockport Forebay, Chicago Sanitary & Ship Canal	02/09/04	3.000	9.0	1458
92	Lockport Forebay, Chicago Sanitary & Ship Canal	02/17/04	4.000	10.0	1060
92	Lockport Forebay, Chicago Sanitary & Ship Canal	02/23/04	3.000	13.0	908
92	Lockport Forebay, Chicago Sanitary & Ship Canal	03/01/04	3.000	13.0	964
92	Lockport Forebay, Chicago Sanitary & Ship Canal	03/08/04	4.000	26.0	752
92	Lockport Forebay, Chicago Sanitary & Ship Canal	03/15/04	0.000	29.0	750
92	Lockport Forebay, Chicago Sanitary & Ship Canal	03/22/04	0.000	7.0	802
92	Lockport Forebay, Chicago Sanitary & Ship Canal	03/29/04	5.000	12.0	706
92	Lockport Forebay, Chicago Sanitary & Ship Canal	04/05/04	0.000	8.0	690
92	Lockport Forebay, Chicago Sanitary & Ship Canal	04/12/04	3.000	8.0	736
92	Lockport Forebay, Chicago Sanitary & Ship Canal	04/19/04	5.000	13.0	740
92	Lockport Forebay, Chicago Sanitary & Ship Canal	04/26/04	0.000	16.0	666
92	Lockport Forebay, Chicago Sanitary & Ship Canal	05/03/04	6.000	14.0	532
92	Lockport Forebay, Chicago Sanitary & Ship Canal	05/10/04	0.000	18.0	501
92	Lockport Forebay, Chicago Sanitary & Ship Canal	05/17/04	4.000	11.0	452
92	Lockport Forebay, Chicago Sanitary & Ship Canal	05/24/04	3.000	23.0	560
92	Lockport Forebay, Chicago Sanitary & Ship Canal	06/01/04	ND	24.0	419
92	Lockport Forebay, Chicago Sanitary & Ship Canal	06/07/04	0.000	30.0	654
92	Lockport Forebay, Chicago Sanitary & Ship Canal	06/14/04	4.000	30.0	377
92	Lockport Forebay, Chicago Sanitary & Ship Canal	06/21/04	0.000	13.0	518

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

WATER QUALITY DATA FOR SELECTED PARAMETERS AND LOCATIONS
AT THE CHICAGO RIVER SYSTEM IN 2004

Location Code	Location	Date	BOD_5 (mg/L)[1]	TSS (mg/L)[2]	TDS (mg/L)[3]
92	Lockport Forebay, Chicago Sanitary & Ship Canal	06/28/04	0.000	5.0	476
92	Lockport Forebay, Chicago Sanitary & Ship Canal	07/06/04	ND	ND	348
92	Lockport Forebay, Chicago Sanitary & Ship Canal	07/12/04	0.000	13.0	416
92	Lockport Forebay, Chicago Sanitary & Ship Canal	07/19/04	0.000	5.0	504
92	Lockport Forebay, Chicago Sanitary & Ship Canal	07/26/04	3.000	17.0	382
92	Lockport Forebay, Chicago Sanitary & Ship Canal	08/02/04	0.000	18.0	442
92	Lockport Forebay, Chicago Sanitary & Ship Canal	08/09/04	3.000	13.0	418
92	Lockport Forebay, Chicago Sanitary & Ship Canal	08/16/04	0.000	22.0	370
92	Lockport Forebay, Chicago Sanitary & Ship Canal	08/23/04	0.000	10.0	458
92	Lockport Forebay, Chicago Sanitary & Ship Canal	08/30/04	3.000	18.0	308
92	Lockport Forebay, Chicago Sanitary & Ship Canal	09/07/04	0.000	10.0	496
92	Lockport Forebay, Chicago Sanitary & Ship Canal	09/13/04	0.000	14.0	480
92	Lockport Forebay, Chicago Sanitary & Ship Canal	09/20/04	0.000	10.0	376
92	Lockport Forebay, Chicago Sanitary & Ship Canal	09/27/04	0.000	13.0	446
92	Lockport Forebay, Chicago Sanitary & Ship Canal	10/04/04	0.000	19.0	472
92	Lockport Forebay, Chicago Sanitary & Ship Canal	10/11/04	0.000	21.0	517
92	Lockport Forebay, Chicago Sanitary & Ship Canal	10/18/04	0.000	22.0	466
92	Lockport Forebay, Chicago Sanitary & Ship Canal	10/25/04	0.000	23.0	468
92	Lockport Forebay, Chicago Sanitary & Ship Canal	11/01/04	0.000	15.0	496
92	Lockport Forebay, Chicago Sanitary & Ship Canal	11/08/04	3.000	12.0	399
92	Lockport Forebay, Chicago Sanitary & Ship Canal	11/15/04	0.000	16.0	526
92	Lockport Forebay, Chicago Sanitary & Ship Canal	11/22/04	0.000	9.0	610
92	Lockport Forebay, Chicago Sanitary & Ship Canal	11/29/04	0.000	10.0	603
92	Lockport Forebay, Chicago Sanitary & Ship Canal	12/06/04	0.000	15.0	442
92	Lockport Forebay, Chicago Sanitary & Ship Canal	12/13/04	4.000	14.0	552
92	Lockport Forebay, Chicago Sanitary & Ship Canal	12/20/04	3.000	7.0	404
92	Lockport Forebay, Chicago Sanitary & Ship Canal	12/27/04	0.000	20.0	602
	Average Joliet Values		1.500	14.6	602
	Max Joliet Values (Max TSS Used from USGS data. Not Available		6.000	30.0	1458
	Min Joliet Values		0.000	5.0	308
	90% value		3.000	21.7	587
	95% value		3.000	22.0	603

[1]Biochemical Oxygen Demand

[2]Total Suspended Solids

[3]Total Dissolved Solids

ND = No Data

EXHIBIT G

Cooling Tower Blowdown, Evaporation and Make-Up Water Data

Station	Average Summer Water Usage – Closed-Cycle Evaporation (gpm)	Makeup (gpm)	Blowdown (gpm)
Fisk 19	2608	3261	652
Crawford 7&8	4776	5972	1194
Will County 3&4	6834	8546	1709
Joliet 6	3006	3759	752
Joliet 7&8	11888	14865	2972

Station	Average Winter Water Usage – Closed-Cycle Evaporation (gpm)	Makeup (gpm)	Blowdown (gpm)
Fisk 19	1708	2136	427
Crawford 7&8	3082	3855	771
Will County 3&4	4430	5541	1108
Joliet 6	1914	2394	479
Joliet 7&8	7788	9740	1947

Station	Average Annual Makeup (Mgal/yr) – Closed-Cycle
Fisk 19	1418
Crawford 7&8	2582
Will County 3&4	3702
Joliet 6	1617
Joliet 7&8	6466

Note: The total annual fresh water makeup (Mgal/yr) is bounded by the winter and summer values. Averaging the winter and summer values is a reasonable approximation for annual average.

EXHIBIT H

Cooling Tower Blowdown Temperature Data

Fisk:

Based on the SPX/Marley wet/dry cooling tower design data tabulated in Exhibit C, the temperature of the cooling tower blowdown from the Fisk 19 cooling system under summer design conditions would be as shown in Table H-1:

Table H-1
Fisk 19 Cooling Tower Blowdown Temperatures at B/D Flowrate = 652 gpm
Towers Designed for 7 F Approach at 78 F Wet Bulb

Month	1% WB Temp (F)	Blowdown Temperature (F)	UAA Proposed Average ALU B Temp Limits (F)
January	47.5	63.9	54.3
February	50.1	65.6	53.6
March	60.9	72.5	57.2
April	65.3	76	60.8/62.1
May	72.1	80.9	69.2/71.4
June	76.2	83.8	74.2/86.7
July	79.5	86	86.7
August	78.5	85.5	86.7
September	74.6	82.5	86.7/77
October	66.3	76.5	73.2/69.6
November	60.7	72.5	66.2
December	56.3	69.5	59.9
Maximum Temperature, Any Month			90.3

Crawford:

Based on the SPX/Marley wet/dry cooling tower design data tabulated in Exhibit C, the temperature of the cooling tower blowdown from the Crawford 7&8 cooling system under summer design conditions would be as shown in Table H-2:

Table H-2
Crawford 7&8 Cooling Tower Blowdown Temperatures at B/D Flowrate = 1194 gpm
Towers Designed for 7 F Approach at 78 F Wet Bulb

Month	1% WB Temp (F)	Cooling Tower Blowdown Temperature (F)	UAA Proposed Average ALU B Temp Limits (F)
January	47.5	63.8	54.3
February	50.1	65.5	53.6
March	60.9	72.8	57.2
April	65.3	75.9	60.8/62.1
May	72.1	80.8	69.2/71.4
June	76.2	83.7	74.2/86.7
July	79.5	86.1	86.7
August	78.5	85.5	86.7
September	74.6	82.3	86.7/77
October	66.3	76.1	73.2/69.6
November	60.7	72.8	66.2
December	56.3	69.8	59.9
Maximum Temperature, Any Month			90.3

Will County:

Based on the SPX/Marley wet/dry cooling tower design data tabulated in Exhibit C, the temperature of the cooling tower blowdown from the Will County 3&4 cooling system under summer design conditions would be as shown in Table H-3:

Table H-3
Will County 3&4 Cooling Tower Blowdown Temperatures at B/D Flowrate = 1709 gpm
Towers Designed for 7 F Approach at 78 F Wet Bulb

Month	1% WB Temp (F)	Cooling Tower Blowdown Temperature (F)	UAA Proposed Average ALU B Temp Limits (F)
January	47.5	63.5	54.3
February	50.1	64.6	53.6
March	60.9	72.6	57.2
April	65.3	75.7	60.8/62.1
May	72.1	80.6	69.2/71.4
June	76.2	83.6	74.2/86.7
July	79.5	86.1	86.7
August	78.5	85.5	86.7
September	74.6	82.5	86.7/77
October	66.3	76.4	73.2/69.6
November	60.7	72.5	66.2
December	56.3	65.5	59.9
Maximum Temperature, Any Month			90.3

Joliet 6:

Based on the SPX/Marley wet/dry cooling tower design data tabulated in Exhibit C, the temperature of the cooling tower blowdown from the Joliet 6 cooling system under summer design conditions would be as shown in Table H-4:

Table H-4
Joliet 6 Cooling Tower Blowdown Temperatures at B/D Flowrate = 752 gpm
Towers Designed for 7 F Approach at 78 F Wet Bulb

Month	1% WB Temp (F)	Cooling Tower Blowdown Temperature (F)	UAA Proposed UDIP Temp Limits (F)
January	47.5	63	54.3
February	50.1	64.8	53.6
March	60.9	72	57.2
April	65.3	75.5	60.8/62.1
May	72.1	80.5	69.2/71.4
June	76.2	83.8	74.2/86.7
July	79.5	86	85.1
August	78.5	85.5	85.1
September	74.6	82.3	85.1/77
October	66.3	76.1	73.2/69.6
November	60.7	72	66.2
December	56.3	69	59.9
Maximum Temperature, Any Month			88.7

Joliet 7&8:

Based on the SPX/Marley wet/dry cooling tower design data tabulated in Exhibit C, the temperature of the cooling tower blowdown from the Joliet 7&8 cooling system under summer design conditions would be as shown in Table H-5:

Table H-5
Joliet 7&8 Cooling Tower Blowdown Temperatures at B/D Flowrate = 2972 gpm
Towers Designed for 7 F Approach at 78 F Wet Bulb

Month	1% WB Temp (F)	Cooling Tower Blowdown Temperature (F)	IEPA UDIP Temp Limits (F)
January	47.5	63.8	54.3
February	50.1	65.1	53.6
March	60.9	72.3	57.2
April	65.3	75.5	60.8/62.1
May	72.1	80.5	69.2/71.4
June	76.2	83.8	74.2/86.7
July	79.5	86.1	85.1
August	78.5	85.5	85.1
September	74.6	82.5	85.1/77
October	66.3	76.5	73.2/69.6
November	60.7	72.2	66.2
December	56.3	69.5	59.9
Maximum Temperature, Any Month			90.3

EXHIBIT I

Capital Cost Estimates

Estimate No.: 21870D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I1

Fisk 19

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
1	COOLING TOWER - WET / DRY	13,271,040	6,082,560	19,353,600
2	COOLING TOWER SUPPLY PUMPS	1,613,520	541,200	2,154,720
3	COOLING TOWER DISCHARGE PUMPS	909,060	204,180	1,113,240
4	YARD PIPING	2,166,000	2,642,640	4,808,640
5		0	0	0
6	BLOWDOWN PUMPS	0	0	NOT REQUIRED
7	BLOWDOWN PIPING	35,090	37,510	72,600
8	MAKEUP PUMPS	0	0	NOT REQUIRED
9	MAKEUP PIPING	0	0	NOT REQUIRED
10	WATER TREATMENT	1,614,600	2,127,840	3,742,440
11	OPEN	0	0	0
20	SITEWORK	0	764,750	764,750
21	CONSTRUCTABILITY ACTIVITIES	0	1,529,500	1,529,500
22	COOLING TOWER BASINS	750,070	1,965,540	2,715,610
23	CT SUPPLY PUMP STRUCTURE AND BASIN	797,040	2,122,130	2,919,170
24	CT DISCHARGE PUMP STRUCTURE AND BASIN	791,640	2,166,600	2,958,240
25	NEW GATE IN EXISTING CW DISCHARGE PIPE	663,000	774,700	1,437,700
26	TIE-IN CT DISCHARGE PIPING	19,720	103,600	123,320
27	MODIFY CRIBHOUSE FOR CT DISCHARGE PIPING	111,360	424,200	535,560
28	FOUNDATIONS FOR NEW CLARIFIERS AND MU WT PLANT	80,040	348,600	428,640
29	NEW MU WT BUILDING	1,173,920	973,000	2,146,920
30	CW PIPE SLEEPERS	419,920	2,072,000	2,491,920
31	MISCELLANEOUS STRUCTURES AND FOUNDATIONS	208,800	715,400	924,200
32	DEMOLISH OLD OIL/WATER SEPARATOR BLDG	0	89,600	89,600
33	DEMOLISH OLD METAL CLEANING TANK	0	89,600	89,600
34	DEMOLISH EXISTING MUW FACILITY	0	361,200	361,200
41	AUXILIARY POWER SYSTEM FOR CT	3,417,120	3,408,790	6,825,910
42	DCS INTEGRATON	186,840	27,930	214,770
43	REPLACE ACTIVE EQUIPMENT IN DEMOLISHED OLD SWITCH-HOUSE NO. 1	2,484,000	11,910,090	14,394,090
44	BOP INSTRUMENTATION	37,800	14,630	52,430
51	CLEANUP ALLOWANCE	0	305,900	305,900
52	WASTE DISPOSAL	0	152,950	152,950
53	MOBILIZE / DEMOBILIZE	524,458	2,097,832	2,622,290

Estimate No.: 21870D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I1

Fisk 19

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
54	EQUIPMENT RENTAL SUPPLEMENT, LARGE CRANES	0	1,101,362	1,101,362
	Total Equipment, Material and Labor Costs	**31,275,038**	**45,155,834**	**76,430,872**
	Consumables	156,375	0	156,375
	Freight-ExWorks To Site	720,160	0	720,160
	Taxes - Sales	**0**	**0**	0
	Contractor's General and Administration Expense	1,563,752	2,257,792	3,821,544
	Contractor's Profit	3,127,504	4,515,583	7,643,087
	Total Direct Project Costs	**36,842,829**	**51,929,209**	**88,772,038**
	Indirect Project Costs			
	Engineering			16,310,528
	Construction Management/Field Engineering			INCL. IN ENGR.
	Permitting			0
	Startup, testing			467,943
	Owner's cost			0
	Spare parts			1,529,000
	Subtotal			**107,079,509**
	EPC Differential			8,566,000
	Project Contingency			21,415,902
	Total Construction Cost			**137,061,411**

Estimate No.: 21871D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I2

Crawford 7 & 8

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
1	COOLING TOWER - WET / DRY	24,883,200	11,404,800	36,288,000
2	COOLING TOWER SUPPLY PUMPS	3,040,200	859,770	3,899,970
3	COOLING TOWER DISCHARGE PUMPS	674,710	157,440	832,150
4	YARD PIPING	4,652,400	5,740,240	10,392,640
5		0	0	0
6	BLOWDOWN PUMPS	0	0	NOT REQUIRED
7	BLOWDOWN PIPING	35,090	37,510	72,600
8	MAKEUP PUMPS	0	0	NOT REQUIRED
9	MAKEUP PIPING	0	0	NOT REQUIRED
10	WATER TREATMENT	322,920	303,800	626,720
11	WASTE WATER TREATMENT	0	0	NOT REQUIRED
19	SITEWORK	0	917,700	917,700
20	CONSTRUCTABILITY ACTIVITIES	0	1,529,500	1,529,500
21	OPEN	0	0	0
22	COOLING TOWER BASINS	1,647,800	4,575,450	6,223,250
23	CT SUPPLY PUMP STRUCTURE AND BASIN	221,400	1,075,450	1,296,850
24	CT DISCHARGE PUMP STRUCTURE AND BASIN	478,440	2,517,120	2,995,560
25	DISCHARGE STRUCTURE TO EXISTING CW DISCHARGE CHANNEL	32,860	105,820	138,680
26	NEW WALL AND GATE IN EXISTING CW DISCHARGE CHANNEL	614,900	419,100	1,034,000
27	DISCHARGE STRUCTURE TO EXISTING CW INLET CHANNEL	38,280	109,200	147,480
28	NEW WALL AND GATE ACROSS MOUTH OF EXISTING INTAKE CHANNEL	768,200	610,560	1,378,760
29	CW PIPE BRIDGE AND SLEEPERS	1,086,920	2,770,600	3,857,520
31	MISCELLANEOUS STRUCTURES AND FOUNDATIONS	208,800	715,400	924,200
32	DEMOLISH OLD SWITCHYARD STRUCTURE	0	180,600	180,600
33	DEMOLISH PEAKER UNITS	0	0	0
34	DEMOLISH LOCOMOTIVE MAINTENANCE BLDG	0	193,200	193,200
35	RELOCATE PART OF THE COAL PILE	0	89,600	89,600
36	TRANSMISSION LINE MODIFICATIONS	248,400	611,800	860,200
41	AUXILIARY POWER SYSTEM FOR CT	5,762,880	5,764,220	11,527,100
42	DCS INTEGRATON	185,760	29,260	215,020
44	BOP INSTRUMENTATION	49,680	22,610	72,290
51	CLEANUP ALLOWANCE	0	305,900	305,900
52	WASTE DISPOSAL	0	152,950	152,950

Estimate No.: 21871D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I2

Crawford 7 & 8

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
53	MOBILIZE / DEMOBILIZE	514,995	2,059,980	2,574,975
54	EQUIPMENT RENTAL SUPPLEMENT, LARGE CRANES	0	1,081,490	1,081,490
	Total Equipment, Material and Labor Costs	**45,467,835**	**44,341,070**	**89,808,905**
	Consumables	227,339	0	227,339
	Freight-ExWorks To Site	823,385	0	823,385
	Taxes - Sales	0	0	0
	Contractor's General and Administration Expense	2,273,392	2,217,053	4,490,445
	Contractor's Profit	4,546,784	4,434,107	8,980,890
	Total Direct Project Costs	**53,338,735**	**50,992,230**	**104,330,965**
	Indirect Project Costs			
	Engineering			22,497,280
	Construction Management/Field Engineering			INCL. IN ENGR.
	Permitting			0
	Startup, testing			467,943
	Owner's cost			0
	Spare parts			1,796,000
	Subtotal			**129,092,188**
	EPC Differential			10,327,000
	Project Contingency			25,818,438
	Total Construction Cost			**165,237,626**

Estimate No.: 21873D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I3

Will County 3 & 4

Wet/Dry Cooling Towers

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
1	COOLING TOWER - WET / DRY	33,177,600	15,206,400	48,384,000
2	COOLING TOWER SUPPLY PUMPS	3,942,000	947,100	4,889,100
3	COOLING TOWER DISCHARGE PUMPS	2,027,400	319,800	2,347,200
4	YARD PIPING	9,240,000	11,253,000	20,493,000
5		0	0	0
6	BLOWDOWN PUMPS	0	0	NOT REQUIRED
7	BLOWDOWN PIPING	35,090	37,510	72,600
8	MAKEUP PUMPS	0	0	NOT REQUIRED
9	MAKEUP PIPING	0	0	NOT REQUIRED
10	WATER TREATMENT	216,000	198,400	414,400
11	WASTE WATER TREATMENT	0	0	NOT REQUIRED
20	SITEWORK	0	3,059,000	3,059,000
21	CONSTRUCTABILITY ACTIVITIES	0	764,750	764,750
22	COOLING TOWER BASINS	3,413,300	6,316,800	9,730,100
23	CT SUPPLY PUMP STRUCTURE AND BASIN	259,200	1,109,700	1,368,900
24	CT DISCHARGE PUMP STRUCTURE AND BASIN	1,032,480	4,927,980	5,960,460
25	DISCHARGE STRUCTURE TO EXISTING CW DISCHARGE CHANNEL	165,360	391,820	557,180
26	NEW WALL AND GATE IN EXISTING CW DISCHARGE CHANNEL	614,900	628,650	1,243,550
27	MODIFY CRIB HOUSES	133,400	338,800	472,200
28	FILL ABANDONED POND	0	292,600	292,600
29	BRIDGE SYSTEM FOR CW PIPING	1,708,680	3,936,800	5,645,480
30	CW PIPE SLEEPERS	1,202,920	5,924,800	7,127,720
31	MISCELLANEOUS STRUCTURES AND FOUNDATIONS	605,520	2,489,200	3,094,720
32	RELOCATE TRANSMISSION LINES	496,800	1,529,500	2,026,300
33	OPEN	0	0	0
34	OPEN	0	0	0
41	AUXILIARY POWER SYSTEM FOR CT	9,007,200	14,310,800	23,318,000
42	DCS INTEGRATON	185,760	29,260	215,020
44	BOP INSTRUMENTATION	37,800	14,630	52,430
51	CLEANUP ALLOWANCE	0	305,900	305,900
52	WASTE DISPOSAL	0	152,950	152,950
53	MOBILIZE / DEMOBILIZE	931,077	3,724,308	4,655,384
54	EQUIPMENT RENTAL SUPPLEMENT, LARGE CRANES	0	1,955,261	1,955,261

Estimate No.: 21873D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I3

Will County 3 & 4

Wet/Dry Cooling Towers

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
	Total Equipment, Material and Labor Costs	**68,432,487**	**80,165,719**	**148,598,206**
	Consumables	342,162	0	342,162
	Freight-ExWorks To Site	1,410,195	0	1,410,195
	Taxes - Sales	0	0	0
	Contractor's General and Administration Expense	3,421,624	4,008,286	7,429,910
	Contractor's Profit	6,843,249	8,016,572	14,859,821
	Total Direct Project Costs	**80,449,718**	**92,190,577**	**172,640,295**
	Indirect Project Costs			
	Engineering			24,747,008
	Construction Management/Field Engineering			INCL. IN ENGR.
	Permitting			0
	Startup, testing			467,943
	Owner's cost			0
	Spare parts			2,972,000
	Subtotal			**200,827,246**
	EPC Differential			16,066,000
	Project Contingency			40,165,449
	Total Construction Cost			**257,058,695**

Estimate No.: 21874D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I4

Joliet 6

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
1	COOLING TOWER- WET / DRY	14,929,920	6,842,880	21,772,800
2	COOLING TOWER SUPPLY PUMPS	2,705,400	751,530	3,456,930
3	COOLING TOWER DISCHARGE PUMPS	1,014,790	205,410	1,220,200
4	YARD PIPING	3,258,000	3,798,190	7,056,190
5		0	0	0
6	BLOWDOWN PUMPS	0	0	NOT REQUIRED
7	BLOWDOWN PIPING	35,090	35,090	70,180
8	MAKEUP PUMPS	0	0	NOT REQUIRED
9	MAKEUP PIPING	0	0	NOT REQUIRED
10	WATER TREATMENT	0	0	NOT REQUIRED
11	WASTE WATER TREATMENT	0	0	NOT REQUIRED
20	SITEWORK INCL FLOOD PLAIN WORK	919,080	1,098,580	2,017,660
21	CONSTRUCTABILITY ACTIVITIES	0	764,750	764,750
22	COOLING TOWER BASINS	1,178,070	2,487,240	3,665,310
23	CT SUPPLY PUMP STRUCTURE AND BASIN	157,680	790,490	948,170
24	CT DISCHARGE PUMP STRUCTURE AND BASIN	333,720	1,489,020	1,822,740
25	DISCHARGE STRUCTURE TO EXISTING CW DISCHARGE CHANNEL	72,080	188,760	260,840
26	NEW WALL AND GATE IN EXISTING CW DISCHARGE CHANNEL	612,300	541,020	1,153,320
27	NEW WALL IN SANITARY CANAL AROUND EXISTING CRIBHOUSE WITH GATES	550,450	689,110	1,239,560
28	BRIDGE SYSTEM FOR CW PIPE	40,600	226,800	267,400
29	CW PIPE SLEEPERS	440,800	1,050,000	1,490,800
31	MISCELLANEOUS STRUCTURES AND FOUNDATIONS	393,240	1,365,000	1,758,240
32	DEMOLISH	0	0	0
33	OPEN	0	0	0
41	AUXILIARY POWER SYSTEM FOR CT	3,321,000	5,724,320	9,045,320
42	DCS INTEGRATON	186,840	29,260	216,100
44	BOP INSTRUMENTATION	37,800	14,630	52,430
51	CLEANUP ALLOWANCE	0	305,900	305,900
52	WASTE DISPOSAL	0	152,950	152,950
53	MOBILIZE / DEMOBILIZE	356,887	1,427,547	1,784,433
54	EQUIPMENT RENTAL SUPPLEMENT, LARGE CRANES	0	749,462	749,462

Estimate No.: 21874D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I4

Joliet 6

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
	Total Equipment, Material and Labor Costs	**30,543,747**	**30,727,938**	**61,271,685**
	Consumables	152,719	0	152,719
	Freight-ExWorks To Site	624,553	0	624,553
	Taxes - Sales	0	0	0
	Contractor's General and Administration Expense	1,527,187	1,536,397	3,063,584
	Contractor's Profit	3,054,375	3,072,794	6,127,169
	Total Direct Project Costs	**35,902,580**	**35,337,129**	**71,239,710**
	Indirect Project Costs			
	Engineering			17,435,392
	Construction Management/Field Engineering			INCL. IN ENGR.
	Permitting			0
	Startup, testing			467,943
	Owner's cost			0
	Spare parts			1,225,000
	Subtotal			**90,368,045**
	EPC Differential			7,229,000
	Project Contingency			18,073,609
	Total Construction Cost			**115,670,654**

Estimate No.: 21875D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I5

Joliet 7 & 8

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
1	COOLING TOWER - WET / DRY	53,084,160	24,330,240	77,414,400
2	COOLING TOWER SUPPLY PUMPS	6,046,000	1,293,000	7,339,000
3	COOLING TOWER DISCHARGE PUMPS	2,391,000	326,000	2,717,000
4	YARD PIPING	9,855,000	6,464,000	16,319,000
5		0	0	0
6	BLOWDOWN PUMPS	0	0	NOT REQUIRED
7	BLOWDOWN PIPING	35,000	35,000	70,000
8	MAKEUP PUMPS	0	0	NOT REQUIRED
9	MAKEUP PIPING	0	0	NOT REQUIRED
10	WATER TREATMENT	323,000	283,000	606,000
11	WASTE WATER TREATMENT	0	0	NOT REQUIRED
20	SITEWORK	0	3,059,000	3,059,000
21	CONSTRUCTABILITY ACTIVITIES	0	1,529,500	1,529,500
22	COOLING TOWER BASINS	4,292,000	9,019,000	13,311,000
23	CT SUPPLY PUMP STRUCTURE AND BASIN	357,000	1,341,000	1,698,000
24	CT DISCHARGE PUMP STRUCTURE AND BASIN	414,000	1,857,000	2,271,000
25	DISCHARGE STRUCTURE TO EXISTING DISCHARGE TUNNEL	220,000	392,000	612,000
26	NEW WALL AND GATE IN EXISTING DISCHARGE CHANNEL	1,344,000	1,738,000	3,082,000
27	NEW CHANNEL AND GATE ACROSS MOUTH OF EXISTING INLET AND DISCHARGE CHANNEL	849,000	1,629,000	2,478,000
28	NEW 2ND CHANNEL AND GATE ACROSS MOUTH OF EXISTING INLET AND DISCHARGE CHANNEL	802,000	756,000	1,558,000
29	CW PIPE EARTHWORK	0	492,100	492,100
31	MISCELLANEOUS STRUCTURES AND FOUNDATIONS	737,000	2,584,000	3,321,000
32	OPEN	0	0	0
33	OPEN	0	0	0
41	AUXILIARY POWER SYSTEM FOR CT	13,460,040	20,418,160	33,878,200
42	DCS INTEGRATON	185,760	29,260	215,020
44	BOP INSTRUMENTATION	37,800	14,630	52,430
51	CLEANUP ALLOWANCE	0	305,900	305,900
52	WASTE DISPOSAL		152,950	152,950
53	MOBILIZE / DEMOBILIZE	975,609	3,902,437	4,878,046
54	EQUIPMENT RENTAL SUPPLEMENT, LARGE CRANES	0	2,048,779	2,048,779

