Indiana Harbor and Canal CDF

Final Conceptual Wastewater Treatment Plant Design Comparison Report

Prepared for

U.S. Army Corps of Engineers

Chicago District

Contract W916P6-09-F-0006
Delivery Order 0006

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MWH
BUILDING A BETTER WORLD

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ACRONYMS AND ABBREVIATIONS

ARCO	Atlantic Richfield Company
bgs	below ground surface
BOD	Biochemical Oxygen Demand
CDF	Confined Disposal Facility
COD	Chemical Oxygen Demand
GAC	Granular Activated Carbon
gpm	gallons per minute
HRT	Hydraulic Retention Time
HVAC	Heating, Ventilation and Air Conditioning
IDEM	Indiana Department of Environmental Management
IGWTP	Interim Groundwater Treatment Plant
IHC	Indiana Harbor and Canal
IX	ion exchange
mg/L	Milligram(s) per Liter
MWH	MWH Americas, Inc.
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
O&M	Operation and Maintenance
PFD	Process Flow Diagram
RCRA	Resource Conservation and Recovery Act
SBR(s)	Sequencing Batch Reactors
SOW	Scope of Work
SVOC	Semivolatile Organic Compound
TOC	Total Organic Carbon
TSS	Total Suspended Solids
ug/L	Microgram(s) per Liter
USACE	United States Army Corps of Engineers
VOC	Volatile Organic Compound
WWTP	Wastewater Treatment Plant

1.0 EXECUTIVE SUMMARY

This Conceptual Design Comparison Report is presented in accordance with the April 23, 2009 Scope of Work (SOW) provided by the United States Army Corps of Engineers, Chicago District (USACE) to MWH Americas Inc. (MWH) for Delivery Order 0006 issued under Contract Number W912P6-09-F-0006. MWH was tasked with evaluating impacts to the proposed wastewater treatment plant (WWTP) resulting from the USACE's decision to change the operation of the Confined Disposal Facility (CDF) cells at the Indiana Harbor and Canal (IHC) site from drained cells to ponded cells. Based on the anticipated impacts to the previous design, MWH prepared conceptual designs and preliminary cost estimates for two different treatment alternatives: a permanent plant; and a package plant.

The permanent plant would consist of equipment that would be owned and operated by USACE over the course of the dredging project. Based on MWH's evaluation of the anticipated influent characteristics and flow rates and available technologies, MWH recommends that the permanent plant consist of clarification for solids/metals removal, chlorination/dechlorination (either by chemical addition or by granular activated carbon (GAC)) for ammonia removal, and sand filtration and GAC for polishing.

The package plant would consist of vendor owned and operated equipment capable of treating the anticipated influent to meet the discharge limits and could be removed from the site when not required. The vendor provided equipment could include ultrafiltration for solids/metal removal, organics removal with GAC, and chlorination/dechlorination for ammonia removal. However, this is one example based on the vendor information that was provided for this task. A number of combinations of equipment could be potentially provided. For the package plant, USACE would only be required to construct the site features, most of which would also need to be constructed for the permanent plant scenario. The permanent plant and package plant conceptual designs, along with the site features, are discussed in detail in Section 3.0 of this report.

Based on the conceptual designs for both types of systems, preliminary estimates of the capital and operation and maintenance costs were developed. Based on the preliminary cost estimates, the net present value of the permanent plant and the package plant are $32,888,320 and $37,315,427, respectively. These estimates were prepared to the Association for the Advancement of Cost Engineering (AACE) Industry Standards for a Class 4 estimate. This class of estimate has an accuracy range of: low is -15% to -30% and high is +20% to +50%. In addition, a contingency of 20% was added to both costs to provide coverage for any potential omissions or unforeseen conditions or requirements.

After completion of the conceptual designs and preliminary cost estimates, an alternatives evaluation workshop was conducted to aid USACE in comparing the two design options based on the following criteria: capital cost; operation and maintenance cost; anticipated schedule/availability of service; contracting; operational flexibility; and potential risk (i.e. uncertainty of influent characteristics, uncertainty of annual funding, uncertainty of continuity of service, risk of full design versus performance-based specifications). The evaluation was conducted by assigning relative importance (or weighting) to each criterion and scoring both alternatives against each of the weighted criteria. USACE determined that operational flexibility was the most important criterion followed by contracting, potential risks, and capital costs. Based on the output of the evaluation, USACE selected the package plant option as the preferred alternative.