Estimate No.: 21875D
Project No.: 10683-130
Issue Date: 1/14/11
Preparer: JMK
Reviewer: RK

Exhibit I5

Joliet 7 & 8

Wet/Dry Cooling Towers

Conceptual Cost Estimate

Sargent & Lundy

Item No.	Description	Equipment & Material Cost	Labor Cost	Total Cost
	Total Equipment, Material and Labor Costs	**95,408,369**	**83,999,956**	**179,408,326**
	Consumables	477,042	0	477,042
	Freight-ExWorks To Site	1,692,968	0	1,692,968
	Taxes - Sales	0	0	0
	Contractor's General and Administration Expense	4,770,418	4,199,998	8,970,416
	Contractor's Profit	9,540,837	8,399,996	17,940,833
	Total Direct Project Costs	**111,889,635**	**96,599,950**	**208,489,585**
	Indirect Project Costs			
	Engineering			22,497,280
	Construction Management/Field Engineering			INCL. IN ENGR.
	Permitting			0
	Startup, testing			467,943
	Owner's cost			0
	Spare parts			3,588,000
	Subtotal			**235,042,808**
	EPC Differential			18,803,000
	Project Contingency			47,009,000
	Total Construction Cost			**300,854,808**

EXHIBIT J

Operation and Maintenance Cost Estimates

Sargent & Lundy LLC **Midwest Generation** **Project No. 10683-130**

Cooling Tower Operations & Maintenance Costs

	Fisk 19	Crawford 7&8	Will County 3&4 Plume Abated	Will County 3&4 Wet Tower	Joliet 6 Plume Abated	Joliet 6 Wet Tower	Joliet 7&8 Plume Abated	Joliet 7&8 Wet Tower
Total Gross MW of Site	348	585	832	832	341	341	1,138	1,138
Approach, F	7	7	7	7	7	7	7	7
Capacity Factor	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Aux Power Cost $/MWh	$37	$37	$37	$37	$37	$37	$37	$37
No of CT Cells	16	30	40	40	18	16	64	60
Fan BHP	250	250	250	250	250	250	250	250
CT MWh/yr	21,287	39,913	53,217	53,217	23,948	21,287	85,147	79,826
CT Power Cost	$781,438	$1,465,197	$1,953,596	$1,953,596	$879,118	$781,438	$3,125,754	$2,930,394
No of Supply Pumps	2	4	4	4	4	4	6	6
Supply Pump BHP	2,000	2,000	3,000	3,000	1,500	1,250	3,500	3,000
Supply Pump MWh/yr	21,287	42,574	63,860	63,860	31,930	26,609	111,756	95,791
Supply Pump Power Cost	$781,438	$1,562,877	$2,344,315	$2,344,315	$1,172,158	$976,798	$4,102,552	$3,516,473
No of Discharge Pumps	4	4	2	2	4	4	6	6
Discharge Pump BHP	200	300	500	500	250	250	400	400
Discharge Pump MWh/yr	4,257	6,386	5,322	5,322	5,322	5,322	12,772	12,772
Discharge Pump Power Cost	$156,288	$234,432	$195,360	$195,360	$195,360	$195,360	$468,863	$468,863
No of Discharge Pumps			4	4				
Discharge Pump BHP			350	300				
Discharge Pump MWh/yr			7,450	6,386				
Discharge Pump Power Cost			$273,503	$234,432				
Total MWh/yr	46,831	88,872	129,849	128,785	61,200	53,217	209,675	188,388
Total Pump Power Cost per year	$937,726	$1,797,308	$2,813,178	$2,774,106	$1,367,517	$1,172,158	$4,571,415	$3,985,336
Total Power Cost per year	$1,719,165	$3,262,505	$4,766,774	$4,727,702	$2,246,635	$1,953,596	$7,697,169	$6,915,730
Inspection $/cell	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
Total Cell Inspection Cost / year	$48,000	$90,000	$120,000	$120,000	$54,000	$48,000	$192,000	$180,000
Annual Cell Inspection and Pump Maintenance $/yr.	$60,000	$112,500	$150,000	$150,000	$67,500	$60,000	$240,000	$225,000
CW Treatment Chemicals $/MW/yr	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Total CW Treatment Chemicals $/yr.	$348,000	$585,000	$832,000	$832,000	$341,000	$341,000	$1,138,000	$1,138,000
Total O&M Costs ($/year)	$2,127,165	$3,960,005	$5,748,774	$5,709,702	$2,655,135	$2,354,596	$9,075,169	$8,278,730

Electronic Filing: Received, Clerk's Office 6/27/2018

EXHIBIT X

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

MIDWEST GENERATION, LLC	)	
Petitioner,	)	
v.	)	**PCB 16-19 (Time-Limited Water Quality**
	)	**Standard Variance)**
ILLINOIS ENVIRONMENTAL	)	
PROTECTION AGENCY	)	
Respondent.	)	

AFFIDAVIT OF RADHIKA deSILVA

1. I am employed as Principal Engineer/Vice President of ASA Analysis and Communications, Inc. (ASA). I have over 12 years of experience in water and wastewater issues for steam electric generating plants, refineries, and manufacturing facilities, including design and cost estimates for wastewater treatment systems, cooling water intake structures, and retrofitting of plants with closed-cycle cooling systems. A copy of my curriculum vitae which contains additional information regarding my experience and qualifications is attached as Exhibit A.

2. I received a Bachelor of Science degree in Environmental Engineering from Harvard University in 1995. I received Masters of Science degrees in both Environmental Engineering and Technology and Policy from the Massachusetts Institute of Technology (MIT) in 1998. I also received a Ph.D. in Environmental Engineering from Harvard University in 2002. I am a professional engineer licensed in the state of Delaware, and I have applied to be licensed as a professional engineer in the state of Illinois.

3. I personally have worked on studies and evaluations of cooling towers for new units and the conversion of existing once-through cooling systems to cooling towers. These studies included sizing, performance and cost estimates of cooling towers, and assessing the impact on the balance of the power plant.

4. I have reviewed documents concerning the intake of cooling water and the thermal discharges from the Midwest Generation, LLC ("MWGen") electric generating stations known as the Will County, Joliet 6 (also known as "Joliet Station 9") and Joliet 7&8 (also known as "Joliet Station 29"). I will refer to these stations collectively as the "MWGen Stations." I have also reviewed the report entitled "Midwest Generation EME, LLC Chicago Area Waterways and Lower Des Plaines River Generating Units Cooling Tower Cost Study", Report No. SL-009359, dated February 1, 2011, prepared by Sargent & Lundy, a copy of which is attached as Exhibit B (the "Sargent & Lundy Report"). I have personally visited the MWGen Stations and observed the intakes, outfalls, and station layouts. I have also observed the helper cooling tower at Joliet 29.

5. I reviewed the Sargent & Lundy Report to evaluate the findings and conclusions relating to the conversion of the Will County, and Joliets 9 and 29 from once-through cooling to closed-cycle cooling. The results of my evaluation are set forth below.

6. I agree with the Sargent & Lundy Report's statement that in the case of the MWGen Stations, the amount of heat rejected from condensing the turbine exhaust steam is greater than the amount of electricity generated and consequently, large cooling systems are required for the types of units at these stations. The MWGen Stations are equipped with once-through cooling systems and only the Joliet 29 Station has any cooling towers (albeit helper cooling towers). The MWGen Stations were not designed nor were the station sites arranged to operate in a closed-cycle cooling mode.

7. I evaluated the Sargent & Lundy Report's review of and findings regarding cooling technologies and agree with its conclusion that closed-cycle cooling technologies are not feasible/practical for the MWGen Stations. Sargent & Lundy correctly concluded that the cooling technologies of man-made cooling lakes and cooling ponds with sprays both require a significant amount of land area to construct and that these technologies are not technically feasible for the MWGen stations because of their site area limitations.

8. Joliet 29 Station is currently equipped with what are called "helper" cooling towers. A MWGen representative informed me that documentation in its files indicate these towers are designed for 400 MW thermal. The Joliet 29 Units 7 and 8 are rated for 572 MW and 578 MW, respectively, meaning that these units are capable of generating 572 megawatt-hours (MWhr) and 578 MWhr of electricity each hour. Of the 1,150 MW rating of the two units, the cooling tower is capable of dissipating the equivalent of only 400 MW (about one-third), approximately 99 percent of the time on average. During warm and humid periods, when the helper cooling towers do not operate as efficiently, they would dissipate less than 400 MW-equivalent heat load. Additionally, these helper towers are not designed for long-term, continuous runs. They are capable of cooling approximately one-third of Joliet Units 7 and 8's total design discharge. I also reviewed a portion of the Pre-Filed Testimony of Julia Wozniak submitted in the Use Attainability Analysis ("UAA") rulemaking for the Chicago Area Waterways and Lower Des Plaines River. Ms. Wozniak's Pre-Filed Testimony explained that generally, the towers are used when the circulating water discharge temperature exceeds 93°F for an extended period of time, and that they do not work efficiently when the wet bulb temperature (*i.e.*, temperature to which the air must be cooled at constant pressure for it to become saturated) approaches or exceeds 78-80°F. The towers cool warm water through an evaporative process, which requires that the ambient air be relatively dry and cool, or the existence of a relatively low wet bulb temperature (*i.e.*, less than 78-80°F). As Ms. Wozniak testified, the tower pumps are not equipped with freeze protection and associated appurtenances needed to sustain winter usage under rapidly changing winter weather conditions. Further, the towers are not used during the winter months due to the potential for creating hazardous icing conditions on nearby power lines and roadways.

9. I also concluded that the existing "helper" cooling towers at Joliet 29 Station are insufficient to attain and maintain compliance with the new thermal water quality standards which will become applicable to the receiving waters into which the MWGen Stations discharge on July 1, 2018 (the "CSSC/UDIP Thermal Standards"). The Joliet 29 helper towers were not designed to dissipate the entire condenser heat load, and the towers (even if they were operable all year) cannot achieve the requisite cold water temperatures all year. This is particularly true during the fall and spring seasons because the ambient wet bulb temperature with 1 percent

exceedance[1] is between approximately 50°F and 72°F, based on American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) data[2]; then assuming a 10°F approach, the cold water produced by even a closed-cycle cooling tower would be between approximately 60°F and 82°F. Per ASHRAE data, only January wet bulb temperature with 1 percent exceedance is below 50°F, meaning that a closed-cycle cooling tower with a 10°F approach temperature would produce water as cool as 60°F or colder than 60°F only in January (on average). Ambient weather conditions would prevent cooling towers (even closed-cycle cooling towers) from producing water sufficiently cold to meet the CSSC/UDIP Thermal Standards. Based on this analysis, the alternative option of installing additional "helper" cooling towers at Joliet 29 also would not be sufficient to cool the effluent discharge temperatures to levels that would achieve consistent compliance.

10. Regarding the Sargent & Lundy Report's evaluation of the suitability of alternative closed loop cooling technologies, I generally agree with its findings with some modifications. As the Sargent & Lundy Report states, closed loop cooling technologies, such as radiator type towers (external water required), air cooled condensers (new condenser is located external to the turbine room), and hyperbolic natural draft cooling towers, either have not been proven on such large-scale installations, would result in unacceptable performance losses at the Stations, are incompatible with the existing condenser design, or are considerably more expensive than the alternative of using mechanical draft cooling towers. The Sargent& Lundy Report concluded that only wet and wet/dry Mechanical Draft Cooling Towers were reasonable alternatives for the MWGen Stations.

11. In the Sargent & Lundy Report, it evaluated three different design scenarios for the MWGen Stations, which included wet towers (which yield a visible, fog-like discharge plume), wet/dry towers (plume-abated towers), and wet towers with provisions to convert to wet/dry operation. I agree that, generally, these are reasonable candidate design scenarios for the MWGen Stations.

12. Based on my review, for the Will County Station, I concluded that the available space at this station for the installation and operation of cooling towers for closed-cycle cooling would not allow enough room for the cooling towers without posing a safety risk due to the presence of ComEd high voltage lines that are located in the only seemingly open space (all other parts of the stations are already utilized). The operation of the cooling towers will expose the high voltage lines to moisture due to the emissions from the cooling towers. Moisture on high voltage lines can lead to electrical arching. Electrical arching occurs when electricity escapes its prescribed path, in this case the high voltage lines. Electrical arching presents a risk of injury to persons in the area. Further, the cooling towers emissions may cause a buildup of ice on high voltage lines

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[1] Cooling towers are typically not designed for the maximum temperature criterion because doing so would result in a large tower that is very costly. Cooling tower designs typically use a design criterion that is exceeded one percent of the time, based on a long data record. But this explicitly means that on average, every year, the cooling tower will not be able to dissipate the full heat load one percent of the time. The reason for saying 'on average' is because meteorological conditions change from year to year; in some years the temperature criterion may be exceeded more than one percent and in other years less than one person.

[2] http://cms.ashrae.biz/weatherdata/STATIONS/725340_s.pdf

which creates a significant risk of snapping these power lines and disrupting the electrical power they supply. The construction of cooling towers at Will County Station would require the relocation of these high voltage lines by ComEd; but an alternate location for these high voltage towers and lines is not available. If the relocation of these lines is not achievable, then this situation would prevent pursuing closed-cycle cooling at the Will County Station. Sargent & Lundy reached the same conclusion in its Report.

13. The Sargent & Lundy Report also presented cost estimates for each of the three different design scenarios. These cost estimates were originally prepared in 2005 and then adjusted to 2011 cost estimates which were described as accurate to within -30%/50%. The Sargent & Lundy Report presented the following capital cost estimates for the MWGen Stations:

Unit	Capital Cost Wet/Dry Tower ($)	Capital Cost Wet Convertible to Wet/Dry ($)	Capital Cost Wet Only ($)
Will County Units 3 & 4	$257,100,000	$230,200,000	$210,700,000
Joliet 9 Unit 6	$115,700,000	$103,600,000	$93,400,000
Joliet 29 Units 7 & 8	300,900,000	$257,900,000	$223,800,000
Totals	**$673,700,000**	**$591,700,000**	**$527,900,000**

14. I have updated the Sargent & Lundy capital cost estimates for the MWGen Stations by doing the following: at Will County Station, because the installation of mechanical draft cooling towers (or any other type of cooling tower) is infeasible owing to ComEd high-voltage transmission lines, I used the lowest cost cooling tower option – wet mechanical draft cooling towers – which allows a back-to-back configuration and makes the overall cooling tower footprint smaller. This is purely for the purposes of evaluating the cost of installing cooling towers, even though they are infeasible. Because of the shorter cooling tower length, I was able to orient the cooling towers parallel to the predominant summer wind direction. The re-orienting of cooling towers necessitated different hot and cold pipeline routes than what Sargent & Lundy used. These costs are accurate to within -30%/50%, and use 2017 dollars. I did not include the cost of plume abatement towers in my capital cost estimates, as did the Sargent & Lundy Report, because I did not identify a need for doing so. Plume abatement towers require more space and may cost significantly more than the cost of cooling towers that are not outfitted with plume abatement equipment. I also based my cost estimate on a different orientation of the cooling towers than that assumed by Sargent & Lundy.

15. At Joliet 9 and Joliet 29, I adjusted the 2011 costs up to 2018 costs using ENR cost indices[3].

16. Based on my work, I calculated the following capital cost estimates:

Unit	Station Total MW	Capital Cost Wet Only ($)
Will County Units 3 & 4	829	$356 million
Joliet 9 Unit 6	337	$112 million
Joliet 29 Units 7 & 8	1,150	$269 million
Totals	**2,316**	**$737 million**

The above cost for Will County Station does not include the cost of relocating ComEd transmission lines and moving those lines does not appear to be feasible (and certainly not practical).

17. The Sargent & Lundy Report also presented the following annual operation and maintenance ("O&M") cost estimates for each of the three different design scenarios.

Unit	Wet/Dry Tower ($)	Wet or Wet Convertible to Wet/Dry ($)
Will County Units 3 & 4	$5,750,000	$5,710,000
Joliet 9 Unit 6	$2,660,000	$2,350,000
Joliet 29 Units 7 & 8	$9,080,000	$8,280,000
Totals	**$17,490,000**	**$16,340,000**

18. I have updated the Sargent & Lundy annual O&M cost estimates as well. Similar to capital costs, Will County costs are based in 2017, and are accurate to within -30%/50%. Sargent

[3] Both the Building Cost Index and Construction Cost Index have increased by approximately 20 percent over this period. Therefore, the Sargent & Lundy costs were increased by 20 percent.

& Lundy O&M costs for Joliet 9 and Joliet 29 were adjusted up from 2011 to 2018 present values. Based on my work, I calculated the following annual O&M estimates:

Unit	Station Total MW	Wet Tower ($), if operated at full capacity (operated at projected capacity)
Will County Units 3 & 4	829	$7.5 million ($2.1 million)
Joliet 9 Unit 6	337	$3.2 million
Joliet 29 Units 7 & 8	1,150	$10.9 million
Totals	**2,316**	**$21.6 million**

19. I also evaluated the estimated timetable necessary to complete the conversion to closed-cycle cooling at the Will County and Joliet Stations. The Sargent & Lundy Report also estimated the time necessary to convert to closed cycle but it did so not only for these stations but also for the former Fisk and Crawford Stations which have been closed down. Sargent & Lundy's estimate that tower installation at a single facility will require approximately 29 months to complete after additional studies are completed and critical design criteria are finalized is reasonable. I also agree with Sargent & Lundy's finding that the overall duration for a multiple station, *i.e.,* both Joliets and Will County Stations, cooling tower installation will be significantly longer.

FURTHER AFFIANT SAYETH NOT.

Radhika deSilva, Ph.D., P.E.

Sworn and subscribed before me
this 25th day of June, 2018

Notary Public

Commonwealth of Pennsylvania - Notary Seal
JONATHAN COSTELLO - Notary Public
Montgomery County
My Commission Expires Jun 11, 2022
Commission Number 1283894

EXHIBIT Y

ProPublica

John Arnett fishes with a friend near Stuart Station, where the hot water released from the power plant is known by locals to make for a plentiful catch. (Philip Montgomery for Bloomberg Businessweek)

Forced to Choose Between a Job — and a Community

As the largest employer in Adams County, Ohio, closes its coal-fired power plants there, politicians and companies have thrown up their hands. Families know that finding work means leaving the place they know.

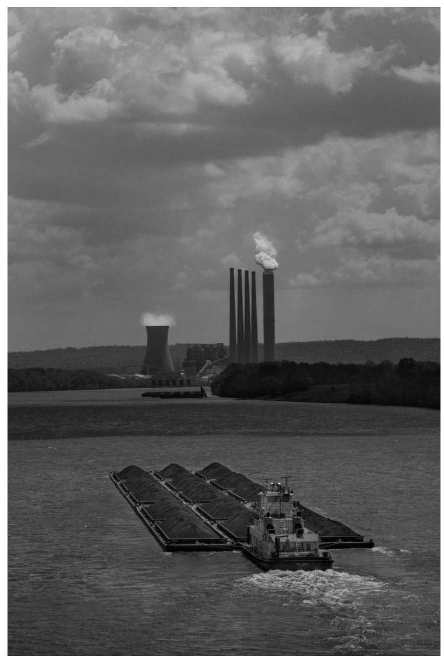
by **Alec MacGillis**, May 23, 6 a.m. EDT

This story was co-published with Bloomberg BusinessWeek.

John Arnett chose Adams County, Ohio, as his home long before he was old enough to vote, drink beer or drive a motorcycle along the Ohio River. After his parents split up, Arnett opted at age 10 to spend most of his time with his grandmother in Adams County, along the river 70 miles southeast of Cincinnati, rather than with his parents in the Dayton area. He liked life on the tobacco farm his grandfather had bought after retiring early from General Motors Co. in Dayton. And his grandmother, who became a widow when her husband died in a tractor accident, welcomed the companionship.

After high school, Arnett joined the U.S. Marine Corps, in 1999. His unit, the 1st Battalion, 7th Marines — the storied Suicide Charley — took him to the other side of the world: South Korea, Japan, Thailand. In the spring of 2003 he was an infantryman in the invasion of Iraq, spending five months in country — Baghdad, Tikrit, Najaf.

Once back in Ohio, he settled in Adams County with his future wife, Crystal, and started taking classes in criminal justice at the University of Cincinnati, figuring he'd follow the well-worn path from the military to law enforcement. One day, though, Crystal alerted him to an ad in the paper for jobs right in Adams County, at the coal-fired power plants down on the river. He jumped at the chance. The Dayton Power & Light Co. plants had been there for years — the larger, 2,400-megawatt J.M. Stuart Station, opened in 1970 as one of the largest in the country, and the 600-megawatt Killen Station followed 12 years later, 14 miles to the east — and weren't going anywhere: Ohio was getting 80 percent of its electricity from burning coal.



A barge transports coal to Stuart Station, one of two power plants in Adams County, Ohio that are scheduled to close. (Philip Montgomery for Bloomberg Businessweek)

Arnett started out in 2004 making $12 an hour, handling heavy machinery in the yard where the coal was offloaded from barges coming up the river from mines in southern Indiana and Illinois. He soon moved inside the plant, operating the boiler and turbines, and finally became an operator chemist in charge of monitoring water quality, making about $38 per hour. He got active in the union that represented the plants' 380 hourly employees, Local 175 of the Utility Workers Union of America; eventually he was elected its vice president. He and his wife started a family and in 2009 bought a larger home, a repossessed rancher they got for $130,000, in Manchester, the community nearest to Stuart. Occasionally he still got out for rides on his Harley, but life was taken over by family and youth sports, which was fine with him. He liked how he could call up his sister-in-law to watch his kids on a snow day when he was at the plant and his wife was in classes for her physical therapy degree. He liked how, at high school football games, he could send his 7-year-old off to buy himself a hot dog. "I can look over to the concession stand and I'll know someone over there," he said.

In mid-November of 2016, a few days after the election of Donald Trump, the president of Local 175, Greg Adams, called Arnett with news: Dayton Power & Light, which had been bought in 2011 by the global energy company AES Corp., had notified the state that it intended to close Stuart and Killen in June 2018. The plants were by far the largest employer and taxpayer in Adams County, population 28,000, which by one measure of median family income is the poorest county in Ohio. The announcement left the county with just a year and change to figure out how it was going to make do without them.

And it provided just a year and change for Arnett and hundreds of other workers — there were more than 100 management employees and 300 contractors in addition to the 380 union workers — to answer the question being asked in other deindustrializing places all over the country: Stay or go?

It was a hard question to confront, one the workers would be left to answer almost entirely on their own. Ohio was facing more retirements of coal-fired power plants than anywhere else in the country. Yet nobody in government — not in the state, not in Washington — was doing anything to grapple comprehensively with the challenge that Adams County and other areas were facing. It wasn't just the economy that was leaving so many places behind.

America was built on the idea of picking yourself up and striking out for more promising territory. Ohio itself was settled partly by early New Englanders who quit their rocky farms for more tillable land to the west. Some of these population shifts helped reshape the country: the 1930s migration from the Dust Bowl to California; the Great Migration of blacks to the North and West, which occurred in phases between 1910 and 1960; the Hillbilly Highway migration of Appalachian whites to the industrial Midwest in the 1940s and '50s.

In recent years, though, Americans have grown less likely to migrate for opportunity. As recently as the early 1990s, 3 percent of Americans moved across state lines each year, but today the rate is half that. Fewer Americans moved in 2017 than in any year in at least a half-century. This change has caused consternation among economists and pundits, who wonder why Americans, especially those lower on the income scale, lack their ancestors' get-up-and-go. "Why is this happening?" New York Times columnist David Brooks asked in 2014. His answer: "A big factor here is a loss in self-confidence. It takes faith to move." Economist Tyler Cowen wrote last year that "poverty and low incomes have flipped from being reasons to move to reasons not to move, a fundamental change from earlier American attitudes."

The reluctance to move is all the more confounding given how wide the opportunity gap has grown between the country's most dynamic urban areas and its struggling small cities and towns, a divide driven by a mix of factors that include technology, globalization and economic concentration. According to a new Brookings Institution report, the largest metro areas — those of 1 million or more people — have experienced 16.7 percent employment growth since 2010, and areas with 250,000 to

1 million have seen growth of 11.6 percent, while areas with fewer than 250,000 residents have lagged far, far behind, with only 0.4 percent growth. The question has taken on a stark political dimension, too, given how much Trump outperformed past Republican candidates in those left-behind places.

For policymakers, the low rates of migration to opportunity present a conundrum. Should there be a wholesale effort to revitalize places that have lost their original economic rationale? Or should the emphasis be on making it easier for people in these places to move elsewhere?

Top: A scene from downtown Manchester in Adams County, Ohio. Bottom: The crowd during a track meet at Manchester High School. (Philip Montgomery for Bloomberg Businessweek)

The country has a long tradition of place-based investment, most notably the New Deal, which, through the Tennessee Valley Authority and similar grand-scale projects, sought to raise up Appalachia and the South. Yet there's strikingly little support these days for similar efforts, anywhere on the political spectrum. Kevin Williamson put it most caustically in a March 2016 essay in National Review. "So the gypsum business in Garbutt ain't what it used to be," he wrote. "The truth about these dysfunctional, downscale communities is that they deserve to die." Paul Krugman was more charitable, but hardly effusive, in a blog post last year. "There are arguably social costs involved in letting small cities implode, so that there's a case for regional development policies that try to preserve their viability," he wrote. "But it's going to be an uphill struggle."

Some calls are easier than others. It's hard to argue that, say, a town that sprang up for a decade around a silver mine in Nevada in the 1870s needed to be sustained forever once the silver was gone. Where does one draw the line, though? If all of southern Ohio is lagging behind an ever-more-vibrant Columbus, should people there be encouraged to seek their fortunes in the capital? What would it look like to write off an entire swath of a state?

This has all become particularly urgent in places that are home to coal-fired power plants. These utilities get less media attention than actual coal mines, but they are far more widespread, employ almost half as many — some 20,000 — and are experiencing a much more immediate decline. Whereas coal mines have been shedding jobs for decades, coal-fired plants are experiencing their biggest crisis right now, squeezed by both competition from cheap natural gas and government constraints on their copious carbon emissions. At least 14 coal-fired plants are scheduled to close this year alone, many in remote places where they're the big employer in the area.

Adams County is a classic example. The plants dominate the landscape — not just the towering stacks along the river but also the moonscapes that have been carved out of the nearby land to hold waste from the plants in so-called ash ponds. The good-paying jobs at the plants — a total $60 million in annual payroll — drew skilled workers to the county and to Maysville, Kentucky, the picturesque former tobacco hub across the river. The plants fattened the tax base. Despite the high poverty rate, the Manchester schools became some of the state's best-funded, with high teacher salaries and an ambitious football program.

In theory, once the plants were closed, Adams County could revert to farm country. But it hadn't been farm country for almost a half-century.

After Arnett got word from Greg Adams of the planned closure, they went to Stuart Station to discuss it with the operations manager, Mark Miller. The two men say Miller asked them to keep word of the closure to themselves. The reason seemed plain to Arnett and Adams: The company didn't want so many workers leaving for new jobs that the plants would lack manpower to operate in the interim. They had no intention of observing the request. They found it irksome that the plants had recently hired new workers away from other jobs, some of them from hundreds of miles away, despite the imminent closure. The union leaders knew other colleagues who were on the verge of buying new trucks or farms, assuming their jobs were safe as ever.

So that same day, they gathered workers in the vast parking lot outside Stuart Station and, speaking from the back of a pickup, told them what was happening. Some in the crowd scoffed openly, saying it was surely a tactic for upcoming labor negotiations. In the months that followed, though, the reality became undeniable. AES began moving management employees to other locations around the country. Needed repairs started going unattended. And in the spring of last year, the company signed off on a final agreement with state regulators that gave it the rate hike it was seeking and also required it to provide some transition funding for workers and the county: a grand total of $2 million.

Desperate to save their members' jobs, the local union leaders, as well as their counterparts at the national level, began to seek a buyer for the plants. This did not seem out of the question. The plants were still making money, they had been upgraded with expensive scrubbers just a decade ago and the company had recently cleared out a whole hollow above Stuart Station for a new ash pond.

A view of Stuart Station from the Ohio River (Philip Montgomery for Bloomberg Businessweek)

The union did manage to find some potential buyers, but AES appeared reluctant to entertain offers. This fed workers' suspicion that the closure was part of a deal involving Ohio's largest utilities, under which those companies agreed not to oppose AES's recent request to state regulators for a rate hike in exchange for AES closing Stuart and Killen, thereby removing competition from the field. Asked about its reasons for shuttering the plants, the company said simply, "It became clear that, without significant changes in market conditions, the plants would not be economically viable beyond mid-2018."

Meeting with so little success on this front, the union leaders reached out to their elected representatives. In May 2017, a half-dozen of them drove to Washington, where they were joined by two Adams County commissioners. The group met with both Ohio senators, Republican Rob Portman and Democrat Sherrod Brown, and what struck Arnett was how similar they were in their unsatisfying responses. "If you put them in a room, you couldn't tell a difference, Republican or Democrat," he says. "Both of them had their people coming in saying they had another meeting." Three months later, County Commissioner Ty Pell, whose father had worked at Stuart Station, returned to meet with Vice President Mike Pence and several cabinet secretaries. But the one who would've been the most helpful to meet with, U.S. Secretary of Energy Rick Perry, was in Houston, where flooding from Hurricane Harvey had become a crisis. Once back in Ohio, Pell and others made repeated attempts to reach Perry, to no avail.

More confounding, though, was the response they met with closer to home. If they couldn't stop the plants from closing, they concluded, they could at least start making the pitch to the state of Ohio for the single best substitute: a pipeline (at an estimated cost of $25 million) to hook up the county to natural gas, which now bypasses it, making it far less appealing for potential employers. Despite months of trying, neither the workers nor county officials could get a meeting with Gov. John Kasich, a Republican, even though Ty Pell had been county chairman of his gubernatorial campaign. They settled for one meeting with Kasich's policy director, which produced nothing tangible.

The meeting that most stuck out for Arnett was the one he landed with the state senator representing Adams County, Joe Uecker. They met at a Panera Bread in the Cincinnati suburbs. Arnett asked Uecker, a Republican in his sixth term in the Legislature, what Uecker might be able to do to forestall the closing or, failing that, to ease the transition for the county. He described to him what a huge impact the closing would have, not least on his kids' schools.

He was startled by the advice Uecker offered in response: "You need to move," the senator said. Uecker confirms this exchange: "I did say, 'Sometimes you have to do what's best for your family.'" The man elected to represent Arnett's community was telling him the most responsible thing he could do was leave it.

It took no time for the fallout to hit. In late 2016, as plant workers were getting word of the closures, the county found out its own way: The state alerted it that the valuation of the plants had dropped by $56 million because of the planned closure. This meant a loss of $218,400 in tax revenue for the county general fund, which has an annual budget of about $8 million to pay for public works, the sheriff's office, the jail, the courthouse, and social services, along with much else. The next valuation reduction came late last year, and a third is expected late this year. All told, the annual loss for the general fund is expected to be $787,800.

County officials are planning to make up some of that by using a final influx of money from a statewide Medicaid managed-care sales tax. That money will be gone in 2019. They are finding efficiencies wherever possible — the county treasurer is sharing an employee with the county recorder, an election board employee is filling a vacancy in the commissioner's office — but at some point, the math just doesn't work. A third of the county budget now goes toward the sheriff's office and jail. Both already operate at levels bordering on negligence. The jail, built to hold a maximum of 38 inmates, often houses as many as 75, the result of both the opioid epidemic that's beset southern Ohio and the state government's push to cut its own budget by putting more inmates in county jails. Not infrequently, one officer monitors more than 60 inmates.

The county spreads over 583 square miles. To patrol that territory, there are only 22 public safety officers between the sheriff and the five municipal police departments. During certain shifts, Sheriff Kimmy Rogers has only two deputies on duty to cover the entire county. At his small, windowless office inside the jail, where he keeps a cardboard box of battered toys by his desk to give to needy kids, he contemplates what he could possibly spare to help make up a huge drop in tax revenue from the plants. "I just don't know how I could cut," he says. "We're bare-bones." That's a standard line from department heads. In this case, it seems hard to deny.


Inmates of the Adams County jail in West Union, Ohio. The jail was built to hold a maximum of 38 inmates but often holds as many as 75. (Philip Montgomery for Bloomberg Businessweek)

Ten miles down Route 136, Brian Rau, superintendent of the Manchester Local School District, is looking at numbers no less incomprehensible. The district — essentially a single campus serving K-12 — was carved out from the countywide school system in 2004, when tax revenue from the plants was flowing freely. Until recently, it spent about $12,000 per pupil, among the highest in the state. As a result of the plant closures, the district is expected to lose at least $4.5 million of its annual funding, more than a third of its $11 million budget. Under Ohio rules, the state will ramp up its funding for Manchester, which will become, in a flash, a high-needs district: State funding will jump to 80 percent of its total budget, from 20 percent now. But the state will make up only so much of the loss; spending in the district will drop to $8,000 per pupil, among the lowest in the state. The loss of enrollment as a result of the closure will mean even less per capita funding. To begin to adjust to the new reality, the district has laid off several employees, cut its school psychologist back to part time (which Rau already regrets), barred the band and cheerleaders from traveling to distant away games, and, to Rau's chagrin, started favoring less experienced teachers in job searches, since they cost less.

That's easy compared with the 1996 bond issue hanging over the district. Rau sketches out different scenarios for paying off the debt if plant revenue vanishes. Under one scenario, residents would see their property taxes quintuple in the final year of the bond, 2021. "It's ludicrous," Rau says.

Lee Anderson, director of governmental affairs at the national Utility Workers Union, has spent years trying to get elected officials around the country to grapple with what's happening in places such as Adams County. But there's just no political will, he says. There's support on the left for public investment in struggling areas, but less so, he says, when it comes to communities that are increasingly voting Republican — Adams County among them — and whose decline is linked to fossil fuels. On the right, he says, there's no appetite for public investment, period. Not to mention that the scale of the challenge is so huge and the potential solutions so expensive.

But this doesn't mean inaction is excusable or that it's enough to tell people to find work elsewhere, Anderson says. "The problem here is trying to treat people like interchangeable widgets," he says. "They're not. They're human beings embedded in communities. We're forcing cultural and social change on people, and people don't like that. They don't move three states away for a hypothetical job. They want to live where they are because their parents are in the same town, and their grandmother is in the next town, and they go to church there. Just picking people up and relocating them, it doesn't work like that. And on the flip side, even if it did work out for an individual, consider what you left behind: What is the ramification for your family and community, now that you're gone for good?"

One by one, the plant workers started leaving — to a natural gas plant in Huntington Beach, California, to coal-fired plants in Kentucky, Oklahoma and Hawaii. Some of them had little farewell meetups at a bar. Others just vanished.

Randy Rothwell left with his wife, Tiffany, and their two sons last summer, after landing what seemed like a dream offer: a high-paying federal job with great benefits at the Grand Coulee Dam in Washington state. It wasn't easy leaving Adams County, where their older son had recently started kindergarten, where Tiffany had belonged to a church for 25 years, where the boys' cousins were their best friends. The Grand Coulee job was hard to pass up, though. The Rothwells managed to sell their house — thereby overcoming one of the major hurdles in leaving a struggling area such as Adams County — and moved in late July.

They lasted half a year. The job was fine, but they didn't realize just how much they'd miss Adams County. The landscape of central Washington state was more desolate than they were prepared for. The nearest Walmart and McDonald's were almost an hour away. Flights back home were expensive. Tiffany had almost no contact with other adults when Randy was at work.

Late last year, Randy got word of a job at Adams County's second-largest private employer, an engine-testing facility for GE Aviation. He applied and got an offer. The position was nonunion and paid only $22 per hour, half of what he was making in Washington state and also much less than the $35 per hour he made at Killen Station. He took it anyway. The family came back to Adams County in a rented truck and, because they'd sold their house, moved in with Tiffany's mother while they looked for a place.

It was different being back now, without a home of their own and with Randy bringing in so much less. Tiffany might have to find work, which won't be easy. "That sense of security is gone," she says. Still, they're confident moving back was the right thing to do. "I know some people think, 'What are you thinking?' For us, it was family, wanting our children to grow up knowing their family and not being strangers to everyone around them," Tiffany says. Randy agrees. "The American dream is kind of to stay close to your family, do well and let your kids grow up around your parents," he says. It was a striking comment: Not that long ago, the American dream more often meant something quite different, about achieving mobility — about moving up, even if that meant moving out.

Others keep leaving, bound for Wyoming, Florida and Nebraska. Those left behind are keenly aware not only of the sheer tally but also of the kinds of people leaving. Over the years, the plants had brought a new cohort of families to the county, led by the sort of skilled workers who were able to get good-paying jobs at the plant. The kids from those families tend to share their parents' traits and habits. Now those sorts of people are leaving and will no longer be arriving. "You're going to lose a lot of your brightest youth," says Rogers, the sheriff. "We've got a lot of bright kids here, and I'd hate to see them leave. But it will happen." Chris Harover, executive vice president at one of the two local banks, shares the same worry. "You're going to lose a big influx of good people," he says. "There's going to be no more moving in."

At the plants, the departures were causing a more immediate problem: There were barely enough people left to keep things running. By February the unionized head count had dropped from 380 to less than 260. Under the union's safety standards, there are supposed to be eight power plant operators for each of the four shifts at Stuart, for a total of 32; by February there were only 15 total.

A couple of groups of potential buyers came by to tour the plants, but nothing seemed to be coming of it. The company sent official notice that it wasn't planning to put any power on the grid after June. A proposal by Rick Perry to subsidize ailing coal-fired plants was shot down by the Federal Energy Regulatory Commission; given the imminence of the plants' closure, it would likely not have helped anyway.

Meanwhile, county officials were getting no answers from the company or state officials about the plans for the plants and ash ponds after the closure. Because fly ash isn't categorized as hazardous, the moonscape could in theory remain a blot along the river in perpetuity. The company, which owned seven miles of riverfront, started ceding hundreds of acres to land conservancies. This handoff sounds benign, but if the company did so with all 5,000 of its acres, it would wipe it all from the tax base for good.

By early March, the union and county still hadn't even gotten a firm closure date from AES. "We have no dialogue between the company and the county at all," said Pell, the county commissioner.

On the first day of March, the state's workforce development agency set up a "transition center" inside DP&L's training facility in Manchester. There were computers to search for jobs and brochures on "Using Social Media to 'Net a Job'" and "Untangling the Internet." A week later the agency held an open house there, with a state employee tasked with explaining how to apply for unemployment and representatives from several local technical schools. There was a chance the workers could qualify for federal trade adjustment assistance, which would help pay for tuition.

About 100 plant workers showed up. There were free "OhioMeansJobs" tote bags and a spread of sandwiches, pasta salad and banana pudding. There was also a door prize: a thumb drive. Officials from Shawnee State University, in nearby Scioto County, were promoting their video game design program. The Southern Hills Career & Technical Center advertised training for nursing assistants. A woman from the Kentucky Career Center had a list of available jobs that included Hampton Inn receptionist, Dollar General sales associate and Domino's Pizza driver.

Inside Dayton Power & Light Company's "transition center" facility in Manchester (Philip Montgomery for Bloomberg Businessweek)

The workers milled about uncertainly. Dean Toller expressed some interest in a six-month welding program in Kentucky that cost $15,000. Brandon Grooms said he was thinking of moving to North Carolina to work for a friend who sold engines for private jets. Missy Hendrickson, the controller for the two plants, was desperately hoping to transfer to another AES facility — she had been with the company 26 years, and if she didn't make it to 30, she'd lose almost half her pension.

John Arnett was there, too. He said he and his wife were still torn about what to do. They were very worried about what the closure would mean for the Manchester schools, which their kids attended. But it was still painful to contemplate leaving. They were as deep in the local rhythms as ever. Youth baseball season was starting up. Soon it would be turkey hunting season, followed by squirrel season, then deer season — the whitetail was legendary in Adams County. "It's just home," he said. "I've been a bunch of different places, different countries. I've been across the equator. And now this is where I want to be, or I'd have stayed somewhere else. It's the most beautiful place in the world, these hills."

All these thoughts had led Arnett to lean toward trying to get transferred to one of AES's jobs as a lineman in the Dayton area, even if it came with a pay cut and meant driving almost two hours to work. Many other workers were also considering this kind of commute. Rumors started swirling that a potential buyer has belatedly emerged for Killen Station, the smaller and younger plant: an IT staffing and consulting company in Atlanta called

American CyberSystems Inc. In theory, Arnett could use his seniority to get one of the 100-odd jobs that would remain at Killen if it stays open, but taking a job as a lineman in Dayton seemed safer than banking on a new owner with zero experience in running a coal-fired plant.

He wasn't sure about the lineman job, though, so at the open house, he drifted over to the man pitching the Kentucky welding program. The man talked about how much demand there is for welders and how good the money is. Arnett asked if there were jobs to be had here, in Adams. Not so much, the man conceded — although, he added brightly, one could do pretty well by traveling elsewhere for temporary stints, several weeks or months at a time.

Arnett turned away, unconvinced. "The issue is traveling," he said under his breath. "I'd be able to get a job. I'm not concerned about that. But that doesn't help the community."

Alec MacGillis

Alec MacGillis covers politics and government for ProPublica.

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EXHIBIT Z

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217)782-2829

PAT QUINN, GOVERNOR LISA BONNETT, DIRECTOR

217/782-0610

September 30, 2014

Midwest Generation, LLC
1800 Channahon Road
Joliet, IL 60436

Re: Midwest Generation, LLC
Joliet 9 Generating Station
NPDES Permit No. IL0002216
Final Permit

Ladies and Gentlemen:

We have reviewed your comments to the public noticed permit and offer the following responses:

1. The pH limits were moved from outfalls A01, B01, and C01 to outfall 001 as requested. A pH limit is necessary to ensure compliance with 35 IAC 304.125.

2. The semi-annual metals monitoring requirement listed as Special Condition 15 is necessary to provide sufficient data on effluent quality and will remain.

3. The 7-Day BOD_5 and TSS limits were removed from outfalls B01 and 002 as requested.

4. Proposed internal monitoring point A04 for coal pile runoff was removed and the effluent limits now apply to the combined discharges from outfall 004.

5. The 0.05 mg/l total residual chlorine limit at outfall 001 will remain to ensure compliance with 35 IAC 302.410.

6. The mercury monitoring requirements of Special Condition 16 were consolidated into Special Condition 15 and Special Condition 16 was removed. Mercury monitoring at outfalls 001, 003, 004, and 005 is required on a monthly basis for the first two years and quarterly thereafter.

7. RO Reject and Boiler Blowdown meets the definition of low volume wastestream of 40 CFR 423.11(b) and thus the oil and grease limits of 40 CFR 423.12(b)(3) will remain.

8. Both TSS and Oil and grease are regulated per 40 CFR 423.12(b)(5) and thus both will be monitored at the same frequency of once per week.

9. Special Condition 7 was revised as requested.

10. Special Condition 10 now specifies that a reduction or elimination of dissolved oxygen monitoring may be requested after two years.

11. The sampling frequency was changed to "daily when discharging" as requested on page 8 of the permit.

12. Oil and grease sampling was changed to a "grab" sample on page 8 of the permit as requested.

13. TRC sampling is required once per week at outfall 001 when residuals are likely to be present in the discharge including low volume house service water treatment.

14. Special Condition 11 was revised to required submittal of a impingement mortality and entrainment characterization study and a compliance alternatives analysis.

15. The Offensive Discharges language of 35 Ill. Adm. Code 304.106 was added to the permit as Special Condition 19.

The discharger address was changed as requested in your June 20, 2014 letter.

Attached is the final NPDES Permit for your discharge. The Permit as issued covers discharge limitations, monitoring, and reporting requirements. Failure to meet any portion of the Permit could result in civil and/or criminal penalties. The Illinois Environmental Protection Agency is ready and willing to assist you in interpreting any of the conditions of the Permit as they relate specifically to your discharge.

The Agency has begun a program allowing the submittal of electronic Discharge Monitoring Reports (NetDMR) instead of paper Discharge Monitoring Reports (DMRs). If you are interested in NetDMR, more information can be found on the Agency website, http://www.epa.state.il.us/water/net-dmr/index.html. If your facility is not registered in the NetDMR program, a supply of preprinted paper DMR Forms for your facility will be sent to you prior to the initiation of DMR reporting under the New permit. Additional information and instructions will accompany the preprinted DMRs upon their arrival.

The attached Permit is effective as of the date indicated on the first page of the Permit. Until the effective date of any re-issued Permit, the limitations and conditions of the previously-issued Permit remain in full effect. You have the right to appeal any condition of the Permit to the Illinois Pollution Control Board within a 35 day period following the issuance date.

Should you have questions concerning the Permit, please contact Jaime Rabins at 217/782-0610.

Sincerely,

Alan Keller

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:JAR:11011701.jar

Attachment: Final Permit

cc: Records
Compliance Assurance Section
Des Plaines Region
Billing
US EPA

NPDES Permit No. IL0002216

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Reissued (NPDES) Permit

Expiration Date: October 31, 2019

Issue Date: September 30, 2014
Effective Date: November 1, 2014

Name and Address of Permittee:

Midwest Generation, LLC
1800 Channahon Road
Joliet, IL 60436

Facility Name and Address:

Midwest Generation, LLC
Joliet 9 Generating Station
1601 South Patterson Road
Joliet, Illinois 60436
(Will County)

Discharge Number and Name:		Receiving Waters:
001	Condenser Cooling Water and House Service Water	Des Plaines River
A01	Reverse Osmosis Reject	
B01	Sanitary - Main	
C01	Boiler Blowdown	
002	Sanitary – Breaker House	Des Plaines River
003	Roof And Yard Area Runoff	Des Plaines River
A03	Chemical Treatment System Effluent	
004	Coal Pile and Switchyard Area Runoff	Des Plaines River
005	Quarry (Ash Pond) Discharge	Des Plaines River
006	Cribhouse Area Runoff	Des Plaines River
007	Material Access Road Area Runoff	Des Plaines River

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of Ill. Adm. Code, Subtitle C and/or Subtitle D, Chapter 1, and the Clean Water Act (CWA), the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Alan Keller

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:JAR:11011701.jar

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall 001: Condenser Cooling Water and House Service Water (DAF = 315.52 MGD)

This discharge consists of:

1. Main Condenser Cooling Water
2. Reverse Osmosis Reject
3. Boiler Blowdown and Drains
4. Sanitary - Main
5. House Service Water
6. Intake Screen Backwash

PARAMETER	LOAD LIMITS 30 DAY AVERAGE	LOAD LIMITS DAILY MAXIMUM	CONCENTRATION 30 DAY AVERAGE	CONCENTRATION DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1				Daily	Continuous
pH	See Special Condition 2				1/Week	Grab
Total Residual Chlorine	See Special Condition 3			0.05	*	Grab
Temperature	See Special Condition 4				Daily	Continuous

*Total Residual Chlorine shall be sampled 1/week whenever chlorination or biocide addition is being performed or residuals are likely to be present in the discharge including low volume house service water treatment. If chlorination and biocide addition are not used during the month it shall be so indicated on the DMR.

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF)		CONCENTRATION LIMITS mg/l		SAMPLE FREQUENCY	SAMPLE TYPE
	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM		
Outfall A01: Reverse Osmosis Reject (DAF = 0.15 MGD)						
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
Total Suspended Solids			15	30	1/Week	Grab
Oil and Grease			15	20	1/Week	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall B01: Sanitary - Main (DAF = 0.01 MGD)						
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
Total Suspended Solids			30	60	1/Week	24-Hour Composite
BOD_5			30	60	1/Week	24-Hour Composite

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall C01: Boiler Blowdown (Intermittent Discharge)						
				Approximate Flow:		
	This discharge consists of:					
	1. Boiler Blowdown			Intermittent		
	2. Boiler Drains			Intermittent		
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
Total Suspended Solids			15	30	1/Month	8-Hour Composite
Oil and Grease			15	20	1/Month	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 002: Sanitary – Breaker House (DAF = 0.0005 MGD)						
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
pH	See Special Condition 2				1/Week	Grab
Total Suspended Solids			30	60	1/Week	24-Hour Composite
BOD_5			30	60	1/Week	24-Hour Composite

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 003: Roof and Yard Runoff (DAF = 0.62 MGD)						
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Estimate
pH	See Special Condition 2				1/Week	Grab
Total Suspended Solids			15	30	1/Week	24-Hour Composite
Oil and Grease			15	20	1/Week	Grab

This discharge consists of:

1. Plant Floor Drain Sump Discharge
2. Plant Roof and Year Area Storm Runoff
3. Gas Side Non-Chemical Metal Cleaning Wastes
4. Reverse Osmosis Reject (Alternate Route)
5. Slag Transport Water (Alternate Route)

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall A03: Gas Side Non-Chemical Metal Cleaning Wastes (Intermittent Discharge)						
Flow (MGD)	See Special Condition 1				Daily When Discharging	24-Hour Total
Total Suspended Solids			30	100	Daily When Discharging	8-Hour Composite
Oil and Grease			15	20	Daily When Discharging	Grab
Iron			1.0	1.0	Daily When Discharging	8-Hour Composite
Copper			1.0	1.0	Daily When Discharging	8-Hour Composite

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 004: Coal Pile and Switchyard Area Runoff (DAF = Intermittent Discharge)						
Flow (MGD)	See Special Condition 1				Daily When Discharging	Continuous
pH	See Special Condition 2				Daily When Discharging	Grab
Total Suspended Solids			15	30	Daily When Discharging	Grab

The above discharges may be routed to the Quarry system tributary to outfall 005 in order to obtain additional treatment.

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall 005: Quarry (Ash Pond) Discharge (DAF = 6.93 MGD)

This discharge consists of:

1. Sand Filter Backwash
2. Slag Transport Water
3. Coal Pile and Switchyard Area Runoff (Alternate Route)
4. Sand Filter Backwash, Bottom Ash Transport and Economizer Ash Transport from Joliet 29 Station. (Alternate Route – NPDES Permit No. IL0064254)

PARAMETER	30 DAY AVERAGE (lbs/day)	DAILY MAXIMUM (lbs/day)	30 DAY AVERAGE (mg/l)	DAILY MAXIMUM (mg/l)	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1				1/Week	Estimate
pH	See Special Condition 2				1/Week	Grab
Total Suspended Solids			15	30	1/Week	24-Hour Composite
Oil and Grease			15	20	1/Week	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

Outfall 006: Cribhouse Area Runoff (Intermittent Discharge)
Outfall 007: Material Access Road Area Runoff (Intermittent Discharge)

Discharges shall be managed in accordance with Special Condition 20.

Special Conditions

SPECIAL CONDITION 1. Flow shall be measured in units of Million Gallons per Day (MGD) and reported as a monthly average and a daily maximum value on the monthly Discharge Monitoring Report.

SPECIAL CONDITION 2. The pH shall be in the range 6.0 to 9.0. The monthly minimum and monthly maximum values shall be reported on the DMR form.

SPECIAL CONDITION 3. All samples for TRC shall be grab samples and analyzed by an applicable method contained in 40 CFR 136, equivalent in accuracy to low-level amperometric titration. Any analytical variability of the method used shall be considered when determining the accuracy and precision of the results obtained.

SPECIAL CONDITION 4. Pursuant to Illinois Pollution Control Board Order AS 96-10, dated October 3, 1996 and amended March 16, 2000 the facility shall comply with the following temperature limitations:

A. At the point of discharge the receiving waters are designated as Secondary Contact and Indigenous Aquatic Life Waters and shall meet the following standards from Section 302.408, Illinois Administration Code, Title 35, Chapter 1, Subtitle C, as amended:

Temperatures at the edge of the mixing zone shall not exceed 93°F (34°C) more than 5% of the time, or 100°F (37.8°C) at any time. Compliance with this part shall be determined by the following equation:

$$T_{FM} = \frac{T_D Q_{CW} + T_{US}(0.25 * Q_{AV})}{Q_{CW} + (0.25 * Q_{AV})}$$

T_{FM} Calculated fully-mixed receiving water temperature in degrees Fahrenheit.

T_D Actual condenser cooling water discharge temperature in degrees Fahrenheit from the continuous temperature monitor.

Q_{CW} Condenser cooling water flow in cubic feet per second based on the number of circulating water pumps on at the time in question. Each of the two circulating water pumps is rated at 130,600 gpm (291 cfs).

Q_{AV} Available receiving stream dilution flow in cfs determined by subtracting condenser cooling water flow from the upstream river flow. If the upstream river flow is equal to or less than the condenser cooling water flow, the available receiving stream dilution flow is zero. Upstream river flow is the average value of flow recorded during the 24-hour period preceding the time in question. The primary source of flow data is the gauging station operated by the USACE at the Brandon Road Lock and Dam. Secondary sources for flow data are gauging stations on the Chicago Sanitary and Ship Canal at Lemont operated by the USGS, and the Des Plaines River gauging station at Riverside, operated by the USACE.

T_{US} Upstream river temperature in degrees Fahrenheit from the continuous temperature monitor located in the stations intake canal.

B. The monthly maximum temperature at the edge of the mixing zone (T_{FM}) and the cumulative number of hours in which temperatures at the edge of the mixing zone exceed 93°F (34°C) shall be reported on the DMR.

C. In the main channel of the Lower Des Plaines River, at the I-55 Bridge, the effluent shall not alone or in combination with other sources cause temperatures to exceed the temperatures set forth in the following table, except in accordance with the allowable monthly excursions detailed below:

	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	June 1-15	June 16-30	July	Aug	Sept	Oct	Nov	Dec
°F	60	60	65	73	80	85	90	90	91	91	91	90	85	75	65

These standards are in lieu of the requirements of 35 Ill. Adm. Code 302.211(d) and (e) and may be exceeded by no more than 3°F during 2% of the hours in the 12-month period ending December 31, except that at no time shall Midwest Generation's plants cause the water temperature at the I-55 Bridge to exceed 93°F. Excursion hours for the purposes of this part is defined as the hours in which the temperatures of this part are exceeded.

D. When it appears that discharges from Outfall 001 have the reasonable potential to cause water temperatures at the I-55 Bridge to exceed the values set forth in the above table, the permittee shall determine whether, and the extent to which, station operations must be restricted to avoid violating the above-stated limits. The permittee shall make such a determination based upon the outputs of a predictive model reasonably suited for such a purpose and which has been submitted to the Agency.

The permittee shall demonstrate to the Agency that the facility has obtained alternate thermal standards from the Illinois Pollution Control Board pursuant to Section 316(a) of the Clean Water Act, and 35 Ill. Adm. Code 304.141(c), in accordance with the procedures as found in 35 Ill. Adm. Code Part 106, Subpart K. This demonstration is only necessary if the permittee intends to obtain relief from the applicable water quality standards for temperature effective at the time the renewal application is filed. This demonstration (if applicable) shall be filed with the renewal application for this permit.

Alternately, the Permittee may demonstrate to the Agency that relief granted in AS 96-10, or other site specific water quality standards for temperature approved by the Illinois Pollution Control Board, and USEPA, meets the requirements of 40 CFR 131 and the Illinois Environmental Protection Act.

Special Conditions

SPECIAL CONDITION 5. Samples taken in compliance with the effluent monitoring requirements shall be taken at a point representative of the discharge, but prior to entry into the receiving stream.

SPECIAL CONDITION 6. The Permittee shall record monitoring results on Discharge Monitoring Report (DMR) Forms using one such form for each outfall each month.

In the event that an outfall does not discharge during a monthly reporting period, the DMR Form shall be submitted with no discharge indicated.

The Permittee may choose to submit electronic DMRs (NetDMR) instead of mailing paper DMRs to the IEPA. More information, including registration information for the NetDMR program, can be obtained on the IEPA website, http://www.epa.state.il.us/water/net-dmr/index.html.

The completed Discharge Monitoring Report forms shall be submitted to IEPA no later than the 28th day of the following month, unless otherwise specified by the permitting authority.

Permittees not using NetDMR shall mail Discharge Monitoring Reports with an original signature to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

Attention: Compliance Assurance Section, Mail Code # 19

SPECIAL CONDITION 7. In the event that the permittee shall require a change in the use of water treatment additives, the permittee must request a change in this permit in accordance with the Standard Conditions -- Attachment H.

SPECIAL CONDITION 8. If an applicable effluent standard or limitation is promulgated under Sections 301(b)(2)(C) and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act and that effluent standard or limitation is more stringent than any effluent limitation in the permit or controls a pollutant not limited in the NPDES Permit, the Agency shall revise or modify the permit in accordance with the more stringent standard or prohibition and shall so notify the permittee.

SPECIAL CONDITION 9. The use or operation of this facility shall be by or under the supervision of a Certified Class K operator.

SPECIAL CONDITION 10. The cooling water prior to entering the plant intake structure and at the discharge from outfall 001 shall be grab sampled once per week at the same time of day within ½ hour of each other between 9:00 a.m. and 3:00 p.m. in a randomized fashion for dissolved oxygen. The results in mg/l and the time of day the influent and effluent sample was taken shall be reported to the Agency as an attachment to the DMR. After 2 years of data has been submitted to the Agency, the permittee may apply to Agency to have the monitoring reduced or eliminated, but in no case shall monitoring change unless notified by the Agency in writing.

SPECIAL CONDITION 11. Cooling Water Intake Structure. Based on available information, the Agency has determined that the operation of the cooling water intake structure met the equivalent of Best Technology Available (BTA) in accordance with the Best Professional Judgment provisions of 40 CFR 125.3, at the time of its construction. However, in order to further evaluate cooling water intake structure operations based on the most up to date information, the permit shall comply with the requirements below:

A. The permittee shall submit the following information/studies within 180 days from the permit effective date:

   1. Source Water Physical Data to include:

      a. A narrative description and scaled drawings showing the physical configuration of all source water bodies used by the facility including aerial dimensions, depths, salinity and temperature regimes;

      b. Identification and characterization of the source waterbody's hydrological and geomorphological features, as well as the methods used to conduct any physical studies to determine the intake's area of influence and the results of such studies; and

      c. Location maps.