During the alternatives evaluation workshop, there was significant discussion regarding the unknowns associated with the anticipated system influent characteristics. The anticipated influent characteristics that were utilized for the conceptual designs were based on gross assumptions of the effect of extending the holding time of the dredge water. It was recognized that the treatment system may be either oversized or undersized, depending on variations in the climatic conditions (rainfall and evaporation) as well as the nature of the dredged material. Because of the large volume capacity of the CDF cells, particularly in the first several years of operation, USACE determined that it would be beneficial to store the first year to two years of dredge water before treating and discharging the water. This would allow USACE to collect further data on the water quality characteristics that the package system will need to treat. In addition, more information could be collected on the actual water volumes that will be generated each year.

Based on the evaluation summarized in Technical Memorandums #1 through #3 and the outcome of the alternatives evaluation workshop, MWH recommends the following approach to the design and implementation of the WWTP:

- Prior to preparing any additional design documents or bid packages, USACE should consult with the regulator – Indiana Department of Environmental Management (IDEM) - to explore the requirements for proceeding with the ponded cells and a package WWTP, as well as delaying the design and construction of the package plant until after dredging has begun;
- After engaging IDEM, the next step would be to prepare a construction bid package for the south end site features necessary to support the package plant. The design of the majority of these features was completed in the earlier permanent plant design submitted by MWH in 2008. These features would require some modification including sizing and design of a package plant equipment pads;
- The final step would be to prepare performance-based specifications for the package plant. The current NPDES permit for the Interim Groundwater Treatment Plant (IGWTP) and gradient control system is due for renewal in 2011. It is USACE’s intention to include treatment of the water generated by the dredging operations and the precipitation collected in the CDF cells in this permit renewal. Therefore, performance-based specification documents for a package plant system will need to be compiled prior to applying for the permit renewal. The package plant documents will indicate the existing data as the anticipated system influent characteristics until the actual influent characteristics can be verified. At that point, the NPDES permit and/or the vendor contract could be modified. It is anticipated that these performance-based specifications would be based on the USACE’s experience with the performance-based specifications prepared for the IGWTP.

2.0 INTRODUCTION

The following sections of this report discuss in more detail the general background of the project, the impacts of the change in CDF cell operation on the previous design, the process evaluation and conceptual designs, the modifications to the site features, the cost estimates, the method used for selecting the design approach, the recommended next steps, and the anticipated schedule. This report is a compilation of Technical Memorandums #1 through #3 and the Alternatives Evaluation Workshop Summary that were previously submitted to USACE. Comments provided by USACE on these documents have been addressed and incorporated into this report, as appropriate.