   2. Source Waterbody Flow Information

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The permittee shall provide the annual mean flow of the waterbody, any supporting documentation and engineering calculations to support the analysis of whether the design intake flow is greater than five percent of the mean annual flow of the river or stream for purposes of determining applicable performance standards. Representative historical data (from a period of time up to 10 years) shall be used, if available.

3. Impingement Mortality and Entrainment Characterization Study

The permittee shall submit an Impingement Mortality and Entrainment Characterization Study whose purpose is to provide information to support the development of a calculation baseline for evaluating impingement mortality and entrainment and to characterize current impingement mortality and entrainment. The Study shall include the following in sufficient detail to support establishment of baseline conditions:

a. Taxonomic identification of all life stages of fish and shellfish and any species protected under Federal, State, or Tribal law (including threatened or endangered species) that are in the vicinity of the cooling water intake structure(s) and are susceptible to impingement and entrainment;

b. A characterization of all life stages of fish and shellfish, and any species protected under Federal, or State law, including a description of the abundance and temporal and spatial characteristics in the vicinity of the cooling water intake structure(s). These may include historical data that are representative of the current operation of the facility and of biological conditions at the site; and

c. Documentation of the current impingement mortality and entrainment of all life stages of fish, shellfish, and any species protected under Federal , State, or Tribal Law (including threatened or endangered species) and an estimate of impingement mortality and entrainment to be used as the calculation baseline. The documentation may include historical data that are representative of the current operation of the facility and of biological conditions at the site. Impingement mortality and entrainment samples to support the calculations required must be collected during periods of representative operational flows for the cooling water intake structure and the flows associated with the samples must be documented.

B. The permittee shall comply with the following requirements:

1. At all times properly operate and maintain the intake equipment.

2. Inform IEPA of any proposed changes to the cooling water intake structure or proposed changes to operations at the facility that affect impingement mortality and/or entrainment.

3. Debris collected on intake screens is prohibited from being discharged back to the canal. Debris does not include living fish or other living aquatic organisms.

4. Compliance Alternatives. The permittee must evaluate each of the following alternatives for establishing best available technology for minimizing adverse environmental impacts at the facility due to operation of the intake structure:

a. Evaluate operational procedures and/or propose facility modifications to reduce the intake through-screen velocity to less than 0.5 ft/sec. The operational evaluation may consider modified circulating water pump operation; reduced flow associated with capacity utilization, recalculation or determination of actual total water withdrawal capacity. The evaluation report and any implementation plan for the operational changes and/ or facility modification shall be submitted to the Agency with the renewal application for this permit.

b. Complete a fish impingement and entrainment mortality minimization alternatives evaluation. The evaluation may include an assessment of modification of the traveling screens, consideration of a separate fish and debris return system and include time frames and cost analysis to implement these measures. The evaluation report and implementation plan for any operational changes and/ or facility modifications shall be submitted to the Agency with the renewal application for this permit.

C. All required reports shall be submitted to the Industrial Unit, Permit Section and Compliance Assurance Section at the address in special condition 6.

This special condition does not relieve the permittee of the responsibility of complying with any laws, regulations, or judicial orders issued pursuant to Section 316(b) of the Clean Water Act. New final federal regulations governing the operation of cooling water intake structures at existing facilities (when effective), shall supersede the requirements of this condition. Unless the final effective federal rules for existing facilities require otherwise, the permittee shall comply with the above requirements of this special condition.

SPECIAL CONDITION 12. There shall be not discharge of polychlorinated biphenyl compounds.

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SPECIAL CONDITION 13. The bypass provisions of 40 CFR 122.41(m) and upset provisions of 40 CFR 122.41(n) are hereby incorporated by reference.

SPECIAL CONDITION 14. The Agency has determined that the effluent limitations for outfalls 003, 004 and 005 constitute BAT/BCT for storm water which is treated in the existing treatment facilities for purposes of this permit reissuance, and no pollution prevention plan will be required for such storm water. In addition to the chemical specific monitoring required elsewhere in this permit, the permittee shall conduct an annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity, and determine whether any facility modifications have occurred which result in previously-treated storm water discharges no longer receiving treatment. If any such discharges are identified the permittee shall request a modification of this permit within 30 days after the inspection. Records of the annual inspection shall be retained by the permittee for the term of this permit and be made available to the Agency on request.

SPECIAL CONDITION 15. The Permittee shall monitor the effluent from outfall 001, 003, 004, and 005 for the following parameters on a semi-annual basis. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The sample shall be a 24-hour effluent composite except as otherwise specifically provided below and the results shall be submitted to the address in special condition 6 in June and December. The parameters to be sampled and the minimum reporting limits to be attained are as follows:

STORET CODE	PARAMETER	Minimum reporting limit
01002	Arsenic	0.05 mg/L
01007	Barium	0.5 mg/L
01027	Cadmium	0.001 mg/L
01032	Chromium (hexavalent) (grab)	0.01 mg/L
01034	Chromium (total)	0.05 mg/L
01042	Copper	0.005 mg/L
00718	Cyanide (grab) (available*** or amendable to chlorination)	5.0 ug/L
00720	Cyanide (grab not to exceed 24 hours) (total)	5.0 ug/L
00951	Fluoride	0.1 mg/L
01045	Iron (total)	0.5 mg/L
01046	Iron (Dissolved)	0.5 mg/L
01051	Lead	0.05 mg/L
01055	Manganese	0.5 mg/L
71900	Mercury (grab)**	1.0 ng/L*
01067	Nickel	0.005 mg/L
00556	Oil (hexane soluble or equivalent) (Grab Sample only)	5.0 mg/L
32730	Phenols (grab)	0.005 mg/L
01147	Selenium	0.005 mg/L
01077	Silver (total)	0.003 mg/L
01092	Zinc	0.025 mg/L

Unless otherwise indicated, concentrations refer to the total amount of the constituent present in all phases, whether solid, suspended or dissolved, elemental or combined, including all oxidation states.

*1.0 ng/L = 1 part per trillion.
**Utilize USEPA Method 1631E and the digestion procedure described in Section 11.1.1.2 of 1631E. Mercury shall be monitored monthly for the first two years and quarterly thereafter. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The quarterly monitoring results shall be submitted on the March, June, September and December DMRs.
***USEPA Method OIA-1677

SPECIAL CONDITION 16. There shall be no discharge of complexed metal bearing wastestreams and associated rinses from chemical metal cleaning unless this permit has been modified to include the new discharge.

SPECIAL CONDITION 17. The permittee shall continue to conduct annually, during the period of May through September, the Upper Illinois Waterway Fisheries Investigation in the Chicago Sanitary & Ship Canal and the Lower Des Plaines River between approximately river mile (RM) 274.4 and RM 296.0. The annual investigation shall include both the same number of sampling locations and scope of work as described in previous annual investigation reports entitled "Upper Illinois Waterway Fisheries Investigation RM 274.4-296.0." Data analysis shall be done according to established fisheries monitoring protocols. Physicochemical measurements shall be taken at each established electrofishing location. All results shall be tabulated in a written report and submitted to the Agency not later than September 30 of the next calendar year following each study period. The annual report also shall include a comparison of the investigation results with the previous years' investigation data to identify any statistically significant changes in the data results.

In the event that the results of the annual investigation demonstrate any adverse, statistically significant change in data results caused by discharges from the facility, the Agency has the right to re-open and modify this permit to include additional requirements necessary to address any such change.

SPECIAL CONDITION 18. If an applicable thermal standard is promulgated under the Clean Water Act for the receiving water during the term of the permit, and that standard is more stringent than any effluent standard or limitation in the permit, the Agency has the right to re-open and modify this permit to include additional requirements necessary to address any such change. The Agency shall provide the permittee with opportunity to comment on any such modification pursuant to applicable Illinois regulations for the issuance of modified NPDES permits.

SPECIAL CONDITION 19. The effluent, alone or in combination with other sources, shall not cause a violation of any applicable water quality standard outlined in 35 Ill. Adm. 302.

SPECIAL CONDITION 20.

STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

A. A storm water pollution prevention plan shall be maintained by the permittee for the storm water associated with industrial activity at this facility except that which is discharged from outfalls 006 and 007. The plan shall identify potential sources of pollution which may be expected to affect the quality of storm water discharges associated with the industrial activity at the facility. In addition, the plan shall describe and ensure the implementation of practices which are to be used to reduce the pollutants in storm water discharges associated with industrial activity at the facility and to assure compliance with the terms and conditions of this permit. The permittee shall modify the plan if substantive changes are made or occur affecting compliance with this condition.

1. Waters not classified as impaired pursuant to Section 303(d) of the Clean Water Act.

   Unless otherwise specified by federal regulation, the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event.

2. Waters classified as impaired pursuant to Section 303(d) of the Clean Water Act

   For any site which discharges directly to an impaired water identified in the Agency's 303(d) listing, and if any parameter in the subject discharge has been identified as the cause of impairment, the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event. If required by federal regulations, the storm water pollution prevention plan shall adhere to a more restrictive design criteria.

B. The operator or owner of the facility shall make a copy of the plan available to the Agency at any reasonable time upon request.

   Facilities which discharge to a municipal separate storm sewer system shall also make a copy available to the operator of the municipal system at any reasonable time upon request.

C. The permittee may be notified by the Agency at any time that the plan does not meet the requirements of this condition. After such notification, the permittee shall make changes to the plan and shall submit a written certification that the requested changes have been made. Unless otherwise provided, the permittee shall have 30 days after such notification to make the changes.

D. The discharger shall amend the plan whenever there is a change in construction, operation, or maintenance which may affect the discharge of significant quantities of pollutants to the waters of the State or if a facility inspection required by paragraph H of this condition indicates that an amendment is needed. The plan should also be amended if the discharger is in violation of any conditions of this permit, or has not achieved the general objective of controlling pollutants in storm water discharges. Amendments to the plan shall be made within 30 days of any proposed construction or operational changes at the facility, and shall be provided to the Agency for review upon request.

E. The plan shall provide a description of potential sources which may be expected to add significant quantities of pollutants to storm water discharges, or which may result in non-storm water discharges from storm water outfalls at the facility. The plan shall include, at a minimum, the following items:

1. A topographic map extending one-quarter mile beyond the property boundaries of the facility, showing: the facility, surface water bodies, wells (including injection wells), seepage pits, infiltration ponds, and the discharge points where the facility's storm water discharges to a municipal storm drain system or other water body. The requirements of this paragraph may be included on the site map if appropriate. Any map or portion of map may be withheld for security reasons.

2. A site map showing:

   i. The storm water conveyance and discharge structures;

   ii. An outline of the storm water drainage areas for each storm water discharge point;

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iii. Paved areas and buildings;

iv. Areas used for outdoor manufacturing, storage, or disposal of significant materials, including activities that generate significant quantities of dust or particulates.

v. Location of existing storm water structural control measures (dikes, coverings, detention facilities, etc.);

vi. Surface water locations and/or municipal storm drain locations

vii. Areas of existing and potential soil erosion;

viii. Vehicle service areas;

ix. Material loading, unloading, and access areas.

x. Areas under items iv and ix above may be withheld from the site for security reasons.

3. A narrative description of the following:

   i. The nature of the industrial activities conducted at the site, including a description of significant materials that are treated, stored or disposed of in a manner to allow exposure to storm water;

   ii. Materials, equipment, and vehicle management practices employed to minimize contact of significant materials with storm water discharges;

   iii. Existing structural and non-structural control measures to reduce pollutants in storm water discharges;

   iv. Industrial storm water discharge treatment facilities;

   v. Methods of onsite storage and disposal of significant materials.

4. A list of the types of pollutants that have a reasonable potential to be present in storm water discharges in significant quantities. Also provide a list of any pollutant that is listed as impaired in the most recent 303(d) report.

5. An estimate of the size of the facility in acres or square feet, and the percent of the facility that has impervious areas such as pavement or buildings.

6. A summary of existing sampling data describing pollutants in storm water discharges.

F. The plan shall describe the storm water management controls which will be implemented by the facility. The appropriate controls shall reflect identified existing and potential sources of pollutants at the facility. The description of the storm water management controls shall include:

1. Storm Water Pollution Prevention Personnel - Identification by job titles of the individuals who are responsible for developing, implementing, and revising the plan.

2. Preventive Maintenance - Procedures for inspection and maintenance of storm water conveyance system devices such as oil/water separators, catch basins, etc., and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water.

3. Good Housekeeping - Good housekeeping requires the maintenance of clean, orderly facility areas that discharge storm water. Material handling areas shall be inspected and cleaned to reduce the potential for pollutants to enter the storm water conveyance system.

4. Spill Prevention and Response - Identification of areas where significant materials can spill into or otherwise enter the storm water conveyance systems and their accompanying drainage points. Specific material handling procedures, storage requirements, spill clean up equipment and procedures should be identified, as appropriate. Internal notification procedures for spills of significant materials should be established.

5. Storm Water Management Practices - Storm water management practices are practices other than those which control the source of pollutants. They include measures such as installing oil and grit separators, diverting storm water into retention basins, etc. Based on assessment of the potential of various sources to contribute pollutants, measures to remove pollutants from storm water discharge shall be implemented. In developing the plan, the following management practices shall be considered:

   i. Containment - Storage within berms or other secondary containment devices to prevent leaks and spills from entering storm water runoff. To the maximum extent practicable storm water discharged from any area where material handling equipment or activities, raw material, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water should not enter vegetated areas or surface waters or infiltrate into the soil unless adequate treatment is provided.

ii. Oil & Grease Separation - Oil/water separators, booms, skimmers or other methods to minimize oil contaminated storm water discharges.

iii. Debris & Sediment Control - Screens, booms, sediment ponds or other methods to reduce debris and sediment in storm water discharges.

iv. Waste Chemical Disposal - Waste chemicals such as antifreeze, degreasers and used oils shall be recycled or disposed of in an approved manner and in a way which prevents them from entering storm water discharges.

v. Storm Water Diversion - Storm water diversion away from materials manufacturing, storage and other areas of potential storm water contamination. Minimize the quantity of storm water entering areas where material handling equipment of activities, raw material, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water using green infrastructure techniques where practicable in the areas outside the exposure area, and otherwise divert storm water away from exposure area.

vi. Covered Storage or Manufacturing Areas - Covered fueling operations, materials manufacturing and storage areas to prevent contact with storm water.

vii. Storm Water Reduction - Install vegetation on roofs of buildings within adjacent to the exposure area to detain and evapotranspirate runoff where precipitation falling on the roof is not exposed to contaminants, to minimize storm water runoff; capture storm water in devices that minimize the amount of storm water runoff and use this water as appropriate based on quality.

6. Sediment and Erosion Prevention - The plan shall identify areas which due to topography, activities, or other factors, have a high potential for significant soil erosion. The plan shall describe measures to limit erosion.

7. Employee Training - Employee training programs shall inform personnel at all levels of responsibility of the components and goals of the storm water pollution control plan. Training should address topics such as spill response, good housekeeping and material management practices. The plan shall identify periodic dates for such training.

8. Inspection Procedures - Qualified plant personnel shall be identified to inspect designated equipment and plant areas. A tracking or follow-up procedure shall be used to ensure appropriate response has been taken in response to an inspection. Inspections and maintenance activities shall be documented and recorded.

G. Non-Storm Water Discharge - The plan shall include a certification that the discharge has been tested or evaluated for the presence of non-storm water discharge. The certification shall include a description of any test for the presence of non-storm water discharges, the methods used, the dates of the testing, and any onsite drainage points that were observed during the testing. Any facility that is unable to provide this certification must describe the procedure of any test conducted for the presence of non-storm water discharges, the test results, potential sources of non-storm water discharges to the storm sewer, and why adequate tests for such storm sewers were not feasible.

H. Quarterly Visual Observation of Discharges - The requirements and procedures of quarterly visual observations are applicable to all outfalls covered by this condition.

1. You must perform and document a quarterly visual observation of a storm water discharge associated with industrial activity from each outfall. The visual observation must be made during daylight hours. If no storm event resulted in runoff during daylight hours from the facility during a monitoring quarter, you are excused from the visual observations requirement for that quarter, provided you document in your records that no runoff occurred. You must sign and certify the document.

2. Your visual observation must be made on samples collected as soon as practical, but not to exceed 1 hour or when the runoff or snow melt begins discharging from your facility. All samples must be collected from a storm event discharge that is greater than 0.1 inch in magnitude and that occurs at least 72 hours from the previously measureable (greater than 0.1 inch rainfall) storm event. The observation must document: color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution. If visual observations indicate any unnatural color, odor, turbidity, floatable material, oil sheen or other indicators of storm water pollution, the permittee shall obtain a sample and monitor for the parameter or the list of pollutants in Part E.4.

3. You must maintain your visual observation reports onsite with the SWPPP. The report must include the observation date and time, inspection personnel, nature of the discharge (i.e., runoff or snow melt), visual quality of the storm water discharge (including observations of color, odor, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution), and probable sources of any observed storm water contamination.

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4. You may exercise a waiver of the visual observation requirement at a facility that is inactive or unstaffed, as long as there are no industrial materials or activities exposed to storm water. If you exercise this waiver, you must maintain a certification with your SWPPP stating that the site is inactive and unstaffed, and that there are no industrial materials or activities exposed to storm water.

5. Representative Outfalls - If your facility has two or more outfalls that you believe discharge substantially identical effluents, based on similarities of the industrial activities, significant materials, size of drainage areas, and storm water management practices occurring within the drainage areas of the outfalls, you may conduct visual observations of the discharge at just one of the outfalls and report that the results also apply to the substantially identical outfall(s).

6. The visual observation documentation shall be made available to the Agency and general public upon written request.

I. The permittee shall conduct an annual facility inspection to verify that all elements of the plan, including the site map, potential pollutant sources, and structural and non-structural controls to reduce pollutants in industrial storm water discharges are accurate. Observations that require a response and the appropriate response to the observation shall be retained as part of the plan. Records documenting significant observations made during the site inspection shall be submitted to the Agency in accordance with the reporting requirements of this permit.

J. This plan should briefly describe the appropriate elements of other program requirements, including Spill Prevention Control and Countermeasures (SPCC) plans required under Section 311 of the CWA and the regulations promulgated thereunder, and Best Management Programs under 40 CFR 125.100.

K. The plan is considered a report that shall be available to the public at any reasonable time upon request.

L. The plan shall include the signature and title of the person responsible for preparation of the plan and include the date of initial preparation and each amendment thereto.

M. Facilities which discharge storm water associated with industrial activity to municipal separate storm sewers may also be subject to additional requirement imposed by the operator of the municipal system

Construction Authorization

Authorization is hereby granted to construct treatment works and related equipment that may be required by the Storm Water Pollution Prevention Plan developed pursuant to this permit.

This Authorization is issued subject to the following condition(s).

N. If any statement or representation is found to be incorrect, this authorization may be revoked and the permittee there upon waives all rights thereunder.

O. The issuance of this authorization (a) does not release the permittee from any liability for damage to persons or property caused by or resulting from the installation, maintenance or operation of the proposed facilities; (b) does not take into consideration the structural stability of any units or part of this project; and (c) does not release the permittee from compliance with other applicable statutes of the State of Illinois, or other applicable local law, regulations or ordinances.

P. Plans and specifications of all treatment equipment being included as part of the stormwater management practice shall be included in the SWPPP.

Q. Construction activities which result from treatment equipment installation, including clearing, grading and excavation activities which result in the disturbance of one acre or more of land area, are not covered by this authorization. The permittee shall contact the IEPA regarding the required permit(s).

REPORTING

R. The facility shall submit an electronic copy of the annual inspection report to the Illinois Environmental Protection Agency. The report shall include results of the annual facility inspection which is required by Part I of this condition. The report shall also include documentation of any event (spill, treatment unit malfunction, etc.) which would require an inspection, results of the inspection, and any subsequent corrective maintenance activity. The report shall be completed and signed by the authorized facility employee(s) who conducted the inspection(s). The annual inspection report is considered a public document that shall be available at any reasonable time upon request.

S. The first report shall contain information gathered during the one year time period beginning with the effective date of coverage under this permit and shall be submitted no later than 60 days after this one year period has expired. Each subsequent report shall contain the previous year's information and shall be submitted no later than one year after the previous year's report was due.

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T. If the facility performs inspections more frequently than required by this permit, the results shall be included as additional information in the annual report.

U. The permittee shall retain the annual inspection report on file at least 3 years. This period may be extended by request of the Illinois Environmental Protection Agency at any time.

Annual inspection reports shall be submitted to the following email and office addresses: epa.npdes.inspection@illinois.gov

Illinois Environmental Protection Agency
Bureau of Water
Compliance Assurance Section
Annual Inspection Report
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

V. The permittee shall notify any regulated small municipal separate storm sewer owner (MS4 Community) that they maintain coverage under an individual NPDES permit. The permittee shall submit any SWPPP or any annual inspection to the MS4 community upon request by the MS4 community.

Attachment H

Standard Conditions

Definitions

Act means the Illinois Environmental Protection Act, 415 ILCS 5 as Amended.

Agency means the Illinois Environmental Protection Agency.

Board means the Illinois Pollution Control Board.

Clean Water Act (formerly referred to as the Federal Water Pollution Control Act) means Pub. L 92-500, as amended. 33 U.S.C. 1251 et seq.

NPDES (National Pollutant Discharge Elimination System) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318 and 405 of the Clean Water Act.

USEPA means the United States Environmental Protection Agency.

Daily Discharge means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurements, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

Maximum Daily Discharge Limitation (daily maximum) means the highest allowable daily discharge.

Average Monthly Discharge Limitation (30 day average) means the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Discharge Limitation (7 day average) means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Aliquot means a sample of specified volume used to make up a total composite sample.

Grab Sample means an individual sample of at least 100 milliliters collected at a randomly-selected time over a period not exceeding 15 minutes.

24-Hour Composite Sample means a combination of at least 8 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over a 24-hour period.

8-Hour Composite Sample means a combination of at least 3 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over an 8-hour period.

Flow Proportional Composite Sample means a combination of sample aliquots of at least 100 milliliters collected at periodic intervals such that either the time interval between each aliquot or the volume of each aliquot is proportional to either the stream flow at the time of sampling or the total stream flow since the collection of the previous aliquot.

(1) **Duty to comply**. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action, permit termination, revocation and reissuance, modification, or for denial of a permit renewal application. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirements.

(2) **Duty to reapply**. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. If the permittee submits a proper application as required by the Agency no later than 180 days prior to the expiration date, this permit shall continue in full force and effect until the final Agency decision on the application has been made.

(3) **Need to halt or reduce activity not a defense**. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

(4) **Duty to mitigate**. The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

(5) **Proper operation and maintenance**. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up, or auxiliary facilities, or similar systems only when necessary to achieve compliance with the conditions of the permit.

(6) **Permit actions**. This permit may be modified, revoked and reissued, or terminated for cause by the Agency pursuant to 40 CFR 122.62 and 40 CFR 122.63. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

(7) **Property rights**. This permit does not convey any property rights of any sort, or any exclusive privilege.

(8) **Duty to provide information**. The permittee shall furnish to the Agency within a reasonable time, any information which the Agency may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee shall also furnish to the Agency upon request, copies of records required to be kept by this permit.

(9) **Inspection and entry**. The permittee shall allow an authorized representative of the Agency or USEPA (including an authorized contractor acting as a representative of the Agency or USEPA), upon the presentation of credentials and other documents as may be required by law, to:
- (a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
- (b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
- (c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
- (d) Sample or monitor at reasonable times, for the purpose of assuring permit compliance, or as otherwise authorized by the Act, any substances or parameters at any location.

(10) **Monitoring and records**.
- (a) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
- (b) The permittee shall retain records of all monitoring information, including all calibration and maintenance records, and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of this permit, measurement, report or application. Records related to the permittee's sewage sludge use and disposal activities shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503). This period may be extended by request of the Agency or USEPA at any time.
- (c) Records of monitoring information shall include:
  - (1) The date, exact place, and time of sampling or measurements;
  - (2) The individual(s) who performed the sampling or measurements;
  - (3) The date(s) analyses were performed;
  - (4) The individual(s) who performed the analyses;
  - (5) The analytical techniques or methods used; and
  - (6) The results of such analyses.
- (d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit. Where no test procedure under 40 CFR Part 136 has been approved, the permittee must submit to the Agency a test method for approval. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals to ensure accuracy of measurements.

(11) **Signatory requirement**. All applications, reports or information submitted to the Agency shall be signed and certified.
- (a) **Application**. All permit applications shall be signed as follows:
  - (1) For a corporation: by a principal executive officer of at least the level of vice president or a person or position having overall responsibility for environmental matters for the corporation:
  - (2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
  - (3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.
- (b) **Reports**. All reports required by permits, or other information requested by the Agency shall be signed by a person described in paragraph (a) or by a duly authorized representative of that person. A person is a duly authorized representative only if:
  - (1) The authorization is made in writing by a person described in paragraph (a); and
  - (2) The authorization specifies either an individual or a position responsible for the overall operation of the facility, from which the discharge originates, such as a plant manager, superintendent or person of equivalent responsibility; and
  - (3) The written authorization is submitted to the Agency.
- (c) **Changes of Authorization**. If an authorization under (b) is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of (b) must be submitted to the Agency prior to or together with any reports, information, or applications to be signed by an authorized representative.
- (d) **Certification**. Any person signing a document under paragraph (a) or (b) of this section shall make the following certification:

  I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

(12) **Reporting requirements**.
- (a) **Planned changes**. The permittee shall give notice to the Agency as soon as possible of any planned physical alterations or additions to the permitted facility.
  Notice is required when:
  - (1) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source pursuant to 40 CFR 122.29 (b); or
  - (2) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements pursuant to 40 CFR 122.42 (a)(1).
  - (3) The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.
- (b) **Anticipated noncompliance**. The permittee shall give advance notice to the Agency of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.
- (c) **Transfers**. This permit is not transferable to any person except after notice to the Agency.
- (d) **Compliance schedules**. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.
- (e) **Monitoring reports**. Monitoring results shall be reported at the intervals specified elsewhere in this permit.
  - (1) Monitoring results must be reported on a Discharge Monitoring Report (DMR).

(2) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR 136 or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR.

(3) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Agency in the permit.

(f) **Twenty-four hour reporting**. The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24-hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and time; and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The following shall be included as information which must be reported within 24-hours:

(1) Any unanticipated bypass which exceeds any effluent limitation in the permit.

(2) Any upset which exceeds any effluent limitation in the permit.

(3) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Agency in the permit or any pollutant which may endanger health or the environment.

The Agency may waive the written report on a case-by-case basis if the oral report has been received within 24-hours.

(g) **Other noncompliance**. The permittee shall report all instances of noncompliance not reported under paragraphs (12) (d), (e), or (f), at the time monitoring reports are submitted. The reports shall contain the information listed in paragraph (12) (f).

(h) **Other information**. Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to the Agency, it shall promptly submit such facts or information.

(13) **Bypass**.

(a) Definitions.

(1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

(2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

(b) Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs (13)(c) and (13)(d).

(c) Notice.

(1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

(2) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in paragraph (12)(f) (24-hour notice).

(d) Prohibition of bypass.

(1) Bypass is prohibited, and the Agency may take enforcement action against a permittee for bypass, unless:

(i) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(iii) The permittee submitted notices as required under paragraph (13)(c).

(2) The Agency may approve an anticipated bypass, after considering its adverse effects, if the Agency determines that it will meet the three conditions listed above in paragraph (13)(d)(1).

(14) **Upset**.

(a) Definition. Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

(b) Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (14)(c) are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

(c) Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An upset occurred and that the permittee can identify the cause(s) of the upset;

(2) The permitted facility was at the time being properly operated; and

(3) The permittee submitted notice of the upset as required in paragraph (12)(f)(2) (24-hour notice).

(4) The permittee complied with any remedial measures required under paragraph (4).

(d) Burden of proof. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

(15) **Transfer of permits**. Permits may be transferred by modification or automatic transfer as described below:

(a) Transfers by modification. Except as provided in paragraph (b), a permit may be transferred by the permittee to a new owner or operator only if the permit has been modified or revoked and reissued pursuant to 40 CFR 122.62 (b) (2), or a minor modification made pursuant to 40 CFR 122.63 (d), to identify the new permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

(b) Automatic transfers. As an alternative to transfers under paragraph (a), any NPDES permit may be automatically

transferred to a new permittee if:
(1) The current permittee notifies the Agency at least 30 days in advance of the proposed transfer date;
(2) The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage and liability between the existing and new permittees; and
(3) The Agency does not notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement.

(16) All manufacturing, commercial, mining, and silvicultural dischargers must notify the Agency as soon as they know or have reason to believe:
(a) That any activity has occurred or will occur which would result in the discharge of any toxic pollutant identified under Section 307 of the Clean Water Act which is not limited in the permit, if that discharge will exceed the highest of the following notification levels:
(1) One hundred micrograms per liter (100 ug/l);
(2) Two hundred micrograms per liter (200 ug/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/l) for 2,4-dinitrophenol and for 2-methyl-4,6 dinitrophenol; and one milligram per liter (1 mg/l) for antimony.
(3) Five (5) times the maximum concentration value reported for that pollutant in the NPDES permit application; or
(4) The level established by the Agency in this permit.
(b) That they have begun or expect to begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the NPDES permit application.

(17) All Publicly Owned Treatment Works (POTWs) must provide adequate notice to the Agency of the following:
(a) Any new introduction of pollutants into that POTW from an indirect discharge which would be subject to Sections 301 or 306 of the Clean Water Act if it were directly discharging those pollutants; and
(b) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.
(c) For purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

(18) If the permit is issued to a publicly owned or publicly regulated treatment works, the permittee shall require any industrial user of such treatment works to comply with federal requirements concerning:
(a) User charges pursuant to Section 204 (b) of the Clean Water Act, and applicable regulations appearing in 40 CFR 35;
(b) Toxic pollutant effluent standards and pretreatment standards pursuant to Section 307 of the Clean Water Act; and
(c) Inspection, monitoring and entry pursuant to Section 308 of the Clean Water Act.

(19) If an applicable standard or limitation is promulgated under Section 301(b)(2)(C) and (D), 304(b)(2), or 307(a)(2) and that effluent standard or limitation is more stringent than any effluent limitation in the permit, or controls a pollutant not limited in the permit, the permit shall be promptly modified or revoked, and reissued to conform to that effluent standard or limitation.

(20) Any authorization to construct issued to the permittee pursuant to 35 Ill. Adm. Code 309.154 is hereby incorporated by reference as a condition of this permit.

(21) The permittee shall not make any false statement, representation or certification in any application, record, report, plan or other document submitted to the Agency or the USEPA, or required to be maintained under this permit.

(22) The Clean Water Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a civil penalty not to exceed $25,000 per day of such violation. Any person who willfully or negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318 or 405 of the Clean Water Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than one year, or both.
Additional penalties for violating these sections of the Clean Water Act are identified in 40 CFR 122.41 (a)(2) and (3).

(23) The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both.

(24) The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

(25) Collected screening, slurries, sludges, and other solids shall be disposed of in such a manner as to prevent entry of those wastes (or runoff from the wastes) into waters of the State. The proper authorization for such disposal shall be obtained from the Agency and is incorporated as part hereof by reference.

(26) In case of conflict between these standard conditions and any other condition(s) included in this permit, the other condition(s) shall govern.

(27) The permittee shall comply with, in addition to the requirements of the permit, all applicable provisions of 35 Ill. Adm. Code, Subtitle C, Subtitle D, Subtitle E, and all applicable orders of the Board or any court with jurisdiction.

(28) The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit is held invalid, the remaining provisions of this permit shall continue in full force and effect.

EXHIBIT AA

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217)782-2829
PAT QUINN, GOVERNOR LISA BONNETT, DIRECTOR

217/782-0610

September, 30, 2014

Midwest Generation, LLC
1800 Channahon Road
Joliet, Illinois 60436

Re: Midwest Generation, LLC
Joliet 29 Generating Station
NPDES Permit No. IL0064254
Final Permit

Ladies and Gentlemen:

We have reviewed your comments to the public noticed permit and offer the following responses:

1. The pH limits were moved from outfalls A01, B01, C01, and G01 to outfall 001 as requested. A pH limit is necessary to ensure compliance with 35 IAC 304.125.

2. The semi-annual metals monitoring requirement listed as Special Condition 15 is necessary to provide sufficient data on effluent quality and will remain.

3. The 7-Day BOD_5 and TSS limits were removed from outfall D01 as requested.

4. Internal monitoring point I01 proposed as a sampling point for coal pile runoff was removed as requested.

5. Internal monitoring point J01 proposed as a sampling point for non-chemical metal cleaning wastes will remain to ensure compliance with the BPT limits of 40 CFR 423.12(b)(5) prior to mixing with other waste streams.

6. The 0.05 mg/l total residual chlorine limit at outfall 001 will remain to ensure compliance with 35 IAC 302.410.

7. Fire Sprinkler Water discharged from outfall 004 meets the definition of low volume wastestream of 40 CFR 423.11(b) and thus the limits of 40 CFR 423.12(b)(3) will remain.

8. The mercury monitoring requirements of Special Condition 16 were consolidated into Special Condition 15 and Special Condition 16 was removed. Mercury monitoring at outfalls 001 and 004 is required on a monthly basis for the first two years and quarterly thereafter. Monthly mercury monitoring was added to page 7 of the permit.

9. RO Reject and Boiler Blowdown meets the definition of low volume wastestream of 40 CFR 423.11(b) and thus the oil and grease limits of 40 CFR 423.12(b)(3) will remain.

10. Special Condition 7 was revised as requested.

11. Special Condition 10 now specifies that a reduction or elimination of dissolved oxygen monitoring may be requested after two years.

12. The sampling frequency on page 8 of the permit was changed to read "daily when discharging".

13. The load limits for TSS and Oil and Grease on page 8 of the permit were erroneous and have been removed from the permit.

14. Oil and grease was changed to a grab sample on page 8 of the permit.

15. TRC sampling is required once per week when residuals are likely to be present in the discharge including low volume house service water treatment.

16. Intake screen backwash may be discharged directly in front of the intake screen bar racks as requested in the April 2, 2013 letter. A State Construction Permit is required for the project pursuant to 35 IAC 309.202.

17. Special condition 11 was revised to require submittal of a impingement mortality and entrainment characterization study and a compliance alternatives analysis.

18. The monitoring requirements of special condition 15 now apply to outfall 004.

19. The Offensive Discharges language of 35 Ill. Adm. Code 304.106 was added to the permit as Special Condition 17.

The discharger address was changed as requested in your June 20, 2014 letter.

Attached is the final NPDES Permit for your discharge. The Permit as issued covers discharge limitations, monitoring, and reporting requirements. Failure to meet any portion of the Permit could result in civil and/or criminal penalties. The Illinois Environmental Protection Agency is ready and willing to assist you in interpreting any of the conditions of the Permit as they relate specifically to your discharge.

The Agency has begun a program allowing the submittal of electronic Discharge Monitoring Reports (NetDMR) instead of paper Discharge Monitoring Reports (DMRs). If you are interested in NetDMR, more information can be found on the Agency website, http://www.epa.state.il.us/water/net-dmr/index.html. If your facility is not registered in the NetDMR program, a supply of preprinted paper DMR Forms for your facility will be sent to you prior to the initiation of DMR reporting under the New permit. Additional information and instructions will accompany the preprinted DMRs upon their arrival.

The attached Permit is effective as of the date indicated on the first page of the Permit. Until the effective date of any re-issued Permit, the limitations and conditions of the previously-issued Permit remain in full effect. You have the right to appeal any condition of the Permit to the Illinois Pollution Control Board within a 35 day period following the issuance date.

Should you have questions concerning the Permit, please contact Jaime Rabins at 217/782-0610.

Sincerely,

Alan Keller

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:JAR:11011301.jar

Attachment: Final Permit

cc: Records
Compliance Assurance Section
Des Plaines Region
Billing
US EPA
CMAP

NPDES Permit No. IL0064254

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Reissued (NPDES) Permit

Expiration Date: October 31, 2019

Issue Date: September 30, 2014
Effective Date: November 1, 2014

Name and Address of Permittee:

Midwest Generation, LLC
1800 Channahon Road
Joliet, Illinois 60436

Facility Name and Address:

Midwest Generation, LLC
Joliet 29 Generating Station
1800 Channahon Road
Joliet, Illinois 60436
(Will County)

Discharge Number and Name:	Receiving Waters:
001 Condenser Cooling Water and House Service Water	Des Plaines River
A01 Reverse Osmosis Reject	
B01 Plant Drains, Coal Pile and West Area Basin Emergency Overflow	
C01 Boiler Blowdown	
D01 Sanitary	
G01 Local Field Ash Pond Effluent	
H01 Cooling Tower Are Runoff	
J01 Gas Side Non-Chemical Metal Cleaning Wastes	
002 Junction Area Tower Runoff	Des Plaines River
003 Abandoned Ash Disposal Area Runoff	Des Plaines River
004 Fire Sprinkler Water (Coal Conveyer)	Des Plaines River

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of Ill. Adm. Code, Subtitle C and/or Subtitle D, Chapter 1, and the Clean Water Act (CWA), the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Alan Keller

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:JAR:11011301.jar

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall 001: Condenser Cooling Water and House Service Water (DAF = 1073 MGD)

This discharge consists of:

1. Condenser Cooling Water Units 7 and 8
2. Reverse Osmosis Reject
3. Sanitary
4. House Service Water
5. Intake Screen Backwash
6. Local Field Ash Pond Effluent
7. Plant Drains, Coal Pile and, West Roof and Plant Area Storm Runoff.
8. Boiler Blowdown

PARAMETER	LOAD LIMITS 30 DAY AVERAGE	LOAD LIMITS DAILY MAXIMUM	CONCENTRATION 30 DAY AVERAGE	CONCENTRATION DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1				Daily	Continuous
pH	See Special Condition 2				1/Week	Grab
Total Residual Chlorine	See Special Condition 3			0.05	*	Grab
Temperature	See Special Condition 4				Daily	Continuous

*Total Residual Chlorine shall be sampled 1/week whenever chlorination or biocide addition is being performed or residuals are likely to be present in the discharge including low volume house service water treatment. If chlorination and biocide addition are not used during the month it shall be so indicated on the DMR.

Intake screen backwash may be discharged directly in front of the station's intake screen bar racks.

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall A01: Reverse Osmosis Reject (DAF = 0.25 MGD)						
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
Total Suspended Solids			15	30	1/Week	Grab
Oil and Grease			15	20	1/Week	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall B01: Plant Drains, Coal Pile and West Area Basin Emergency Overflow (Intermittent Discharge)						
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
Total Suspended Solids			15	30	1/Week	24-Hour Composite
Oil and Grease			15	20	1/Week	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall C01: Boiler Blowdown (Intermittent Discharge)						
				Approximate Flow: 0.038 MGD		
	This discharge consists of:					
	1. Boiler Blowdown			Intermittent		
	2. Boiler Drains			Intermittent		
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
Total Suspended Solids			15	30	1/Month	8-Hour Composite
Oil and Grease			15	20	1/Month	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall D01: Sanitary (DAF = 0.04 MGD)						
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
pH					1/Week	Grab
Total Suspended Solids			30	60	1/Week	24-Hour Composite
BOD_5			30	60	1/Week	24-Hour Composite

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall G01: Local Field Ash Pond Effluent (DAF = 2.61 MGD)

This discharge consists of:

1. Reverse Osmosis Filter Backwash*
2. Bottom Ash and Economizer Ash Sluice Water*
3. Plant Drains, Coal Pile, and West Area Basin Emergency Overflow**
4. Pyrite Sluice Water
5. Gas Side Non-Chemical Metal Cleaning Wastewater

* These sub-waste streams can be alternately routed to the Joliet Unit 6 Station Quarry -- outfall 005, NPDES Permit No. IL0002216.

**This Sub-Waste can be alternately discharged through outfall B01.

Flow (MGD)	See Special Condition 1				3/Week	24-Hour Total
Total Suspended Solids			15	30	1/Month	8-Hour Composite
Oil and Grease			15	20	1/Month	Grab
Mercury					1/Month	Grab

Mercury shall be monitored in accordance with USEPA Method 1631E and the digestion procedure described in Section 11.1.1.2 of 1631E with a minimum reporting limit of one part per trillion (1 ng/L).

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall J01: Gas Side Non-Chemical Metal Cleaning Wastes (Intermittent Discharge)						
Flow (MGD)	See Special Condition 1				Daily When Discharging	Continuous
Total Suspended Solids			30	100	Daily When Discharging	Grab
Oil and Grease			15	20	Daily When Discharging	Grab
Iron			1.0	1.0	Daily When Discharging	24-Hour Composite
Copper			1.0	1.0	Daily When Discharging	24-Hour Composite

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

Outfall H01: Cooling Tower Area Runoff (Intermittent Discharge)
Outfall 002: Junction Tower Area Runoff (Intermittent Discharge)
Outfall 003: Abandoned Ash Disposal Area Runoff (Intermittent Discharge)

Discharges shall be managed in accordance with Special Condition 20.

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 004: Fire Sprinkler Water (Coal Conveyer) (DAF = 0.06 MGD)						
Flow (MGD)	See Special Condition 1				Daily When Discharging	Estimate
pH	See Special Condition 2				Daily When Discharging	Grab
Total Suspended Solids			15	30	Daily When Discharging	Grab
Oil and Grease			15	20	Daily When Discharging	Grab
Iron			1.0	2.0	Daily When Discharging	Grab

Special Conditions

SPECIAL CONDITION 1. Flow shall be measured in units of Million Gallons per Day (MGD) and reported as a monthly average and a daily maximum value on the monthly Discharge Monitoring Report.

SPECIAL CONDITION 2. The pH shall be in the range 6.0 to 9.0. The monthly minimum and monthly maximum values shall be reported on the DMR form.

SPECIAL CONDITION 3. All samples for TRC shall be grab samples and analyzed by an applicable method contained in 40 CFR 136, equivalent in accuracy to low-level amperometric titration. Any analytical variability of the method used shall be considered when determining the accuracy and precision of the results obtained.

SPECIAL CONDITION 4. Pursuant to Illinois Pollution Control Board Order AS 96-10, dated October 3, 1996 and amended March 16, 2000 the facility shall comply with the following temperature limitations:

A. At the point of discharge the receiving waters are designated as Secondary Contact and Indigenous Aquatic Life Waters and shall meet the following standards from Section 302.408, Illinois Administration Code, Title 35, Chapter 1, Subtitle C, as amended:

Temperatures at the edge of the mixing zone shall not exceed 93°F (34°C) more than 5% of the time, or 100°F (37.8°C) at any time. Compliance with this part shall be determined by the following equations:

$$T_{EF} = \frac{T_{CW}(Q_{CW} - Q_T) + T_T Q_T}{Q_{CW}}$$

$$T_{FM} = \frac{T_{EF} Q_{CW} + T_{US}(0.25 * Q_{AV})}{Q_{CW} + (0.25 * Q_{AV})}$$

T_{EF} Calculated effective condenser cooling water discharge temperature after mixing with cooling tower discharge in degrees Fahrenheit.

T_{CW} Actual condenser cooling water discharge temperature in degrees Fahrenheit from continuous temperature monitor located at head of the stations discharge canal.

Q_{CW} Condenser cooling water flow in cubic feet per second based on the number of circulating water pumps on at the time in question. Each of the four circulating water pumps is rated at 230,000 gpm (512.5 cfs).

Q_T Flow of condenser cooling water routed through the cooling towers in cfs based on the number of circulating water pumps on at the time in question. Each of the 48 cooling tower pumps is rated at 7500 gpm (16.7 cfs).

T_T Cooling tower discharge temperature in degrees Fahrenheit obtained by averaging the readings from the three thermocouples in the cooling tower discharge flume.

T_{FM} Calculated fully-mixed receiving water temperature in degrees Fahrenheit.

Q_{AV} Available receiving stream dilution flow in cfs determined by subtracting condenser cooling water flow from the upstream river flow. If the upstream river flow is equal to or less than the condenser cooling water flow, the available receiving stream dilution flow is zero. Upstream river flow is the average value of flow recorded during the 24-hour period preceding the time in question. The primary source of flow data is the gauging station operated by the USACE at the Brandon Road Lock and Dam. Secondary sources for flow data are gauging stations on the Chicago Sanitary and Ship Canal at Lemont operated by the USGS, and the Des Plaines River gauging station at Riverside, operated by the USACE.

T_{US} Upstream river temperature in degrees Fahrenheit from the continuous temperature monitor located in the stations intake canal.

B. The monthly maximum temperature at the edge of the mixing zone (T_{FM}) and the cumulative number of hours in which temperatures at the edge of the mixing zone exceed 93°F (34°C) shall be reported on the DMR.

C. In the main channel of the Lower Des Plaines River, at the I-55 Bridge, the effluent shall not alone or in combination with other sources cause temperatures to exceed the temperatures set forth in the following table, except in accordance with the allowable monthly excursions detailed below:

	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	June 1-15	June 16-30	July	Aug	Sept	Oct	Nov	Dec
°F	60	60	65	73	80	85	90	90	91	91	91	90	85	75	65

These standards are in lieu of the requirements of 35 Ill. Adm. Code 302.211(d) and (e) and may be exceeded by no more than 3°F during 2% of the hours in the 12-month period ending December 31, except that at no time shall Midwest Generation's plants cause the water temperature at the I-55 Bridge to exceed 93°F. Excursion hours for the purposes of this part is defined as the hours in which the temperatures of this part are exceeded. The cumulative number of excursion hours shall be reported on the monthly DMR.

D. When it appears that discharges from Outfall 001 have the reasonable potential to cause water temperatures at the I-55 Bridge to exceed the values set forth in the above table, the permittee shall determine whether, and the extent to which, station operations must be restricted to avoid violating the above-stated limits. The permittee shall make such a determination based upon the outputs of a predictive model reasonably suited for such a purpose and which has been submitted to the Agency.

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E. The permittee shall maintain and operate a water temperature monitor and a suitable back-up monitor at the I-55 Bridge. The permittee shall record river temperatures at the I-55 bridge at least once every 15 minutes, and shall report on the monthly discharge monitoring report the daily maximum temperature recorded.

F. Permittee's failure to submit the temperature monitoring data from the I-55 bridge due to equipment malfunction shall not be deemed a permit violation provided the permittee employs reasonable efforts to repair the malfunction. If the malfunction lasts more than 24 hours, a manual measurement of river temperature shall be made at least once per day.

The permittee shall demonstrate to the Agency that the facility has obtained alternate thermal standards from the Illinois Pollution Control Board pursuant to Section 316(a) of the Clean Water Act, and 35 Ill. Adm. Code 304.141(c), in accordance with the procedures as found in 35 Ill. Adm. Code Part 106, Subpart K. This demonstration is only necessary if the permittee intends to obtain relief from the applicable water quality standards for temperature effective at the time the renewal application is filed. This demonstration (if applicable) shall be filed with the renewal application for this permit.

Alternately, the Permittee may demonstrate to the Agency that relief granted in AS 96-10, or other site specific water quality standards for temperature approved by the Illinois Pollution Control Board, and USEPA, meets the requirements of 40 CFR 131 and the Illinois Environmental Protection Act.

SPECIAL CONDITION 5. Samples taken in compliance with the effluent monitoring requirements shall be taken at a point representative of the discharge, but prior to entry into the receiving stream.

SPECIAL CONDITION 6. The Permittee shall record monitoring results on Discharge Monitoring Report (DMR) Forms using one such form for each outfall each month.

In the event that an outfall does not discharge during a monthly reporting period, the DMR Form shall be submitted with no discharge indicated.

The Permittee may choose to submit electronic DMRs (NetDMR) instead of mailing paper DMRs to the IEPA. More information, including registration information for the NetDMR program, can be obtained on the IEPA website, http://www.epa.state.il.us/water/net-dmr/index.html.

The completed Discharge Monitoring Report forms shall be submitted to IEPA no later than the 28th day of the following month, unless otherwise specified by the permitting authority.

Permittees not using NetDMR shall mail Discharge Monitoring Reports with an original signature to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

Attention: Compliance Assurance Section, Mail Code # 19

SPECIAL CONDITION 7. In the event that the permittee must request a change in the use of water treatment additives, the permittee must request a change in this permit in accordance with Standard Conditions - - Attachment H.

SPECIAL CONDITION 8. If an applicable effluent standard or limitation is promulgated under Sections 301(b)(2)(C) and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act and that effluent standard or limitation is more stringent than any effluent limitation in the permit or controls a pollutant not limited in the NPDES Permit, the Agency shall revise or modify the permit in accordance with the more stringent standard or prohibition and shall so notify the permittee.

SPECIAL CONDITION 9. The use or operation of this facility shall be by or under the supervision of a Certified Class K operator.

SPECIAL CONDITION 10. The cooling water prior to entering the plant intake structure and at the discharge from outfall 001 shall be grab sampled once per week at the same time of day within ½ hour of each other between 9:00 a.m. and 3:00 p.m. in a randomized fashion for dissolved oxygen. The results in mg/l and the time of day the influent and effluent sample was taken shall be reported to the Agency as an attachment to the DMR. After 2 years of data has been submitted to the Agency, the permittee may apply to Agency to have the monitoring reduced or eliminated, but in no case shall monitoring change unless notified by the Agency in writing.

SPECIAL CONDITION 11. Cooling Water Intake Structure. Based on available information, the Agency has determined that the operation of the cooling water intake structure met the equivalent of Best Technology Available (BTA) in accordance with the Best Professional Judgment provisions of 40 CFR 125.3, at the time of its construction. However, in order to further evaluate cooling water

Special Conditions

intake structure operations based on the most up to date information, the permit shall comply with the requirements below:

A. The permittee shall submit the following information/studies within 180 days from the permit effective date:

1. Source Water Physical Data to include:

   a. A narrative description and scaled drawings showing the physical configuration of all source water bodies used by the facility including aerial dimensions, depths, salinity and temperature regimes;

   b. Identification and characterization of the source waterbody's hydrological and geomorphological features, as well as the methods used to conduct any physical studies to determine the intake's area of influence and the results of such studies; and

   c. Location maps.

2. Source Waterbody Flow Information

   The permittee shall provide the annual mean flow of the waterbody, any supporting documentation and engineering calculations to support the analysis of whether the design intake flow is greater than five percent of the mean annual flow of the river or stream for purposes of determining applicable performance standards. Representative historical data (from a period of time up to 10 years) shall be used, if available.

3. Impingement Mortality and Entrainment Characterization Study

   The permittee shall submit an Impingement Mortality and Entrainment Characterization Study whose purpose is to provide information to support the development of a calculation baseline for evaluating impingement mortality and entrainment and to characterize current impingement mortality and entrainment. The Study shall include the following in sufficient detail to support establishment of baseline conditions:

   a. Taxonomic identification of all life stages of fish and shellfish and any species protected under Federal, State, or Tribal law (including threatened or endangered species) that are in the vicinity of the cooling water intake structure(s) and are susceptible to impingement and entrainment;

   b. A characterization of all life stages of fish and shellfish, and any species protected under Federal, or State law, including a description of the abundance and temporal and spatial characteristics in the vicinity of the cooling water intake structure(s). These may include historical data that are representative of the current operation of the facility and of biological conditions at the site; and

   c. Documentation of the current impingement mortality and entrainment of all life stages of fish, shellfish, and any species protected under Federal , State, or Tribal Law (including threatened or endangered species) and an estimate of impingement mortality and entrainment to be used as the calculation baseline. The documentation may include historical data that are representative of the current operation of the facility and of biological conditions at the site. Impingement mortality and entrainment samples to support the calculations required must be collected during periods of representative operational flows for the cooling water intake structure and the flows associated with the samples must be documented.

B. The permittee shall comply with the following requirements:

1. At all times properly operate and maintain the intake equipment.

2. Inform IEPA of any proposed changes to the cooling water intake structure or proposed changes to operations at the facility that affect impingement mortality and/or entrainment.

3. Debris collected on intake screens is prohibited from being discharged back to the canal. Debris does not include living fish or other living aquatic organisms.

4. Compliance Alternatives. The permittee must evaluate each of the following alternatives for establishing best available technology for minimizing adverse environmental impacts at the facility due to operation of the intake structure:

   a. Evaluate operational procedures and/or propose facility modifications to reduce the intake through-screen velocity to less than 0.5 ft/sec. The operational evaluation may consider modified circulating water pump operation; reduced flow associated with capacity utilization, recalculation or determination of actual total water withdrawal capacity. The evaluation report and any implementation plan for the operational changes and/ or facility modification shall be submitted to the Agency with the renewal application for this permit.

b. Complete a fish impingement and entrainment mortality minimization alternatives evaluation. The evaluation may include an assessment of modification of the traveling screens, consideration of a separate fish and debris return system and include time frames and cost analysis to implement these measures. The evaluation report and implementation plan for any operational changes and/ or facility modifications shall be submitted to the Agency with the renewal application for this permit.

C. All required reports shall be submitted to the Industrial Unit, Permit Section and Compliance Assurance Section at the address in special condition 6.

This special condition does not relieve the permittee of the responsibility of complying with any laws, regulations, or judicial orders issued pursuant to Section 316(b) of the Clean Water Act. New final federal regulations governing the operation of cooling water intake structures at existing facilities (when effective), shall supersede the requirements of this condition. Unless the final effective federal rules for existing facilities require otherwise, the permittee shall comply with the above requirements of this special condition.

SPECIAL CONDITION 12. There shall be not discharge of polychlorinated biphenyl compounds.

SPECIAL CONDITION 13. The bypass provisions of 40 CFR 122.41(m) and upset provisions of 40 CFR 122.41(n) are hereby incorporated by reference.

SPECIAL CONDITION 14. The Agency has determined that the effluent limitations for outfalls B01 and G01 constitute BAT/BCT for storm water which is treated in the existing treatment facilities for purposes of this permit reissuance, and no pollution prevention plan will be required for such storm water. In addition to the chemical specific monitoring required elsewhere in this permit, the permittee shall conduct an annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity, and determine whether any facility modifications have occurred which result in previously-treated storm water discharges no longer receiving treatment. If any such discharges are identified the permittee shall request a modification of this permit within 30 days after the inspection. Records of the annual inspection shall be retained by the permittee for the term of this permit and be made available to the Agency on request.

SPECIAL CONDITION 15. The Permittee shall monitor the effluent from outfalls 001 and 004 for the following parameters on a semi-annual basis. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The sample shall be a 24-hour effluent composite except as otherwise specifically provided below and the results shall be submitted to the address in special condition 6 in June and December. The parameters to be sampled and the minimum reporting limits to be attained are as follows:

STORET CODE	PARAMETER	Minimum reporting limit
01002	Arsenic	0.05 mg/L
01007	Barium	0.5 mg/L
01027	Cadmium	0.001 mg/L
01032	Chromium (hexavalent) (grab)	0.01 mg/L
01034	Chromium (total)	0.05 mg/L
01042	Copper	0.005 mg/L
00718	Cyanide (grab) (available*** or amendable to chlorination)	5.0 ug/L
00720	Cyanide (grab not to exceed 24 hours) (total)	5.0 ug/L
00951	Fluoride	0.1 mg/L
01045	Iron (total)	0.5 mg/L
01046	Iron (Dissolved)	0.5 mg/L
01051	Lead	0.05 mg/L
01055	Manganese	0.5 mg/L
71900	Mercury (grab)**	1.0 ng/L*
01067	Nickel	0.005 mg/L
00556	Oil (hexane soluble or equivalent) (Grab Sample only)	5.0 mg/L
32730	Phenols (grab)	0.005 mg/L
01147	Selenium	0.005 mg/L
01077	Silver (total)	0.003 mg/L
01092	Zinc	0.025 mg/L

Unless otherwise indicated, concentrations refer to the total amount of the constituent present in all phases, whether solid, suspended or dissolved, elemental or combined, including all oxidation states.

*1.0 ng/L = 1 part per trillion.
**Utilize USEPA Method 1631E and the digestion procedure described in Section 11.1.1.2 of 1631E. Mercury shall be monitored monthly for the first two years and quarterly thereafter. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The quarterly monitoring results shall be submitted on the March, June,

September and December DMRs.
***USEPA Method OIA-1677

SPECIAL CONDITION 16. There shall be no discharge of complexed metal bearing wastestreams and associated rinses from chemical metal cleaning unless this permit has been modified to include the new discharge.

SPECIAL CONDITION 17. The effluent, alone or in combination with other sources, shall not cause a violation of any applicable water quality standard outlined in 35 Ill. Adm. 302.

SPECIAL CONDITION 18. The permittee shall continue to conduct annually, during the period of May through September, the Upper Illinois Waterway Fisheries Investigation in the Chicago Sanitary & Ship Canal and the Lower Des Plaines River between approximately river mile (RM) 274.4 and RM 296.0. The annual investigation shall include both the same number of sampling locations and scope of work as described in previous annual investigation reports entitled "Upper Illinois Waterway Fisheries Investigation RM 274.4-296.0." Data analysis shall be done according to established fisheries monitoring protocols. Physicochemical measurements shall be taken at each established electrofishing location. All results shall be tabulated in a written report and submitted to the Agency not later than September 30 of the next calendar year following each study period. The annual report also shall include a comparison of the investigation results with the previous years' investigation data to identify any statistically significant changes in the data results.

In the event that the results of the annual investigation demonstrate any adverse, statistically significant change in data results caused by discharges from the facility, the Agency has the right to re-open and modify this permit to include additional requirements necessary to address any such change.

SPECIAL CONDITION 19. If an applicable thermal standard is promulgated under the Clean Water Act for the receiving water during the term of the permit, and that standard is more stringent than any effluent standard or limitation in the permit, the Agency has the right to re-open and modify this permit to include additional requirements necessary to address any such change. The Agency shall provide the permittee with opportunity to comment on any such modification pursuant to applicable Illinois regulations for the issuance of modified NPDES permits.

SPECIAL CONDITION 20.

STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

A. A storm water pollution prevention plan shall be maintained by the permittee for the storm water associated with industrial activity at this facility except that which is discharged from outfalls B01 and G01. The plan shall identify potential sources of pollution which may be expected to affect the quality of storm water discharges associated with the industrial activity at the facility. In addition, the plan shall describe and ensure the implementation of practices which are to be used to reduce the pollutants in storm water discharges associated with industrial activity at the facility and to assure compliance with the terms and conditions of this permit. The permittee shall modify the plan if substantive changes are made or occur affecting compliance with this condition.

   1. Waters not classified as impaired pursuant to Section 303(d) of the Clean Water Act.

      Unless otherwise specified by federal regulation, the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event.

   2. Waters classified as impaired pursuant to Section 303(d) of the Clean Water Act

      For any site which discharges directly to an impaired water identified in the Agency's 303(d) listing, and if any parameter in the subject discharge has been identified as the cause of impairment, the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event. If required by federal regulations, the storm water pollution prevention plan shall adhere to a more restrictive design criteria.

B. The operator or owner of the facility shall make a copy of the plan available to the Agency at any reasonable time upon request.

   Facilities which discharge to a municipal separate storm sewer system shall also make a copy available to the operator of the municipal system at any reasonable time upon request.

C. The permittee may be notified by the Agency at any time that the plan does not meet the requirements of this condition. After such notification, the permittee shall make changes to the plan and shall submit a written certification that the requested changes have been made. Unless otherwise provided, the permittee shall have 30 days after such notification to make the changes.

D. The discharger shall amend the plan whenever there is a change in construction, operation, or maintenance which may affect the discharge of significant quantities of pollutants to the waters of the State or if a facility inspection required by paragraph H of this condition indicates that an amendment is needed. The plan should also be amended if the discharger is in violation of any conditions of this permit, or has not achieved the general objective of controlling pollutants in storm water discharges. Amendments to the plan

Special Conditions

shall be made within 30 days of any proposed construction or operational changes at the facility, and shall be provided to the Agency for review upon request.

E. The plan shall provide a description of potential sources which may be expected to add significant quantities of pollutants to storm water discharges, or which may result in non-storm water discharges from storm water outfalls at the facility. The plan shall include, at a minimum, the following items:

1. A topographic map extending one-quarter mile beyond the property boundaries of the facility, showing: the facility, surface water bodies, wells (including injection wells), seepage pits, infiltration ponds, and the discharge points where the facility's storm water discharges to a municipal storm drain system or other water body. The requirements of this paragraph may be included on the site map if appropriate. Any map or portion of map may be withheld for security reasons.

2. A site map showing:

   i. The storm water conveyance and discharge structures;

   ii. An outline of the storm water drainage areas for each storm water discharge point;

   iii. Paved areas and buildings;

   iv. Areas used for outdoor manufacturing, storage, or disposal of significant materials, including activities that generate significant quantities of dust or particulates.

   v. Location of existing storm water structural control measures (dikes, coverings, detention facilities, etc.);

   vi. Surface water locations and/or municipal storm drain locations

   vii. Areas of existing and potential soil erosion;

   viii. Vehicle service areas;

   ix. Material loading, unloading, and access areas.

   x. Areas under items iv and ix above may be withheld from the site for security reasons.

3. A narrative description of the following:

   i. The nature of the industrial activities conducted at the site, including a description of significant materials that are treated, stored or disposed of in a manner to allow exposure to storm water;

   ii. Materials, equipment, and vehicle management practices employed to minimize contact of significant materials with storm water discharges;

   iii. Existing structural and non-structural control measures to reduce pollutants in storm water discharges;

   iv. Industrial storm water discharge treatment facilities;

   v. Methods of onsite storage and disposal of significant materials.

4. A list of the types of pollutants that have a reasonable potential to be present in storm water discharges in significant quantities. Also provide a list of any pollutant that is listed as impaired in the most recent 303(d) report.

5. An estimate of the size of the facility in acres or square feet, and the percent of the facility that has impervious areas such as pavement or buildings.

6. A summary of existing sampling data describing pollutants in storm water discharges.

F. The plan shall describe the storm water management controls which will be implemented by the facility. The appropriate controls shall reflect identified existing and potential sources of pollutants at the facility. The description of the storm water management controls shall include:

1. Storm Water Pollution Prevention Personnel - Identification by job titles of the individuals who are responsible for developing, implementing, and revising the plan.

2. Preventive Maintenance - Procedures for inspection and maintenance of storm water conveyance system devices such as oil/water separators, catch basins, etc., and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water.

Special Conditions

3. Good Housekeeping - Good housekeeping requires the maintenance of clean, orderly facility areas that discharge storm water. Material handling areas shall be inspected and cleaned to reduce the potential for pollutants to enter the storm water conveyance system.

4. Spill Prevention and Response - Identification of areas where significant materials can spill into or otherwise enter the storm water conveyance systems and their accompanying drainage points. Specific material handling procedures, storage requirements, spill clean up equipment and procedures should be identified, as appropriate. Internal notification procedures for spills of significant materials should be established.

5. Storm Water Management Practices - Storm water management practices are practices other than those which control the source of pollutants. They include measures such as installing oil and grit separators, diverting storm water into retention basins, etc. Based on assessment of the potential of various sources to contribute pollutants, measures to remove pollutants from storm water discharge shall be implemented. In developing the plan, the following management practices shall be considered:

   i. Containment - Storage within berms or other secondary containment devices to prevent leaks and spills from entering storm water runoff. To the maximum extent practicable storm water discharged from any area where material handling equipment or activities, raw material, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water should not enter vegetated areas or surface waters or infiltrate into the soil unless adequate treatment is provided.

   ii. Oil & Grease Separation - Oil/water separators, booms, skimmers or other methods to minimize oil contaminated storm water discharges.

   iii. Debris & Sediment Control - Screens, booms, sediment ponds or other methods to reduce debris and sediment in storm water discharges.

   iv. Waste Chemical Disposal - Waste chemicals such as antifreeze, degreasers and used oils shall be recycled or disposed of in an approved manner and in a way which prevents them from entering storm water discharges.

   v. Storm Water Diversion - Storm water diversion away from materials manufacturing, storage and other areas of potential storm water contamination. Minimize the quantity of storm water entering areas where material handling equipment of activities, raw material, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water using green infrastructure techniques where practicable in the areas outside the exposure area, and otherwise divert storm water away from exposure area.

   vi. Covered Storage or Manufacturing Areas - Covered fueling operations, materials manufacturing and storage areas to prevent contact with storm water.

   vii. Storm Water Reduction - Install vegetation on roofs of buildings within adjacent to the exposure area to detain and evapotranspirate runoff where precipitation falling on the roof is not exposed to contaminants, to minimize storm water runoff; capture storm water in devices that minimize the amount of storm water runoff and use this water as appropriate based on quality.

6. Sediment and Erosion Prevention - The plan shall identify areas which due to topography, activities, or other factors, have a high potential for significant soil erosion. The plan shall describe measures to limit erosion.

7. Employee Training - Employee training programs shall inform personnel at all levels of responsibility of the components and goals of the storm water pollution control plan. Training should address topics such as spill response, good housekeeping and material management practices. The plan shall identify periodic dates for such training.

8. Inspection Procedures - Qualified plant personnel shall be identified to inspect designated equipment and plant areas. A tracking or follow-up procedure shall be used to ensure appropriate response has been taken in response to an inspection. Inspections and maintenance activities shall be documented and recorded.

G. Non-Storm Water Discharge - The plan shall include a certification that the discharge has been tested or evaluated for the presence of non-storm water discharge. The certification shall include a description of any test for the presence of non-storm water discharges, the methods used, the dates of the testing, and any onsite drainage points that were observed during the testing. Any facility that is unable to provide this certification must describe the procedure of any test conducted for the presence of non-storm water discharges, the test results, potential sources of non-storm water discharges to the storm sewer, and why adequate tests for such storm sewers were not feasible.

H. Quarterly Visual Observation of Discharges - The requirements and procedures of quarterly visual observations are applicable to all outfalls covered by this condition.

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1. You must perform and document a quarterly visual observation of a storm water discharge associated with industrial activity from each outfall. The visual observation must be made during daylight hours. If no storm event resulted in runoff during daylight hours from the facility during a monitoring quarter, you are excused from the visual observations requirement for that quarter, provided you document in your records that no runoff occurred. You must sign and certify the document.

2. Your visual observation must be made on samples collected as soon as practical, but not to exceed 1 hour or when the runoff or snow melt begins discharging from your facility. All samples must be collected from a storm event discharge that is greater than 0.1 inch in magnitude and that occurs at least 72 hours from the previously measureable (greater than 0.1 inch rainfall) storm event. The observation must document: color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution. If visual observations indicate any unnatural color, odor, turbidity, floatable material, oil sheen or other indicators of storm water pollution, the permittee shall obtain a sample and monitor for the parameter or the list of pollutants in Part E.4.

3. You must maintain your visual observation reports onsite with the SWPPP. The report must include the observation date and time, inspection personnel, nature of the discharge (i.e., runoff or snow melt), visual quality of the storm water discharge (including observations of color, odor, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution), and probable sources of any observed storm water contamination.

4. You may exercise a waiver of the visual observation requirement at a facility that is inactive or unstaffed, as long as there are no industrial materials or activities exposed to storm water. If you exercise this waiver, you must maintain a certification with your SWPPP stating that the site is inactive and unstaffed, and that there are no industrial materials or activities exposed to storm water.

5. Representative Outfalls - If your facility has two or more outfalls that you believe discharge substantially identical effluents, based on similarities of the industrial activities, significant materials, size of drainage areas, and storm water management practices occurring within the drainage areas of the outfalls, you may conduct visual observations of the discharge at just one of the outfalls and report that the results also apply to the substantially identical outfall(s).

6. The visual observation documentation shall be made available to the Agency and general public upon written request.

I. The permittee shall conduct an annual facility inspection to verify that all elements of the plan, including the site map, potential pollutant sources, and structural and non-structural controls to reduce pollutants in industrial storm water discharges are accurate. Observations that require a response and the appropriate response to the observation shall be retained as part of the plan. Records documenting significant observations made during the site inspection shall be submitted to the Agency in accordance with the reporting requirements of this permit.

J. This plan should briefly describe the appropriate elements of other program requirements, including Spill Prevention Control and Countermeasures (SPCC) plans required under Section 311 of the CWA and the regulations promulgated thereunder, and Best Management Programs under 40 CFR 125.100.

K. The plan is considered a report that shall be available to the public at any reasonable time upon request.

L. The plan shall include the signature and title of the person responsible for preparation of the plan and include the date of initial preparation and each amendment thereto.

M. Facilities which discharge storm water associated with industrial activity to municipal separate storm sewers may also be subject to additional requirement imposed by the operator of the municipal system

Construction Authorization

Authorization is hereby granted to construct treatment works and related equipment that may be required by the Storm Water Pollution Prevention Plan developed pursuant to this permit.

This Authorization is issued subject to the following condition(s).

N. If any statement or representation is found to be incorrect, this authorization may be revoked and the permittee there upon waives all rights thereunder.

O. The issuance of this authorization (a) does not release the permittee from any liability for damage to persons or property caused by or resulting from the installation, maintenance or operation of the proposed facilities; (b) does not take into consideration the structural stability of any units or part of this project; and (c) does not release the permittee from compliance with other applicable statutes of the State of Illinois, or other applicable local law, regulations or ordinances.

P. Plans and specifications of all treatment equipment being included as part of the stormwater management practice shall be included in the SWPPP.

Special Conditions

Q. Construction activities which result from treatment equipment installation, including clearing, grading and excavation activities which result in the disturbance of one acre or more of land area, are not covered by this authorization. The permittee shall contact the IEPA regarding the required permit(s).

REPORTING

R. The facility shall submit an electronic copy of the annual inspection report to the Illinois Environmental Protection Agency. The report shall include results of the annual facility inspection which is required by Part I of this condition. The report shall also include documentation of any event (spill, treatment unit malfunction, etc.) which would require an inspection, results of the inspection, and any subsequent corrective maintenance activity. The report shall be completed and signed by the authorized facility employee(s) who conducted the inspection(s). The annual inspection report is considered a public document that shall be available at any reasonable time upon request.

S. The first report shall contain information gathered during the one year time period beginning with the effective date of coverage under this permit and shall be submitted no later than 60 days after this one year period has expired. Each subsequent report shall contain the previous year's information and shall be submitted no later than one year after the previous year's report was due.

T. If the facility performs inspections more frequently than required by this permit, the results shall be included as additional information in the annual report.

U. The permittee shall retain the annual inspection report on file at least 3 years. This period may be extended by request of the Illinois Environmental Protection Agency at any time.

Annual inspection reports shall be submitted to the following email and office addresses: epa.npdes.inspection@illinois.gov

Illinois Environmental Protection Agency
Bureau of Water
Compliance Assurance Section
Annual Inspection Report
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

V. The permittee shall notify any regulated small municipal separate storm sewer owner (MS4 Community) that they maintain coverage under an individual NPDES permit. The permittee shall submit any SWPPP or any annual inspection to the MS4 community upon request by the MS4 community.

Attachment H

Standard Conditions

Definitions

Act means the Illinois Environmental Protection Act, 415 ILCS 5 as Amended.

Agency means the Illinois Environmental Protection Agency.

Board means the Illinois Pollution Control Board.

Clean Water Act (formerly referred to as the Federal Water Pollution Control Act) means Pub. L 92-500, as amended. 33 U.S.C. 1251 et seq.

NPDES (National Pollutant Discharge Elimination System) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318 and 405 of the Clean Water Act.

USEPA means the United States Environmental Protection Agency.

Daily Discharge means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurements, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

Maximum Daily Discharge Limitation (daily maximum) means the highest allowable daily discharge.

Average Monthly Discharge Limitation (30 day average) means the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Discharge Limitation (7 day average) means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Aliquot means a sample of specified volume used to make up a total composite sample.

Grab Sample means an individual sample of at least 100 milliliters collected at a randomly-selected time over a period not exceeding 15 minutes.

24-Hour Composite Sample means a combination of at least 8 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over a 24-hour period.

8-Hour Composite Sample means a combination of at least 3 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over an 8-hour period.

Flow Proportional Composite Sample means a combination of sample aliquots of at least 100 milliliters collected at periodic intervals such that either the time interval between each aliquot or the volume of each aliquot is proportional to either the stream flow at the time of sampling or the total stream flow since the collection of the previous aliquot.

(1) **Duty to comply**. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action, permit termination, revocation and reissuance, modification, or for denial of a permit renewal application. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirements.

(2) **Duty to reapply**. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. If the permittee submits a proper application as required by the Agency no later than 180 days prior to the expiration date, this permit shall continue in full force and effect until the final Agency decision on the application has been made.

(3) **Need to halt or reduce activity not a defense**. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

(4) **Duty to mitigate**. The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

(5) **Proper operation and maintenance**. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up, or auxiliary facilities, or similar systems only when necessary to achieve compliance with the conditions of the permit.

(6) **Permit actions**. This permit may be modified, revoked and reissued, or terminated for cause by the Agency pursuant to 40 CFR 122.62 and 40 CFR 122.63. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

(7) **Property rights**. This permit does not convey any property rights of any sort, or any exclusive privilege.

(8) **Duty to provide information**. The permittee shall furnish to the Agency within a reasonable time, any information which the Agency may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee shall also furnish to the Agency upon request, copies of records required to be kept by this permit.

(9) **Inspection and entry**. The permittee shall allow an authorized representative of the Agency or USEPA (including an authorized contractor acting as a representative of the Agency or USEPA), upon the presentation of credentials and other documents as may be required by law, to:
- (a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
- (b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
- (c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
- (d) Sample or monitor at reasonable times, for the purpose of assuring permit compliance, or as otherwise authorized by the Act, any substances or parameters at any location.

(10) **Monitoring and records**.
- (a) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
- (b) The permittee shall retain records of all monitoring information, including all calibration and maintenance records, and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of this permit, measurement, report or application. Records related to the permittee's sewage sludge use and disposal activities shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503). This period may be extended by request of the Agency or USEPA at any time.
- (c) Records of monitoring information shall include:
  - (1) The date, exact place, and time of sampling or measurements;
  - (2) The individual(s) who performed the sampling or measurements;
  - (3) The date(s) analyses were performed;
  - (4) The individual(s) who performed the analyses;
  - (5) The analytical techniques or methods used; and
  - (6) The results of such analyses.
- (d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit. Where no test procedure under 40 CFR Part 136 has been approved, the permittee must submit to the Agency a test method for approval. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals to ensure accuracy of measurements.

(11) **Signatory requirement**. All applications, reports or information submitted to the Agency shall be signed and certified.
- (a) **Application**. All permit applications shall be signed as follows:
  - (1) For a corporation: by a principal executive officer of at least the level of vice president or a person or position having overall responsibility for environmental matters for the corporation:
  - (2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
  - (3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.
- (b) **Reports**. All reports required by permits, or other information requested by the Agency shall be signed by a person described in paragraph (a) or by a duly authorized representative of that person. A person is a duly authorized representative only if:
  - (1) The authorization is made in writing by a person described in paragraph (a); and
  - (2) The authorization specifies either an individual or a position responsible for the overall operation of the facility, from which the discharge originates, such as a plant manager, superintendent or person of equivalent responsibility; and
  - (3) The written authorization is submitted to the Agency.
- (c) **Changes of Authorization**. If an authorization under (b) is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of (b) must be submitted to the Agency prior to or together with any reports, information, or applications to be signed by an authorized representative.
- (d) **Certification**. Any person signing a document under paragraph (a) or (b) of this section shall make the following certification:

  I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

(12) **Reporting requirements**.
- (a) **Planned changes**. The permittee shall give notice to the Agency as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required when:
  - (1) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source pursuant to 40 CFR 122.29 (b); or
  - (2) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements pursuant to 40 CFR 122.42 (a)(1).
  - (3) The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.
- (b) **Anticipated noncompliance**. The permittee shall give advance notice to the Agency of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.
- (c) **Transfers**. This permit is not transferable to any person except after notice to the Agency.
- (d) **Compliance schedules**. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.
- (e) **Monitoring reports**. Monitoring results shall be reported at the intervals specified elsewhere in this permit.
  - (1) Monitoring results must be reported on a Discharge Monitoring Report (DMR)

(2) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR 136 or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR.

(3) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Agency in the permit.

(f) **Twenty-four hour reporting**. The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24-hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and time; and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The following shall be included as information which must be reported within 24-hours:

(1) Any unanticipated bypass which exceeds any effluent limitation in the permit.

(2) Any upset which exceeds any effluent limitation in the permit.

(3) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Agency in the permit or any pollutant which may endanger health or the environment.

The Agency may waive the written report on a case-by-case basis if the oral report has been received within 24-hours.

(g) **Other noncompliance**. The permittee shall report all instances of noncompliance not reported under paragraphs (12) (d), (e), or (f), at the time monitoring reports are submitted. The reports shall contain the information listed in paragraph (12) (f).

(h) **Other information**. Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to the Agency, it shall promptly submit such facts or information.

(13) **Bypass**.

(a) Definitions.

(1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

(2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

(b) Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs (13)(c) and (13)(d).

(c) Notice.

(1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

(2) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in paragraph (12)(f) (24-hour notice).

(d) Prohibition of bypass.

(1) Bypass is prohibited, and the Agency may take enforcement action against a permittee for bypass, unless:

(i) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(iii) The permittee submitted notices as required under paragraph (13)(c).

(2) The Agency may approve an anticipated bypass, after considering its adverse effects, if the Agency determines that it will meet the three conditions listed above in paragraph (13)(d)(1).

(14) **Upset**.

(a) Definition. Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

(b) Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (14)(c) are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

(c) Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An upset occurred and that the permittee can identify the cause(s) of the upset;

(2) The permitted facility was at the time being properly operated; and

(3) The permittee submitted notice of the upset as required in paragraph (12)(f)(2) (24-hour notice).

(4) The permittee complied with any remedial measures required under paragraph (4).

(d) Burden of proof. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

(15) **Transfer of permits**. Permits may be transferred by modification or automatic transfer as described below:

(a) Transfers by modification. Except as provided in paragraph (b), a permit may be transferred by the permittee to a new owner or operator only if the permit has been modified or revoked and reissued pursuant to 40 CFR 122.62 (b) (2), or a minor modification made pursuant to 40 CFR 122.63 (d), to identify the new permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

(b) Automatic transfers. As an alternative to transfers under paragraph (a), any NPDES permit may be automatically

transferred to a new permittee if:
(1) The current permittee notifies the Agency at least 30 days in advance of the proposed transfer date;
(2) The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage and liability between the existing and new permittees; and
(3) The Agency does not notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement.

(16) All manufacturing, commercial, mining, and silvicultural dischargers must notify the Agency as soon as they know or have reason to believe:
(a) That any activity has occurred or will occur which would result in the discharge of any toxic pollutant identified under Section 307 of the Clean Water Act which is not limited in the permit, if that discharge will exceed the highest of the following notification levels:
(1) One hundred micrograms per liter (100 ug/l);
(2) Two hundred micrograms per liter (200 ug/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/l) for 2,4-dinitrophenol and for 2-methyl-4,6 dinitrophenol; and one milligram per liter (1 mg/l) for antimony.
(3) Five (5) times the maximum concentration value reported for that pollutant in the NPDES permit application; or
(4) The level established by the Agency in this permit.
(b) That they have begun or expect to begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the NPDES permit application.

(17) All Publicly Owned Treatment Works (POTWs) must provide adequate notice to the Agency of the following:
(a) Any new introduction of pollutants into that POTW from an indirect discharge which would be subject to Sections 301 or 306 of the Clean Water Act if it were directly discharging those pollutants; and
(b) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.
(c) For purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

(18) If the permit is issued to a publicly owned or publicly regulated treatment works, the permittee shall require any industrial user of such treatment works to comply with federal requirements concerning:
(a) User charges pursuant to Section 204 (b) of the Clean Water Act, and applicable regulations appearing in 40 CFR 35;
(b) Toxic pollutant effluent standards and pretreatment standards pursuant to Section 307 of the Clean Water Act; and
(c) Inspection, monitoring and entry pursuant to Section 308 of the Clean Water Act.

(19) If an applicable standard or limitation is promulgated under Section 301(b)(2)(C) and (D), 304(b)(2), or 307(a)(2) and that effluent standard or limitation is more stringent than any effluent limitation in the permit, or controls a pollutant not limited in the permit, the permit shall be promptly modified or revoked, and reissued to conform to that effluent standard or limitation.

(20) Any authorization to construct issued to the permittee pursuant to 35 Ill. Adm. Code 309.154 is hereby incorporated by reference as a condition of this permit.

(21) The permittee shall not make any false statement, representation or certification in any application, record, report, plan or other document submitted to the Agency or the USEPA, or required to be maintained under this permit.

(22) The Clean Water Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a civil penalty not to exceed $25,000 per day of such violation. Any person who willfully or negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318 or 405 of the Clean Water Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than one year, or both.
Additional penalties for violating these sections of the Clean Water Act are identified in 40 CFR 122.41 (a)(2) and (3).

(23) The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both.

(24) The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

(25) Collected screening, slurries, sludges, and other solids shall be disposed of in such a manner as to prevent entry of those wastes (or runoff from the wastes) into waters of the State. The proper authorization for such disposal shall be obtained from the Agency and is incorporated as part hereof by reference.

(26) In case of conflict between these standard conditions and any other condition(s) included in this permit, the other condition(s) shall govern.

(27) The permittee shall comply with, in addition to the requirements of the permit, all applicable provisions of 35 Ill. Adm. Code, Subtitle C, Subtitle D, Subtitle E, and all applicable orders of the Board or any court with jurisdiction.

(28) The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit is held invalid, the remaining provisions of this permit shall continue in full force and effect.

EXHIBIT BB

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
BRUCE RAUNER, GOVERNOR   ALEC MESSINA, DIRECTOR

217/785-1705

MAY 09 2017

CONSTRUCTION PERMIT -- REVISED

MAY 12 2017

PERMITTEE

Midwest Generation, LLC
Attn: Sharene Shealey
529 East 135th Street
Romeoville, Illinois 60466

Application No.: 15030051   I.D. No.: 197809AAO
Applicant's Designation: Natural Gas   Date Received: April 14, 2017
Subject: Natural Gas Conversion Project
Date Issued: MAY 09 2017
Location: Joliet Generating Station, 1800 Channahon Road, Joliet, Will County

Permit is hereby granted to the above-designated Permittee to CONSTRUCT emission source(s) and air pollution control equipment consisting of a natural gas conversion project as described in the above-referenced application. This Permit is subject to standard conditions attached hereto (as Attachment 2) and the following special conditions.

If you have any questions on this permit, please call Bob Smet at 217/785-9250.

Raymond E. Pilapil

Raymond E. Pilapil
Manager, Permit Section
Division of Air Pollution Control

REP:RPS:clc

cc: USEPA Region V (Lotus Notes)

PART 1: PROJECT-WIDE CONDITIONS

1.1 Introduction

a. This permit addresses a natural gas conversion project for the Joliet Generation Station. In this project, the five boilers at this station that serve electrical generating units, as listed below, will be converted from burning coal to burning natural gas with installation of new natural gas-fired burners. As part of this project, a new natural gas-fired auxiliary boiler and new natural gas-fired fuel heaters would also be constructed to support the operation of the existing boilers (the main boilers) on natural gas. This project will greatly reduce the emissions of most pollutants from the station, including emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and particulate ($PM/PM_{10}/PM_{2.5}$).

Main Boiler(s)	Electrical Generating Unit
Boiler 5	Unit 6
Boilers 71 and 72	Unit 7
Boilers 81 and 82	Unit 8

b. This permit was revised on June 8, 2016 to address provisions of 35 IAC Part 201 Subpart I for startup and malfunction/ breakdown of each affected boiler as related to the applicable state standard for NOx, 35 IAC 217.141(a).

c. For Boiler 5, this revised permit provides additional time to conduct the emission testing required by Condition 2.1.7(b)(i), until September 30, 2018, to enable this testing to be conducted while this boiler is operating at its maximum load range.

1.2 Termination of Coal-Firing Capability

a. Upon initial startup of a main boiler following conversion to natural gas, as provided for by this permit, that boiler shall cease to fire coal.

b. On such date that a main boiler initially starts up following conversion to natural gas, the existing air pollution control operating permits that address burning of coal in the boilers shall terminate and be replaced by this construction permit:

Unit 6	Permit 73030837
Unit 7	Permit 73030838
Unit 8	Permit 73030839

1.3 Non-Applicability of New Source Review (MSSCAM and PSD)

a. This permit is issued based on this project not being a major project for purposes of Illinois' rules for Major Stationary

Sources Construction And Modification (MSSCAM), 35 IAC Part 203. For NO_x, this is because this project will reduce NOx emissions from the main boilers and the NOx emissions of the new emission units will not be significant. For volatile organic material (VOM), this is because the source will continue to not be a major source for VOM emissions. (See also Attachment 1.)

b. This permit is issued based on this project not being a major project for purposes of the federal rules for the Prevention of Significant Deterioration (PSD), 40 CFR 52.21. This is because this project will reduce emissions of regulated PSD pollutants from the main boilers and the emissions of regulated PSD pollutants from the new emission units will not be significant. (See also Attachment 1.)

1.4 Applicability of 40 CFR 63 Subpart DDDDD

a. For purposes of applicability of 40 CFR 63, this permit is issued based on this plant being a major source of hazardous air pollutants (HAPs) on January 31, 2016, the compliance date of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Major Source: Industrial, Commercial, and Institutional Boilers and Process Heaters, 40 CFR 63 Subpart DDDDD. As a consequence, the new auxiliary boiler, the fuel heaters and potentially the main boilers following conversion to natural gas will be subject to the applicable provisions of 40 CFR 63 Subpart DDDDD, which NESHAP addresses major sources of HAPs, notwithstanding the reductions in the HAP emissions of the plant that will result from this project.

1.5 Compliance with Emission Limits

a. The emission limits set by this permit address all emissions from affected emission units, including emissions during startup, shutdown and malfunction or breakdown.

b. When emission testing is conducted, hourly emission rates shall be determined from the average of the test results, commonly three runs, each nominally one hour in duration.

c. i. Except as provided below or unless otherwise specified in a particular provision, compliance with annual limits established by this permit shall be determined from a rolling total of 12 months of data, i.e., from the sum of the data for the current month and data for the preceding 11 months (12 month total), and shall consider all emissions, including emissions during startup, shutdown, and malfunction or breakdown.

ii. For the main boilers, for the first year (12 months) of operation following conversion of a main boiler or boilers to natural gas, compliance shall be determined from a cumulative total of monthly data for the main boiler or boilers that have been converted, i.e., from the sum of the data for the current month and data for all preceding months for such boilers beginning on the date or dates that boiler or boilers first resumed operation following conversion on natural gas.

iii. For the new auxiliary boiler and fuel heaters, for the first year of operation, compliance shall be determined from a cumulative total of monthly data, i.e., from the sum of the data for the current month and data for all preceding months.

1.6 Retention and Availability of Records

a. Unless otherwise provided for by a Clean Air Act Permit Program (CAAPP) permit for the source, the Permittee shall retain all records and logs required by this permit for at least five years from the date of entry (unless a longer retention period is specified by a particular provision), keep the records at a location at the plant that is readily accessible to the Illinois EPA or USEPA, and make records available for inspection and copying by the Illinois EPA or USEPA upon reasonable request.

1.7 Submittals to the Illinois EPA

a. All reports and notifications required by this permit shall be sent to the Illinois EPA, Bureau of Air Compliance Section in Springfield.

b. A copy of all required reports and notifications concerning performance testing and emissions monitoring shall also be sent directly to the Source Monitoring Unit in the Illinois EPA, Bureau of Air, Compliance Section.

1.8 Authorization for Operation

The plant may be operated in accordance with this construction permit pursuant to this permit until a Clean Air Act Permit Program (CAAPP) permit is issued for the source that addresses this project, provided that the initial performance testing required by this permit for the main boilers by Condition 2.1.7 is completed in a timely manner and a complete application for a CAAPP permit for this source is submitted that addresses this project within one year of initial operation of a main boiler on natural gas or initial operation of a new unit, whichever occurs first, as provided by Section 39.5(5)(x) of the Act. This condition supersedes Standard Condition 6.

1.9 Standard Permit Conditions

Standard conditions for issuance of construction permits, attached hereto, shall apply to this project, unless superseded by other conditions in the permit. (Refer to Attachment 2.)

PART 2: UNIT-SPECIFIC CONDITIONS FOR PARTICULAR EMISSION UNITS

Subpart 2.1: Unit-Specific Conditions for the Main Boilers

2.1.1 Description

The affected boilers for the purpose of these unit-specific conditions are the five existing generating unit boilers or "main boilers" at the plant following conversion to natural gas as described below. These boilers are served by three stacks, with two pairs of boilers having common stacks. When this conversion is completed for a boiler with installation of new natural gas burners, certain emission standards that are applicable to fuel combustion emission units that fire coal will no longer be applicable for the boiler. In addition, certain existing emission control equipment and systems that were used when burning coal, i.e., the electrostatic precipitators for particulate, the selective non-catalytic reduction systems for NO_x and the sorbent injection system for mercury, will no longer be needed. Continuous emissions monitoring will no longer be required for emissions of sulfur dioxide (SO_2) or mercury. It is also expected that continuous opacity monitoring will no longer be required.

Boiler/ Generating Unit	Description	Emission Control Equipment
Boiler 5 (BLR5)/ Unit 6	Babcock and Wilcox Boiler Nominal 3,543 mmBtu/hour	Over fired Air, and Gas Reburn
Boilers 71 & 72 (BLR71 & 72)/ Unit 7	Combustion Engineering Boilers Nominal 6,034 mmBtu/hour, combined	Low NOx Burners and Over-fired Air
Boilers 81 & 82 (BLR81 & 82)/ Unit 8	Combustion Engineering Boilers Nominal 6,386 mmBtu/hour, combined	Low NOx Burners, and Over-fired Air

2.1.2 New Applicable Emission Standards and Requirements

a. Unless the USEPA revises 40 CFR Part 63 to provide that gas-fired utility boilers are not subject to the NESHAP for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters, 40 CFR 63 Subpart DDDDD (the Boiler NESHAP), the affected boilers will become subject to the Boiler NESHAP when they cease to be subject to the provisions of the NESHAP for Coal and Oil-Fired Electric Utility Steam Generating Units, 40 CFR 63 Subpart UUUUU (commonly referred to as the Mercury and Air Toxics Standards or MATS). On such date, for each affected boiler, the Permittee must comply with applicable requirements of 40 CFR 63 Subpart DDDDD for the "units designed to burn gas 1 fuel" category, and related requirements of 40 CFR 63 Subpart A, General Provisions, including the following:

i. Pursuant to 40 CFR 63.7500 and Table 3 of 40 CFR 63 Subpart DDDDD, the Permittee shall conduct periodic tune-ups of the affected boiler as specified in 40 CFR 63.7540(a)(10), (12) and/or (13).

ii. Pursuant to 40 CFR 63.7500(a)(3), the Permittee, as the owner or operator of the affected boiler, must operate and maintain the boiler, including associated air pollution control equipment and monitoring equipment, in a manner consistent with safety and good air pollution control practices for minimizing emissions.

iii. Pursuant to 40 CFR 63.7500 and Table 3 of 40 CFR 63 Subpart DDDDD, by the applicable compliance date for the first main boilers to comply with this NESHAP, the Permittee shall have one-time energy assessment performed for the plant by a qualified energy assessor, which assessment meets the relevant requirements of Table 3 and the definition of "energy assessment" in 40 CFR 63.7575.

b. i. Pursuant to 35 IAC 217.141, the NO_x emissions of Boiler 5 shall not exceed 0.30 lbs/mmBtu of actual heat input, as provided by 35 IAC 217.141(a) for large existing fuel combustion emission units in the Chicago Major Metropolitan Area firing gaseous or liquid fossil fuel.

Note: Boiler 5 was not previously subject to a NO_x limit pursuant to 35 IAC 217.141 because 35 IAC 217.141(d) excluded cyclone fired boilers burning solid fuel from this rule.

ii. Subject to the following terms and conditions, the Permittee is authorized to operate each affected boiler in violation of 35 IAC 217.141(a) during startup, pursuant to 35 IAC 201.149, 201.261, and 201.262. As provided by 35 IAC 201.265, this authorization does not shield the Permittee from enforcement for any such violation and shall only constitute a prima facie defense to such an enforcement action provided that the Permittee has fully complied with all terms and conditions connected with such authorization.

A. The Permittee shall conduct startup of each affected boiler in accordance with written procedures maintained by the Permittee which serve to minimize excess emissions from startups and that include, at a minimum, the following measures:

1. Review of the operational condition of the boiler prior to initiating startup; and

2. Management of the operational parameters of the boiler during each startup as necessary to

make appropriate adjustments to the startup to reduce or eliminate excess emissions.

B. The Permittee shall fulfill the recordkeeping and reporting requirements of Conditions 2.1.9(c)(i)(A) and (d), and 2.1.10(b)(iii) with respect to startups.

C. This authorization does not relieve the Permittee from the continuing obligation to demonstrate that all reasonable efforts are made to minimize startup emissions.

iii. Subject to the following terms and conditions, the Permittee is authorized to continue operation of each affected boiler in violation of 35 IAC 217.141(a) in the event of a malfunction or breakdown of each affected boiler. This authorization is made pursuant to 35 IAC 201.149, 201.261, and 201.262. As provided by 35 IAC 201.265, this authorization does not shield the Permittee from enforcement for any such violation and shall only constitute a prima facie defense to such an enforcement action provided that the Permittee has fully complied with all terms and conditions connected with such authorization.

A. This authorization only allows such continued operation as necessary to provide essential service or to prevent injury to personnel or severe damage to equipment, provided however, that operation shall not continue solely for the economic benefit of the owner or operator of the plant.

B. Upon occurrence of excess emissions due to malfunction or breakdown, the Permittee shall as soon as practicable take action(s) so that excess emissions cease.

C. The Permittee shall fulfill recordkeeping and reporting requirements of Conditions 2.1.9(c)(i)(C) and (d) and 2.1.10(b)(iii) and (c) with respect to malfunctions and breakdowns.

D. Following reporting of an incident to the Illinois EPA of a malfunction or breakdown that resulted in excess NOx emissions, the Permittee shall comply with all reasonable directives of the Illinois EPA with respect to such incident, pursuant to 35 IAC 201.263.

2.1.3 Changes to Emission Standards and Requirements

a. The affected boilers are affected units under the Acid Rain Deposition Control Program pursuant to Title IV of the Clean Air Act and are subject to certain control requirements and emissions monitoring requirements pursuant to 40 CFR Parts 72, 73 and 75.

Note: Condition 2.1.4(c) addresses the possibility that opacity monitoring will no longer be required for the affected boilers under the Acid Rain Program.

b. The affected boilers are not subject to the following standards in 35 IAC Part 212 Subpart E for emissions of particulate matter from existing fuel combustion emission units burning solid fuel:

Boiler 5: 35 IAC 212.201 and 212.203
Boilers 71, 72, 81 and 82: 35 IAC 212.201

c. The affected boilers are not subject to the standard in 35 IAC 214.141 for SO_2 emissions from existing fuel combustion emission units burning solid fuel that are located in the Chicago major Metropolitan Area.

d. Pursuant to 35 IAC 217.141, the NOx emissions of affected Boilers 71 and 72 and Boilers 81 and 82 shall not exceed 0.30 lbs/mmBtu of actual heat input, as provided by 35 IAC 217.141(a) for large existing fuel combustion emission units in the Chicago Major Metropolitan Area firing gaseous or liquid fossil fuel.

Note: This limit takes the place of the limit in 35 IAC 217.141(b), which limits the NOx emissions of such boilers firing solid fuel to 0.90 lbs/mmBtu of actual heat input.

2.1.4 Non-Applicability Provisions

a. This permit is issued based on the affected boilers not becoming subject to the New Source Performance Standards (NSPS) for Electric Utility Steam Generating Units, 40 CFR 60 Subpart Da, as a result of this project. This is because these boilers will not undergo modifications as addressed by 40 CFR 60.14, i.e., there will not be increases in the hourly rate of emissions of any pollutant for which this NSPS has standards from any of the boilers. This project will also not constitute reconstruction as addressed by 40 CFR 60.15. This is because the capital cost of the changes made to each affected boiler will not exceed 50 percent of the capital cost of a replacement boiler.

b. Pursuant to 40 CFR 63.10000(f), this permit is issued based on affected EGUs not being subject to the NESHAP for Coal and Oil-Fired Electric Utility Steam Generating Units, 40 CFR 63 Subpart UUUUU, or MATS, beginning six months after coal is last combusted in the EGU unless the Permittee elects to remain subject to the provisions of MATS. This is because, pursuant to 40 CFR 63.9981, MATS only applies to a "coal-fired EGU or oil-fired EGU," as defined by 40 CFR 63.10042. In addition, 40 CFR 63.10000(f) only requires that an EGU that is subject to MATS continue to be subject to its provisions for six months following the last date that the EGU met the definition of an EGU subject to MATS.

c. This permit is issued based on the Permittee potentially no longer being required to conduct continuous monitoring for opacity for the affected boilers:

i. For purposes of 35 IAC Part 201 Subpart L, Continuous Monitoring, this is because natural gas is the only fuel burned in the EGU and the EGUs are excluded from such opacity monitoring pursuant to 35 IAC 201.401(a)(1)(A)(i).

ii. For purposes of the Acid Rain Program, this is because, pursuant to 40 CFR 75.14(c), the affected boilers or EGUs will qualify as "gas-fired units," as defined by 40 CFR 72.2, for purposes of 40 CFR Part 75, Continuous Emission Monitoring, if the designated representative for the source submits to USEPA either:

A. A minimum of 720 hours of unit operating data following the change in the boiler's fuel usage, showing that no less than 90.0 percent of its heat input is from the combustion of gaseous fuels and the remaining heat input is from the combustion of fuel oil, and a statement that this changed pattern of fuel usage is considered permanent and is projected to continue for the foreseeable future; or

B. Three calendar years of data following the change in the boiler's fuel usage, showing that no less than 90.0 percent of its average annual heat input during the previous three calendar years, and no less than 85.0 percent of its annual heat input during any one of the previous three calendar years, is from the combustion of gaseous fuels and the remaining heat input is from the combustion of fuel oil.

2.1.5 Operational Requirements

a. Before beginning operation of each affected boiler on natural gas pursuant to this permit, the Permittee shall clean the interior of the boilers to remove accumulated ash.

2.1.6 Operational and Emission Limits

a. i. The combined heat input to the affected boilers shall not exceed 12.0 million mmBtu/month and 69.9 million mmBtu/year.

ii. The heat input to Boiler 5 shall not exceed 2.6 million mmBtu/month and 15.52 million mmBtu/year.

b. i. The NO_x emissions of the affected boilers shall not exceed the following limits. Compliance with the limits below in lbs/mmBtu shall be determined on a 30-boiler operating day rolling average basis, in accordance with the provisions of 40 CFR 60.48Da(d). Compliance with the limits in lbs/mmBtu and tons/year shall consider all emissions, including emissions during periods of startup or malfunction/breakdown. Compliance with the limits in lbs/hour, which are set to address non-applicability of the NSPS, 40 CFR 60 Subpart Da, shall only consider normal operation.

Boiler(s)	Limits		
	Lbs/mmBtu	Lbs/Hour	Tons/Year
Boiler 5	0.135	2103	1047.6
Boiler 71/72	0.110	4136	---
Boiler 81/82	0.110	1251	---
Total	---	---	4040

ii. The VOM emissions of the affected boilers shall not exceed the following limits:

A. 0.0027 lb/mmBtu, and

B. 94.9 tons/year.

c. Notwithstanding Conditions 2.1.6(a)(i) and (b)(ii)(A), until results of emission testing conducted pursuant to Condition 2.1.7 have been submitted to the Illinois EPA showing that the VOM emissions of the affected boilers do not exceed 0.0027 lb/mmBtu, the combined heat input to the affected boilers shall not exceed 34.5 million mmBtu/year (rather than 69.9 million mmBtu/year) and the VOM emissions of the affected boilers shall not exceed 0.0055 lb/mmBtu (rather than 0.0027 lb/mmBtu).

Note: The limits in Condition 2.1.6 address the operation and emissions of Boilers 5, 71/72 and 81/82 following their conversion to natural gas.

2.1.7 Emission Testing

a. The Permittee shall have emissions testing conducted for the affected boiler(s) for CO and VOM as follows:

b. The timing of this testing shall be as follows:

i. Within one year (365 days) after initially operating Boilers 71/72 and Boilers 81/82, following conversion to natural gas and for Boiler 5, by September 30, 2018, the Permittee shall have initial emission tests conducted for such boiler(s) while the boiler(s) are operating at maximum rates and other representative operating conditions.

ii. Until a CAAPP permit is issued that addresses the affected boilers, this testing shall be repeated within at least three years of the previous testing.

iii. The Permittee shall perform emission tests as provided below for boiler(s) as requested by the Illinois EPA within 90 days of a written request by the Illinois EPA or such later date agreed to by the Illinois EPA.

c. i. The following methods and procedures shall be used for this testing, unless other methods adopted by or being developed by USEPA or other alternative test methods are approved by the Illinois EPA.

Carbon Monoxide	Method 10
Volatile Organic Material	Method 18 or 25A

ii. In conjunction with the initial emission tests, the Permittee shall also conduct measurements for opacity. These measurements shall be conducted using the continuous opacity monitors (COMS) on the boiler(s) or by Method 9, if the COMS are no longer in service.

d. Test plans, test notifications, and test reports shall be submitted to the Illinois EPA in accordance with Condition 3.1. In addition to other required information, if test runs that are longer than one-hour in duration are planned, the expected duration of the runs and the reason for extended runs shall be explained in the test plans and in the test reports.

e. In addition to other information required in a test report, test reports shall include detailed information on the operating conditions of the affected boiler(s) during testing, including:

A. Firing rate (mmBtu/hour).

B. Significant operating parameters of the affected boiler(s).

C. Opacity of the exhaust from the affected boiler(s), 6-minute averages.

D. Turbine Generator output (MW_e gross).

2.1.8-1 Continuous Emissions Monitoring for NOx

a. For the affected boilers or EGUs, the Permittee shall continue to calibrate, maintain, and operate continuous emissions monitoring systems (CEMS) for the NOx emissions in accordance with the applicable monitoring requirements of the federal Acid Rain Program, 40 CFR Part 75, and the Cross State Air Pollution Rule, 40 CFR 96 Subpart HHH unless it obtains approval from USEPA to transition to the alternative monitoring protocol for a natural gas-fired peaking unit for such boilers or EGUs.

b. For the affected boilers or EGUs, this monitoring for NOx emissions conducted above shall also be used to determine compliance with the limits for NOx emissions in Condition 2.1.6(b)(i), except that the provisions for substitution of missing data need not be used.

2.1.8-2 Changes in Monitoring for Emissions of SO_2 and Mercury and for Opacity

a. The Permittee shall notify the Illinois EPA at least 30 days in advance of discontinuing use of SO_2 CEMS on the affected boilers or EGUs and beginning monitoring of SO_2 emissions on such units using the Optional SO_2 Emissions Data Protocol for Gas-Fired and Oil-Fired Units, Appendix D to 40 CFR Part 75, as provided for by 40 CFR 75.11(d)(2). With this notification, the Permittee shall provide: 1) A copy of the notification submitted to the USEPA for this change in monitoring methodology for SO_2 emissions; and 2) If the EGU is still subject to MATS, a showing that the EGU now qualifies as a low emitting EGU for SO_2 emissions under the MATS, as addressed by 40 CFR 63.10005(h)(1), or that an SO_2 CEMS is no longer otherwise required by MATS.

b. The Permittee shall notify the Illinois EPA at least 30 days in advance of discontinuing use of mercury CEMS on the affected boilers or EGUs. With this notification, if the EGU is still subject to MATS, the Permittee shall provide a demonstration that the EGU now qualifies as a low emitting EGU for mercury emissions under the MATS, as addressed by 40 CFR 63.10005(h)(2), or that a mercury CEMS is no longer otherwise required by MATS. Unless 35 IAC Part 225 Subpart B has been amended to provide that its requirements related to mercury emissions no longer apply when an EGU permanently ceases combustion of coal, this notification shall also include a demonstration that such EGU is eligible to use the low mass emission excepted monitoring methodology, as provided for by 35 IAC 225.240(a)(4), and will continue to comply with a mercury emission standard in 35 IAC 225.294(c)(i) (0.0080 lbs mercury/GWh gross electrical output) for the remainder of the calendar year.

c. The Permittee shall notify the Illinois EPA at least 30 days in advance of discontinuing use of COMS on affected boilers or EGUs. With this notification, the Permittee shall provide: 1) A copy of the notification submitted to the USEPA pursuant to 40 CFR 75.14(c)(c) showing that the EGU now qualifies as a "gas-fired unit" for purposes of monitoring under 40 CFR Part 75; 2) Confirmation that continued use of COMS is not required by 35 IAC 201.401(a)(1), 3) The average and maximum values of opacity, 6-minute average, monitored for the EGU during the previous 720 hours of operation, not including any time after conversion to natural gas when the ESPs on the EGU were still being operated, and 4) If the ESPs are operated for any time after conversion to natural gas, the average and maximum value of opacity for such periods when the ESPs were operated.

2.1.9 Recordkeeping

a. For the affected boilers, unless the USEPA revises 40 CFR Part 63 to provide that gas-fired utility boilers are not subject to the Boiler NESHAP, the Permittee shall maintain the records required by this NESHAP, including the records required by 40 CFR 63.7540(a)(10)(vi) and 63.7555(a)(1), (i) and (j).

b. The Permittee shall maintain the records of the following information for Boiler 5, Boilers 71/72 and Boilers 81/82, on a monthly and annual basis:

i. Fuel consumption, in million scf.

ii. Heat input, in mmBtu.

iii. Total operating hours of the generating unit.

iv. Total number of boiler startups.

c. The Permittee shall maintain the following records for the operation and maintenance of each affected boiler:

i. An operating log for the boiler that, at a minimum, shall address:

A. Each startup of the boiler, including the date, time when burning of natural gas began, time startup was completed and description.

B. Each shutdown of the boiler, including the date and time, and description.

C. Any upset of the boiler that significantly impaired emission performance, including a description of the event, corrective actions taken, and preventative actions taken to address similar events.

ii. Inspection, maintenance and repair log(s) for the boiler and associated control system that, at a minimum, shall identify dates and nature of activities performed related to components that may affect emissions; the reason for such activities, i.e., whether planned or initiated due to a specific event or condition; and any failure to carry out the established maintenance procedures, with explanation.

d. The Permittee shall record the information specified by Condition 3.3 for any period during which the affected boiler deviated from an applicable emission limit or other requirement.

e. For the affected boilers, the Permittee shall maintain the following records related to NOx emissions:

i. The following records for Boiler 5, Boilers 71/72 and Boilers 81/82, with supporting data and calculations:

A. NO_x emissions, recorded hourly in units of lbs/hour and lbs/mmBtu, which shall be determined from monitoring in accordance with Condition 2.1.8-1.

B. NO_x emissions, in lbs/mmBtu, on a 30 boiler-operating-day rolling average basis.

C. NO_x emissions (tons/month and tons/year).

ii. Records for the combined NO_x emissions of the affected boilers (tons/month and tons/year).

f. For the affected boilers, the Permittee shall maintain the following records related to VOM emissions:

i. A file containing a determination of the maximum hourly VOM emission rates of Boiler 5, Boilers 71/72 and Boilers

81/82, (lbs/mmBtu and lbs/hour), with supporting documentation And calculations.

ii. Records of combined actual VOM emissions of the boilers (tons/month and tons/year), with supporting calculations.

2.1.10 Notification and Reporting

a. For the affected boilers, the Permittee shall notify the Illinois EPA within 30 days of the following events:

i. The date that each affected boiler or EGU last fires coal. With this notification, the Permittee shall notify the Illinois EPA if it intends to voluntarily continue to comply with MATS for longer than six months from this date.

ii. The date that each affected boiler or EGU initially fires natural gas following conversion pursuant to this permit.

b. The Permittee shall notify the Illinois EPA of deviations of affected boiler(s) from applicable requirements of this permit as follows. These notifications shall include the information specified by Condition 3.4.

i. Unless the USEPA revises 40 CFR Part 63 to provide that gas-fired utility boilers are not subject to the Boiler NESHAP, deviations from requirements of the Boiler NESHAP shall be reported in the reports required by the Boiler NESHAP or otherwise in accordance with Condition 2.1.10(b)(iv).

ii. Deviations from the limits for NO_x emissions in lbs/mmBtu in Condition 2.1.6(b)(i) shall be reported in the semi-annual monitoring reports for the NO_x CEMS.

iii. Deviations from the NO_x limits shall be reported within 30 days.

iv. Other deviations from applicable requirements, including deviations that occurred during startup or malfunction/breakdown, shall be reported in a quarterly report.

d. Pursuant to 35 IAC 201.263, the Permittee shall submit a report to the Illinois EPA for any incident when operation of each affected boiler continued for more than two hours with NOx emissions in excess of 35 IAC 217.141(a) during malfunction/ breakdown, as addressed by Condition 2.1.2(b)(iii). This requirement does not apply for excess emissions, if any that occur during startup or shutdown of the affected boiler. These reports shall be expeditiously provided by telephone, facsimile or electronic mail to the Illinois EPA, Air Compliance Section and Air Regional Office. These reports shall include a description of the incident and, if excess emissions are still continuing, a description of the corrective actions that are being taken or are planned and the expected duration of the incident.

Subpart 2.2: UNIT-SPECIFIC CONDITIONS FOR THE AUXILIARY BOILERS

2.2.1 Description

The affected boiler for the purpose of these unit-specific conditions is the new natural gas-fired auxiliary boiler, as described below that will be installed to support the operation of the plant on natural gas. The auxiliary boiler will supply steam for heating and to assist in the startup of the electrical generating units. The steam from this boiler will not be sent to the existing steam turbine generators to produce electricity that goes to the grid.

Emission Unit	Nominal Heat Input Capacity	Control Measures
Auxiliary Boiler	286 mmBtu/hour	Low-NOx Combustion Technology

2.2.2 Applicable Federal Emission Standards

a. The affected boiler is an affected facility under the federal NSPS for Industrial-Commercial-Institutional Steam Generating Units, 40 CFR 60 Subpart Db. For the affected boiler, the Permittee shall comply with applicable requirements of this NSPS and applicable requirements of 40 CFR 60 Subpart A, General Provisions, including the following:

i. The NO_x emissions of the affected boiler shall not exceed 43 ng/J (0.10 lb/million Btu) on a 30-day rolling average, pursuant to 40 CFR 60.44b(a), on and after the date on which the initial performance test is completed or is required to be completed under 40 CFR 60.8, whichever date comes first.

ii. The Permittee shall at all times, maintain and operate the affected boiler in a manner consistent with good air pollution control practices for minimizing emissions, pursuant to 40 CFR 60.11(d).

b. The affected boiler is subject to 40 CFR 63 Subpart DDDDD (the Boiler NESHAP). For the affected boiler, the Permittee must comply with applicable requirements of this NESHAP for the "units designed to burn gas 1 fuel" category, and related requirements of 40 CFR 63 Subpart A, General Provisions, including the following:

i. Pursuant to 40 CFR 63.7500 and Table 3 of 40 CFR 63 Subpart DDDDD, the Permittee shall conduct periodic tune-ups of the affected boiler as specified in 40 CFR 63.7540(a)(10), (12) and/or (13).

ii. Pursuant to 40 CFR 63.7500(a)(3), the Permittee, as the owner or operator of the affected boiler, must operate and maintain the boiler, including associated air pollution control equipment and monitoring equipment, in a manner consistent with safety and good air pollution control practices for minimizing emissions.

2.2.3 Applicable State Emission Standards

a. Pursuant to 35 IAC 212.122(a), the opacity of the exhaust from the affected boiler shall not exceed 20 percent, except as provided by 35 IAC 212.122(b).

b. Pursuant to 35 IAC 216.121, the CO emissions from the affected boiler shall not exceed 200 ppm, corrected to 50 percent excess air.

c. Pursuant to 35 IAC 217.164, the NO_x emissions of the affected boiler on an ozone season basis (May 1 through September 30) and an annual basis shall not exceed 0.08 lbs/mmBtu, as applicable for a boiler that fires natural gas.

d. Pursuant to 35 IAC 217.150(e), the Permittee shall operate the affected boiler in a manner consistent with good air pollution control practices to minimize NOx emissions.

2.2.4 Non-Applicability Provisions

a. This permit is issued based on certain provisions of the NSPS, 40 CFR 60 Subpart Db, as follows, not being applicable to the affected boiler:

i. The standard for PM and opacity, because this boiler only burns natural gas. [40 CFR 60.43b(f) and (h)(1)]

ii. The SO_2 standards, because this boiler only fires fuel with a potential SO_2 emission rate of 0.32 lb/mmBtu heat input or less. [40 CFR 60.42b(k)(2), 60.47b(f) and 60.49b(r)]

iii. The opacity monitoring requirements of this NSPS, 40 CFR 60.48b, because this boiler only burns gaseous fuels, without post-combustion technology to reduce SO2 or PM emissions. [40 CFR 60.48b(j)(2)]

b. The affected boiler is not subject to the federal Acid Rain Program pursuant to Title IV of the federal Clean Air Act since it does not qualify as a utility unit or an electrical generating unit for the purpose of this program.

2.2.5 Operational Requirements, Work Practices and Production Limits

a. Natural gas shall be the only fuel fired in the affected boiler.

b. The nominal rated heat input capacity of the affected boiler shall not exceed 286 mmBtu/hour.

c. The usage of fuel in the affected boiler shall not exceed 260,000 mmBtu/month and 1,380,000 mmBtu/year.

d. The steam from the affected boiler shall not be used to produce electricity for commercial sale to the grid.

e. The Permittee shall maintain and operate the affected boiler in a manner consistent with good air pollution control practices to minimize emissions.

2.2.6 Emission Limits

a. The NO_x emissions from the affected boiler shall not exceed 0.036 lb/mmBtu, 30-day average, determined in accordance with the methodology of the NSPS.

b. i. The emissions of the affected boiler shall not exceed the following limits.

Pollutant	Short-Term Emissions (lbs/mmBtu)	Annual Emissions (tons/year)
NO_x	*	24.8
CO	0.037	25.2
VOM	0.0042	2.9
PM	0.0019	1.31
$PM_{10}/PM_{2.5}$	0.0076	5.24

* See Condition 2.2.6(a)

ii. This permit is issued based on minimal emissions of SO_2 from the affected boiler, i.e., emissions of no more than 0.4 tons/year.

2.2.7 Emission Testing Requirements

a. i. For the affected boiler, for NO_x emissions, the Permittee shall fulfill applicable performance testing requirements of the NSPS, including 40 CFR 60.8(a), (c) and (d) and 60.46b(e).

ii. For each performance evaluation conducted to demonstrate compliance with the NSPS, in addition to submitting a test report to the Illinois EPA, the Permittee shall electronically submit the test data to USEPA if required by the NSPS.

b. The Permittee shall have emissions testing conducted for the affected boiler as follows, at its expense by a qualified testing service under representative operating conditions, for emissions of VOM and CO.

i. The timing of testing shall be as follows:

A. Testing shall initially be conducted for the affected boiler within 365 days after initial startup of the boiler.

B. In addition, the Permittee shall have testing performed as requested by the Illinois EPA for an affected boiler within 45 days of a written request by the Illinois EPA or such later date agreed to by the Illinois EPA.

ii. Appropriate USEPA test methods, including the following methods, shall be used for testing, unless other methods adopted by or being developed by USEPA or other alternative test methods are approved by the Illinois EPA.

Carbon Monoxide	Method 10
Volatile Organic Material	Method 18 or 25A

c. i. Test plans, test notifications, and test reports shall be submitted to the Illinois EPA in accordance with the Condition 3.1.

ii. In addition to other information required in a test report, test reports shall include detailed information on the operating conditions of the affected boiler during testing, including:

A. Fuel consumption (scf);

B. Firing rate (mmBtu/hour) and other significant operating parameters of the affected boiler;

C. Opacity of the exhaust, 6-minute averages, as determined by USEPA Method 9, if visible emissions are normally present, as determined by Method 22.

2.2.8-1 Monitoring Requirements for NOx Emissions

a. Pursuant to 40 CFR 60.48b, for the affected boiler, the Permittee shall install, calibrate, operate and maintain a CEMS for NOx emissions discharged from the affected boiler and the concentration of CO_2 or O_2 in the exhaust.

i. The procedures under 40 CFR 60.13 shall be followed for installation, evaluation, and operation of these CEMS. This CEMS shall be operated during all periods of operation of the affected boiler except for CEMS breakdowns and repairs. This CEMS shall obtain emission data for at least 75 percent of the operating hours in at least 22 out of 30 successive units operating days as specified and pursuant to 40 CFR 60.48b(f). Data is to be obtained in the scheduling and course of performing calibration checks, and zero and span adjustments as specified in the NSPS.*

* Fulfillment of the above criteria for availability of emission data from the CEMS does not shield the Permittee from potential enforcement for failure to properly maintain and operate the CEMS.

ii. The 1-hour average NO_x emission rates measured by the CEMS shall be expressed in lbs/mmBtu heat input and shall be used to calculate average emission rates pursuant to the NSPS. The 1-hour averages shall be calculated using the data points required under 40 CFR 60.13(h)(2), except as allowed under 60.48b(b)(2).

iii. This CEMS shall also be used to determine compliance with the NO_x limits in Conditions 2.2.3(c) and 2.2.6.

b. The Permittee shall fulfill applicable requirements of the NSPS for this continuous monitoring system, including the following, unless alternative requirements are approved by USEPA pursuant to 40 CFR 60.13(i). For this purpose, pursuant to 40 CFR 60.13(b), the continuous monitoring system shall be installed and operational prior to conducting the initial performance test for NO_x under 40 CFR 60.8. Verification of operational status shall, as a minimum, include completion of the manufacturer's written requirements or recommendations for installation, operation, and calibration of the monitoring devices.

i. Applicable notification requirements, including 40 CFR 60.7(a)(5), 60.8(d) and 60.49b(b).

ii. Applicable operational requirements, including 40 CFR 60.13(e) and 60.48b(c), which provide that a continuous monitoring system shall be operated during all periods of operation of an affected facility except for continuous monitoring system breakdowns and repairs. Data is to be recorded during calibration checks, and zero and span adjustment.

iii. Applicable recordkeeping requirements, including 40 CFR 60.49b(g).

iv. Applicable reporting requirements, including 40 CFR 60.7(c), (d) and/or (e) and 60.49b(h).

c. The Permittee shall also fulfill applicable requirements of 35 IAC Part 217 Subpart D for this monitoring system, including the following:

i. Applicable notification requirements of 35 IAC 217.155.

ii. Applicable recordkeeping requirements of 35 IAC 217.156(b)(9) and (b)(10).

iii. Applicable operational requirements of 35 IAC 217.157(a)(1).

iv. Applicable reporting requirements of 35 IAC 217.156(j).

2.2.8-2 Instrumentation Requirements

a. The Permittee shall install, calibrate, operate and maintain instrumentation for the affected boiler for fuel usage, scf.

2.2.8-3 Opacity Observations

a. The Permittee shall perform opacity observations for the affected boiler in accordance with Method 9 on at least an annual basis if visible emissions are normally present when the boiler is operating, as determined by Method 22.

2.2.9 Recordkeeping Requirements

a. For the affected boiler, the Permittee shall maintain the records required by the NESHAP, 40 CFR 63 Subpart DDDDD, including the records required by 40 CFR 63.7540(a)(10)(vi) and 63.7555(a)(1), (i) and (j).

b. The Permittee shall maintain a file or other record containing the following information for the affected boiler:

i. If the maximum design heat input capacity is not stated on the nameplate attached to the affected boiler, the maximum design heat input capacity of the affected boiler, mmBtu/hour, with supporting documentation.

ii. The Permittee's established operating and maintenance procedures for the affected boiler.

c. An operating log or other records for the affected boiler that, at a minimum, shall include the information specified in Condition 3.2 and the following information:

i. Information for each startup and shutdown, including date, time and duration, as required by 40 CFR 60.7(b).

ii. Information for any incident in which the operation of the affected boiler continued during malfunction or breakdown, including: date, time, and duration; a description of the incident; whether emissions exceeded or may have exceeded any applicable standard; a description of the corrective actions taken to reduce emissions and the duration of the incident; and a description of the preventative actions taken, as addressed by 40 CFR 60.7(b).

d. The Permittee shall maintain the following operating records for the affected boiler:

i. Daily records of fuel use, which records shall be prepared and maintained following the procedures of 40 CFR 60.49b(d);

ii. Amount of fuel consumed, (million scf/month and million scf/year) and the annual capacity factor, determined on a 12-month rolling basis with a new annual capacity factor calculated for each month pursuant to 40 CFR 60.49b(d).

iii. For the affected boiler, pursuant to 40 CFR 60.49b(r), the fuel receipts from the fuel supplier that certify that the gaseous fuel meets the definition of natural gas as that term is defined in 40 CFR 60.41b, and the applicable sulfur limit.

iv. Pursuant to 35 IAC Part 217 Subparts D and E, the following operating records for the affected boiler:

A. Usage of natural gas, in million scf per month and million scf per year.

B. The actual heat input in mmBtu per ozone season and mmBtu per year with supporting documentation for the heat content of the fuel.

C. The applicable NO_x emission limitation in lbs/mmBtu for each ozone season and each calendar year, calculated in accordance with 35 IAC 217.165.

e. The Permittee shall keep inspection, maintenance and repair logs or other similar records for the affected boiler that contains the information specified in Condition 3.2(b).

f. The Permittee shall maintain records of the following information for the NO_x emissions of the affected boiler for each operating day, pursuant to 40 CFR 60.49b(g) unless alternative recordkeeping requirements are approved for the boiler in conjunction with USEPA approval of alternative monitoring procedures under the NSPS:

i. Calendar date.

ii. The measured average hourly emission rates (expressed in lbs/mmBtu heat input).

iii. The 30-day average emission rate (lbs/mmBtu heat input and lbs/hour) calculated at the end of each operating day from the measured hourly emission rates for the preceding 30 unit operating days.

iv. Identification of the operating days when the calculated 30-day average emission rates are in excess of an applicable standard or limit, with the reasons for such excess emissions as well as a description of corrective actions taken.

v. Identification of the operating days for which emission data have not been obtained, including a description of corrective actions taken.

vi. Identification of the times when emission data have been excluded from the calculation of average emission rates and the reasons for excluding data.

vii. If continuous emissions monitoring is conducted, the information specified by 40 CFR 60.49b(g)(5), (6), (7), (8) and (9).

g. Pursuant to 35 IAC Part 217 Subpart D and E, the Permittee shall maintain the following records related to the NO_x emissions of the affected boiler:

i. The average hourly NO_x emission data as determined by the CEMS.

ii. The ozone season and annual NO_x emissions (pounds).

iii. The ozone season average and annual average NO_x emission rates (lbs/mmBtu heat input), calculated within 30 days of the end of the averaging periods (i.e., calculated by October 30 for ozone season averaging period and by January 30 of the following year for annual averaging period).

h. The Permittee shall keep the following records related to the emissions of NO_x, CO, VOM, PM and $PM_{10}/PM_{2.5}$ from the affected boiler:

i. For NO_x, the emissions of NOx from the affected boiler based on continuous emissions monitoring data (tons/month and tons/year).

ii. For pollutants other than NO_x:

A. A file containing the emission factors that are used to calculate emissions, with supporting documentation; and

B. The emissions of the affected boiler based on operating data and applicable emission factors, in tons/month and tons/year, with supporting calculations.

2.2.10 Notification and Reporting Requirements

a. For the affected boiler, the Permittee shall fulfill applicable notification and reporting requirements of the NSPS, 40 CFR 60.7 and 60.49b, by sending required notifications and reports to the Illinois EPA, including the following reports:

i. Written notification of commencement of construction, no later than 30 days after such date. [40 CFR 60.7(a)(1)]

ii. Written notification of the actual date of initial startup, within 15 days after such date. [40 CFR 60.7(a)(3)]

iii. Reports containing the information recorded under 40 CFR 60.49b(a), (b), (g) and (j).

iv. Periodic reports for excess emissions, as further addressed by Condition 2.2.10(d)(i).

v. With the periodic compliance reports, reports certifying that only natural gas that is known to contain insignificant amounts of sulfur were combusted in the affected boilers during the reporting period, pursuant to 40 CFR 60.49b(r).

b. For the affected boiler, the Permittee shall fulfill the applicable notification and reporting requirements of the NESHAP, 40 CFR 63 Subpart DDDDD, including the notifications and reports required by 40 CFR 63.7545(a) and 63.7550(c)(1).

c. For the affected boiler, the Permittee shall fulfill the applicable notification and reporting requirements of 35 IAC Part 217 Subpart D, including 35 IAC 217.155(b) and 217.156((g) and (j).

d. For the affected boiler, the Permittee shall submit periodic compliance reports to the Illinois EPA for the affected boilers, which reports shall include the following information related to excess NOx emissions and deviations from other permit requirements. These reports shall be submitted on a semi-annual basis, with each report submitted no later than 30 days following the end of the reporting period.

i. As related to the NSPS standard for NOx (Condition 2.2.2(a)(i)), the state emission standard for NO_x (Conditions 2.2.3(c)) and the limits for NOx emissions set by this permit (Conditions 2.2.6(a) and (b)), the information required for reporting of exceedances under 40 CFR 60.7(c) or (d) and 60.49b(h) and (j) and the information specified by Condition 3.4. If there are no such exceedances during the reporting period, the report shall state that no exceedances occurred during the reporting period.

ii. Information for other deviations during the reporting period, if any, which shall include the information specified by Condition 3.4.

iii. When no excess emissions or deviations have occurred or the CEMS have not been inoperative, repaired, or adjusted, such information shall be stated in the report.

Subpart 2.3: UNIT-SPECIFIC CONDITIONS FOR THE HEATERS

2.3.1 Description

The affected units for the purpose of these unit-specific conditions are natural gas-fired pipeline heaters. These heaters are used to indirectly heat natural gas to counteract the cooling that occurs when the pressure of natural gas is lowered when transitioning between pipelines. The conversion project may need up to six fuel heaters with nominal rated heat input capacities of up to 11.0 mmBtu/hour each to heat the natural gas supply to the main boilers.

2.3.2 Applicable Federal Emission Standards

a. The affected units are subject to the Boiler NESHAP, 40 CFR 63 Subpart DDDDD. For each affected unit, the Permittee must comply with applicable requirements of the NESHAP, 40 CFR 63 Subpart DDDDD, for the "units designed to burn gas 1 fuel" category, and related requirements of 40 CFR 63 Subpart A, General Provisions, including the following:

i. Pursuant to 40 CFR 63.7500 and Table 3 of 40 CFR 63 Subpart DDDDD, the Permittee shall conduct periodic tune-ups of each affected unit as specified in 40 CFR 63.7540(a)(10), (11), (12) or (13), as applicable. (See also Condition 2.3.4(d).)

ii. Pursuant to 40 CFR 63.7500(a)(3), the Permittee, as the owner or operator of the affected units, must operate and maintain each unit, including associated air pollution control equipment and monitoring equipment, in a manner consistent with safety and good air pollution control practices for minimizing emissions.

b. i. Each affected unit with a heat input capacity of 10 mmBtu/hour or greater is an affected facility under the federal New Source Performance Standard (NSPS) for Small Industrial-Commercial-Institutional Steam Generating Units, 40 CFR 60, Subpart Dc. As an affected facility, the Permittee must comply with applicable requirements of the NSPS, 40 CFR 60 Subpart Dc, and related requirements of 40 CFR 60 Subpart A, General Provisions, for the heater.

ii. Pursuant to the NSPS, 40 CFR 60.11(d), at all times the Permittee shall, to the extent practicable, maintain and operate each affected unit with a heat input capacity of 10 mmBtu/hour or greater in a manner consistent with good air pollution control practices for minimizing emissions.

2.3.3 Applicable State Emission Standards

a. Pursuant to 35 IAC 212.123(a), the opacity of the exhaust from each affected unit shall not exceed 30 percent, except as provided by 35 IAC 212.123(b).

b. Pursuant to 35 IAC 216.121, for each affected unit with actual heat input greater than 10 mmBtu/hour, the CO emissions from the affected unit shall not exceed 200 ppm, corrected to 50 percent excess air.

2.3.3 Non-applicability Provisions

a. This permit is based on the affected units not being subject to the National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources, 40 CFR 63 Subpart JJJJJJ, because the source is a major source of HAP.

2.3.4 Operational Limits and Work Practice Requirements

a. Natural gas shall be the only fuel fired in the affected units.

b. The rated heat input capacity of each affected unit shall not exceed 11.0 million Btu/hour.

c. The combined usage of fuel in the affected units shall not exceed 31,000 mmBtu/month and 184,000 mmBtu/year.

d. Pursuant to 40 CFR 63.7500 and Table 3 of the Boiler NESHAP, the Permittee shall conduct periodic tune-ups of the affected units as specified in 40 CFR 63.7540 as follows. These tune-ups shall also serve as work practices for the emissions of CO and VOM of the affected units.

i. For each affected unit without a continuous oxygen trim system and with a heat input capacity of 10 mmBtu per hour or greater: Annually.

ii. For each affected unit without a continuous oxygen trim system and with a heat input capacity of less than 10 mmBtu per hour but greater than 5 mmBtu per hour: Biennially.

iii. For each affected unit with a continuous oxygen trim system that maintains an optimum air to fuel ratio or with a heat input capacity of less than or equal to 5 mmBtu per hour: At least every five years.

2.3.5 Emissions

a. Total emissions from the affected units, combined, shall not exceed the following limits. Compliance with these limits shall be determined from a running total of monthly data.

Pollutant	Limits	
	lb/mmBtu, HHV	Tons/Year
NO_x	0.101	9.3
CO	0.050	4.4
VOM	0.002	0.2

b. This permit is issued based on minimal emissions of PM, $PM_{10}/PM_{2.5}$ and SO_2 from the affected units, i.e., total emissions of each pollutant that are no more than 0.7 tons/year.

2.3.6 Recordkeeping Requirements

a. For the affected units, the Permittee shall maintain the records required by the NESHAP, 40 CFR 63 Subpart DDDDD, including the records required by 40 CFR 63.7540(a)(10)((vi) and 63.7555(a)(1), (i) and (j).

b. For the affected units, the Permittee shall maintain a file containing the following information for each affected unit: model name, serial number, maximum design heat input capacity (mmBtu/hour), the date installed, the date the unit last operated and the date removed from service.

c. The Permittee shall maintain the following records for the amount of fuel combusted in the affected units (scf/month and scf/year).

d. For the affected units, the Permittee shall maintain an operating log or other records for the affected units that, at a minimum, shall include the following information:

i. An inspection, maintenance, and repair log or other records with dates and the nature of such activities for the affected units.

ii. A. For the affected units with a heat input capacity of 10 mmBtu/hour or greater, information for each startup and shutdown, including date, time and duration, as required by 40 CFR 60.7(b).

B. Information for any incident in which the operation of the affected unit continued during malfunction or breakdown, as required by 40 CFR 60.7(b). These records shall include date, time, and duration; a description of the incident; whether emissions exceeded or may have exceeded any applicable standard; a description of the corrective actions taken to reduce emissions and the duration of the incident; and a description of the preventative actions taken.

e. The Permittee shall keep the following records related to emissions of NOx, CO and VOM of the affected units, with supporting calculations:

i. A file containing a determination of the maximum emission rates of each pollutant in lbs/mmBtu, with supporting documentation.

ii. Records of actual emissions of each pollutant (tons/month and tons/year), with supporting calculations.

iii. Records of the actual emissions of each pollutant from all affected units, combined (tons/month and tons/year), with supporting calculations.

2.3.7 Notification and Reporting Requirements

a. For the affected units, the Permittee shall fulfill the applicable notification and reporting requirements of the NESHAP, 40 CFR 63 Subpart DDDDD, including the notifications and reports required by 40 CFR 63.7545(a) and 63.7550(c)(1).

b. The Permittee shall furnish the Illinois EPA with written notification as follows with respect to commencement of construction and operation of the affected units:

i. The date construction of the affected unit commenced, postmarked no later than 30 days after such date, pursuant to 40 CFR 60.7(a)(1) and 40 CFR 60.48c(a).

ii. The actual date of initial startup of the affected units, postmarked within 15 days after such date, pursuant to 40 CFR 60.7(a)(3) and 60.48c(a), which shall be accompanied by the following information:

A. The design heat input capacity of the units and identification of the fuels to be combusted in the affected units, pursuant to 40 CFR 60.48c(a)(1).

B. The annual capacity factor at which the Permittee anticipates operating the units based on fuel fired, pursuant to 40 CFR 60.48c(a)(3).

c. For the affected units, the Permittee shall notify the Illinois EPA of deviations from the permit requirements within 30 days of an occurrence. Reports shall include the information specified in Condition 3.4.

PART 3: GENERAL CONDITIONS

3.1 General Requirements for Emission Testing

a. At least 60 days prior to the actual date of initial emission testing required by this permit, a written test plan shall be submitted to the Illinois EPA for review. This plan shall describe the specific procedures for testing and shall include at a minimum:

i. The person(s) who will be performing sampling and analysis and their experience with similar tests.

ii. The specific conditions, e.g., operating rate and control device operating conditions, under which testing shall be performed including a discussion of why these conditions will be representative and the means by which the operating parameters will be determined.

iii. The specific determinations of emissions that are intended to be made, including sampling and monitoring locations.

iv. The test method(s) that will be used, with the specific analysis method if the method can be used with different analysis methods.

b. i. The Permittee shall notify the Illinois EPA prior to performing emissions testing required by this permit to enable the Illinois EPA to observe the tests. Notification for the expected date of testing shall be submitted a minimum of 30 days prior to the expected date, and identify the testing that will be performed. Notification of the actual date and expected time of testing shall be submitted a minimum of 5 working days prior to the actual date of testing. Notwithstanding applicable rules, the Illinois EPA may at its discretion accept notifications with shorter advance notice provided that the Illinois EPA will not accept such notifications if it interferes with the Illinois EPA's ability to observe testing.

ii. This notification shall also identify the parties that will be performing testing and the set or sets of operating conditions under which testing will be performed.

c. Three copies of the Final Reports for emission tests shall be forwarded to the Illinois EPA within 30 days after the test results are compiled and finalized but not later than 90 days after the date of testing. At a minimum, the Final Report for testing shall contain the following. Copies of emission test reports shall be retained for at least five years after the date that an emission test is superseded by a more recent test.

i. A tabular summary of results which includes:

- Process rates (e.g., fuel usage rate or firing rate)
- Measured emission rates for different pollutants tested
- Emission factor, calculated using the average test results in the terms of the applicable limits, for example, in units of lbs pollutant emitted per mmBtu
- Compliance demonstrated - Yes/No.

ii. Description of test method(s) and procedures, including a description of sampling points, sampling train, analysis equipment, and test schedule.

iii. Detailed description of test conditions, including:

- Pertinent process information (e.g., the usage and type of fuel or raw material and the firing or operating rate.)
- Control equipment information (i.e., monitored data and other relevant operating parameters during testing).

iv. Data and calculations, including copies of all raw data sheets and records of laboratory analysis, sample calculations, and data on equipment calibration.

3.2 General Requirements for "Logs" or Similar Records

a. Operating logs or other similar records required by this permit shall, at a minimum, include the following information related to the emission units and associated control system:

i. Information identifying periods when an emission unit or group of related emission units was not in service.

ii. For periods when a unit or group of related units is in service and operating normally, relevant process and control system information to generally confirm normal operation.

iii. For periods when a unit or group of related units is in service and is not operating normally, identification of each such period, with detailed information describing the operation of the unit(s), the potential consequences for additional emissions from the unit(s), the potential of any excess emissions from the affected unit(s), the actions taken to restore normal operation, and any actions taken to prevent similar events in the future.

iv. Other information as may be appropriate to show that the emission unit or group of related emission units is operated in accordance with good air pollution control practices.

b. Inspection, maintenance and repair logs or other similar information required by this permit shall, at a minimum, include the following information related to the emission units and associated control system:

i. Identification of equipment, with date, time, responsible employee and type of activity.

ii. For inspections, a description of the inspection, findings, and any recommended actions, with reason.

iii. For maintenance and repair activity, a description of actions taken, reason for action (e.g., preventative measure or corrective action as a result of inspection), probable cause for requiring maintenance or repair if not routine or preventative, and the condition of equipment following completion of the activity.

iv. Other information as may be appropriate to show that the emission unit or group of related emission units is maintained in accordance with good air pollution control practices, including prompt repair of defects that interfere with effective control of emissions.

c. All records and logs required by this permit shall be retained at a readily accessible location at the source for at least five years from the date of entry and shall be available for inspection and copying by the Illinois EPA upon request. Any record retained in an electronic format (e.g., computer) shall be capable of being retrieved and printed on paper during normal source office hours so as to be able to respond to an Illinois EPA request for records during the course of an on-site inspection. The logs required by this permit may be part of a larger database maintained by the Permittee provided that the information that is required to be kept is readily accessible.

3.3 General Requirements for Records for Deviations

a. Except as specified in a particular provision of this permit or in a subsequent CAAPP Permit for the plant, records for deviations from applicable requirements shall include at least the following information: the date, time and estimated duration of the deviation; a description of the deviation; the manner in which the deviation was identified, if not readily apparent; the probable cause for deviation, if known, including a description of any equipment malfunction or breakdown associated with the deviation; information on the magnitude of the deviation, including actual emissions or performance in terms of the applicable standard if measured or readily estimated; confirmation that standard procedures were followed or a description of any event-specific corrective actions taken; and a description of any preventative measures taken to prevent future occurrences, if appropriate.

3.4 General Requirements for Reporting of Deviations

a. The Permittee shall include the following information in records and reports for deviations:

i. Identity of the deviation, with date, time, duration and description.

ii. Describe the effect of the deviation on compliance, with an estimate of the excess emissions that accompanied the deviation, if any.

iii. Describe the probable cause of the deviation and any corrective actions or preventive measures taken.

b. Unless otherwise specified in a particular condition of this permit, if deviation(s) from requirements of this permit occurs during a calendar quarter, a report shall be submitted no later than 45 days after the end of the quarter. This report shall also provide a listing of all deviations for which earlier reporting was required, but need not include copies of the previously submitted information.

c. For the purpose of determining whether a deviation must be reported prior to a periodic compliance report, a deviation shall be considered to continue even if operation of an emission unit is interrupted if the deviation is still present when operation of the unit is resumed.

ATTACHMENT 1: SUMMARY OF PROJECT EMISSIONS

Summary of Project Emissions[a] (Tons/Year)

Emission Unit(s)	NO_x	CO	SO_2	PM	PM_{10}[b]	$PM_{2.5}$[b]
Existing Units (Main Boilers)						
Baseline Actual Emissions	6160	5355	17060	2440	2023	1049
Future Emissions	4040	3611	21	66	266	266
Change	-2120	-1744	-17039	-2374	-1757	-783
New Units						
Auxiliary Boilers	24.8	25.2	0.41	1.31	5.24	5.24
Fuel Heaters	9.3	4.4	0.7	0.7	0.7	0.7
Subtotal	34.1	29.6	1.11	2.01	5.94	5.94
Total	-2086	-1714	-17038	-2372	-1751	-777
Total w/o decreases	34.1	29.6	1.11	2.0	5.9	5.94
Significant Emission Rate	40	100	40	25	15	10
Greater Than Significant?	No	No	No	No	No	No

Notes:

a. For VOM emissions, the Joliet Station will continue to be a non-major source, permitted for annual future VOM emission less than 100 tons.

Emission Unit(s)	Permitted VOM Emissions (Tons/Year)
Main Boilers	94.9
Auxiliary Boilers	2.9
Fuel Heaters	0.2
Total	98.0

b. PM_{10} and $PM_{2.5}$ include filterable particulate and condensable particulate.

ATTACHMENT 2: STANDARD PERMIT CONDITIONS

STANDARD CONDITIONS FOR CONSTRUCTION/DEVELOPMENT PERMITS ISSUED BY THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

The Illinois Environmental Protection Act (Illinois Revised Statutes, Chapter 111-1/2, Section 1039) authorizes the Environmental Protection Agency to impose conditions on permits, which it issues.

The following conditions are applicable unless superseded by special condition(s).

1. Unless this permit has been extended or it has been voided by a newly issued permit, this permit will expire one year from the date of issuance, unless a continuous program of construction or development on this project has started by such time.

2. The construction or development covered by this permit shall be done in compliance with applicable provisions of the Illinois Environmental Protection Act and Regulations adopted by the Illinois Pollution Control Board.

3. There shall be no deviations from the approved plans and specifications unless a written request for modification, along with plans and specifications as required, shall have been submitted to the Illinois EPA and a supplemental written permit issued.

4. The Permittee shall allow any duly authorized agent of the Illinois EPA upon the presentation of credentials, at reasonable times:

   a. To enter the Permittee's property where actual or potential effluent, emission or noise sources are located or where any activity is to be conducted pursuant to this permit,

   b. To have access to and to copy any records required to be kept under the terms and conditions of this permit,

   c. To inspect, including during any hours of operation of equipment constructed or operated under this permit, such equipment and any equipment required to be kept, used, operated, calibrated and maintained under this permit,

   d. To obtain and remove samples of any discharge or emissions of pollutants, and

   e. To enter and utilize any photographic, recording, testing, monitoring or other equipment for the purpose of preserving, testing, monitoring, or recording any activity, discharge, or emission authorized by this permit.

5. The issuance of this permit:

   a. Shall not be considered as in any manner affecting the title of the premises upon which the permitted facilities are to be located;

   b. Does not release the Permittee from any liability for damage to person or property caused by or resulting from the construction, maintenance, or operation of the proposed facilities;

   c. Does not release the Permittee from compliance with other applicable statutes and regulations of the United States, of the State of Illinois, or with applicable local laws, ordinances and regulations;

   d. Does not take into consideration or attest to the structural stability of any units or parts of the project; and

   e. In no manner implies or suggests that the Illinois EPA (or its officers, agents or employees) assumes any liability, directly or indirectly, for any loss due to damage, installation, maintenance, or operation of the proposed equipment or facility.

6. a. Unless a joint construction/operation permit has been issued, a permit for operation shall be obtained from the Illinois EPA before the equipment covered by this permit is placed into operation.

   b. For purposes of shakedown and testing, unless otherwise specified by a special permit condition, the equipment covered under this permit may be operated for a period not to exceed thirty (30) days.

7. The Illinois EPA may file a complaint with the Board for modification, suspension or revocation of a permit.

   a. Upon discovery that the permit application contained misrepresentations, misinformation or false statement or that all relevant facts were not disclosed, or

   b. Upon finding that any standard or special conditions have been violated, or

   c. Upon any violations of the Environmental Protection Act or any regulation effective thereunder as a result of the construction or development authorized by this permit.

STATE OF ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF AIR POLLUTION CONTROL
P. O. BOX 19506
SPRINGFIELD, ILLINOIS 62794-9506

STANDARD CONDITIONS FOR CONSTRUCTION/DEVELOPMENT PERMITS ISSUED BY THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

July 1, 1985

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The following conditions are applicable unless superseded by special condition(s).

1. Unless this permit has been extended or it has been voided by a newly issued permit, this permit will expire one year from the date of issuance, unless a continuous program of construction or development on this project has started by such time.

2. The construction or development covered by this permit shall be done in compliance with applicable provisions of the Illinois Environmental Protection Act, and Regulations adopted by the Illinois Pollution Control Board.

3. There shall be no deviations from the approved plans and specifications unless a written request for modification, along with plans and specifications as required, shall have been submitted to the Agency and a supplemental written permit issued.

4. The Permittee shall allow any duly authorized agent of the Agency upon the presentation of credentials, at reasonable times:

   a. to enter the Permittee's property where actual or potential effluent, emission or noise sources are located or where any activity is to be conducted pursuant to this permit,

   b. to have access to and copy any records required to be kept under the terms and conditions of this permit,

   c. to inspect, including during any hours of operation of equipment constructed or operated under this permit, such equipment and any equipment required to be kept, used, operated, calibrated and maintained under this permit,

   d. to obtain and remove samples of any discharge or emission of pollutants, and

   e. to enter and utilize any photographic, recording, testing, monitoring or other equipment for the purpose of preserving, testing, monitoring, or recording any activity, discharge, or emission authorized by this permit.

5. The issuance of this permit:

   a. shall not be considered as in any manner affecting the title of the premises upon which the permitted facilities are to be located,

   b. does not release the Permittee from any liability for damage to person or property caused by or resulting from the construction, maintenance, or operation of the proposed facilities,

   c. does not release the Permittee from compliance with the other applicable statues and regulations of the United States, of the State of Illinois, or with applicable local laws, ordinances and regulations,

   d. does not take into consideration or attest to the structural stability of any units or parts of the project, and

e. in no manner implies or suggests that the Agency (or its officers, agents or employees) assumes any liability, directly or indirectly, for any loss due to damage, installation, maintenance, or operation of the proposed equipment or facility.

6. a. Unless a joint construction/operation permit has been issued, a permit for operation shall be obtained from the Agency before the equipment covered by this permit is placed into operation.

   b. For purposes of shakedown and testing, unless otherwise specified by a special permit condition, the equipment covered under this permit may be operated for a period not to exceed thirty (30) days.

7. The Agency may file a complaint with the Board for modification, suspension or revocation of a permit:

   a. upon discovery that the permit application contained misrepresentations, misinformation or false statements or that all relevant facts were not disclosed, or

   b. upon finding that any standard or special conditions have been violated, or

   c. upon any violations of the Environmental Protection Act or any regulation effective thereunder as a result of the construction or development authorized by this permit.