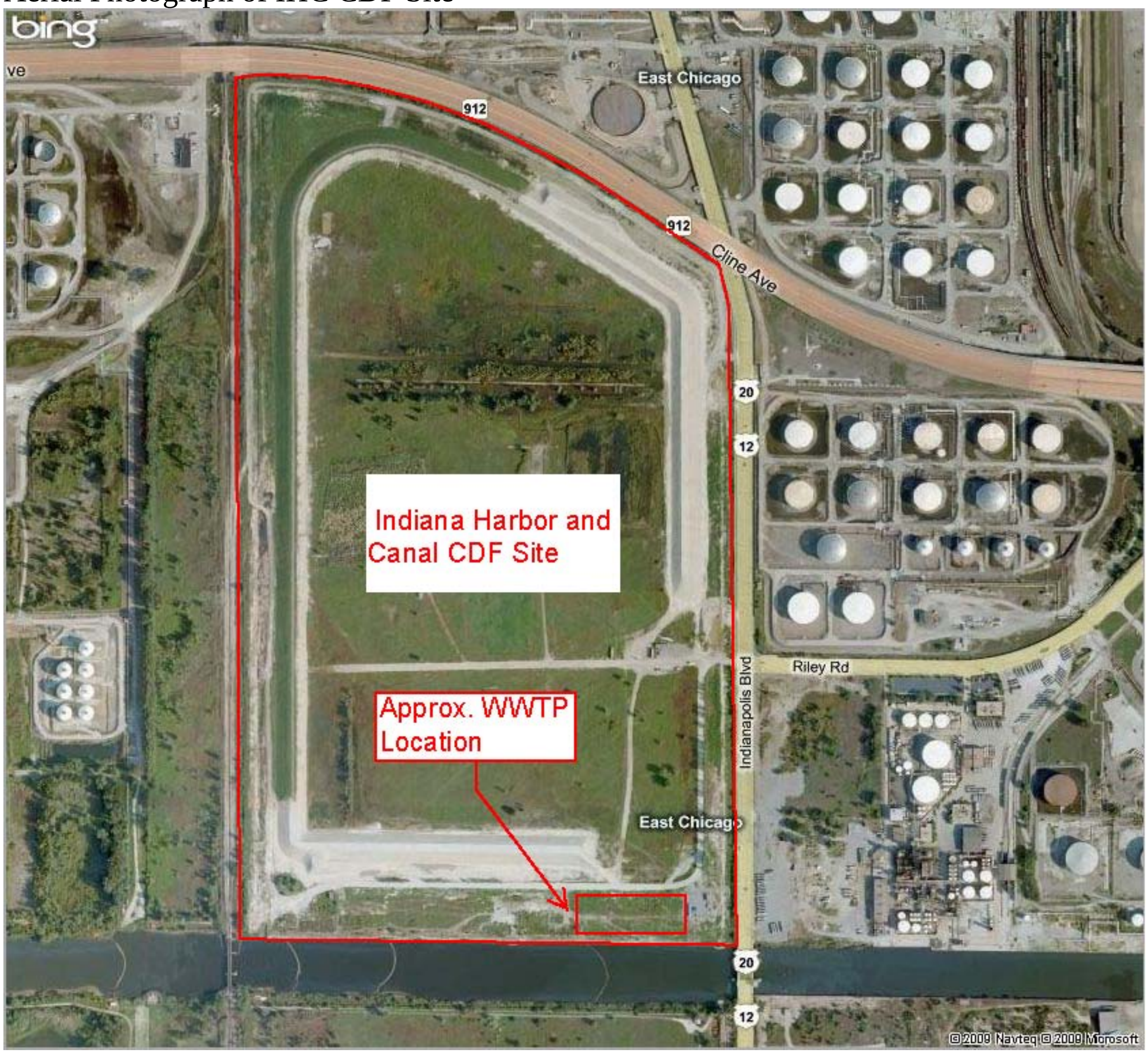
2.1 Background

The CDF is being constructed on property belonging to the project local sponsor, the East Chicago Waterway Management District (ECWMD). The CDF site consists of approximately 164 acres of land formerly occupied by an oil refinery owned by Atlantic Richfield Company (ARCO) and subsequently acquired by Energy Cooperative Industries (ECI). The site is adjacent to the Lake George Branch of the IHC to the south and Indianapolis Boulevard in East Chicago, Indiana to the east. After the site was abandoned, the plant was demolished to ground level, abandoning all foundations, and underground piping and utilities. The site currently has open Resource Conservation and Recovery Act (RCRA) status due to contamination from past waste handling activities at the site. Construction of the CDF at the site is subject to RCRA corrective action and closure requirements. The corrective action consists of a perimeter cutoff wall tied into an underlying clay till unit at approximately 33 feet (ft) below ground surface (bgs), and a groundwater removal system for hydraulic gradient control within the wall.

The sediments of the IHC are contaminated and have been determined to be unsuitable for open water disposal, unconfined upland disposal, or beneficial use. Dredging of the IHC has been deferred since 1972 while a technically and economically feasible and environmentally acceptable management plan was developed. As a result of studies completed by the USACE, dredging is to be undertaken throughout the IHC Federal Navigation project to authorized depths and widths. The contaminated sediments will be dredged by mechanical methods and placed onto a barge. The dredged material will then be transported and pumped to the CDF for disposal. Water collected in the CDF will be recycled to the barge to facilitate pumping of the sediment to the CDF. After the CDF is filled with dredge material (after an anticipated 30 years of dredging activities) the interior of the CDF will be covered with a RCRA cover. Due to the open RCRA status and past activities on the site, it is likely that exterior areas of the CDF site will also eventually require a RCRA cap.

USACE has made the decision to operate the CDF cells as a ponded facility. Prior to this decision, the CDF cells were to be completely drained at the end of each dredging season, with all drained water sent to the WWTP prior to discharge to the Lake George Branch. The required treatment volumes, WWTP flow rates, and anticipated constituent concentrations used for the completed WWTP design (submitted by MWH in November 2008) were based on the CDF being completely drained. The impacts to the influent concentrations and the proposed WWTP resulting from the USACE's decision to change the operation of the CDF cells from drained cells to ponded cells are discussed further in Section 2.0 of this report. It should be noted that USACE has indicated that there may still be years when the CDF cells will be completely drained. While this would increase the volume to be treated during that year, the impacts to the concentrations provided in Table 1 are not certain. Per USACE direction, the conceptual designs do not account for any fluctuations in the provided concentrations..

Aerial Photograph of IHC CDF Site



2.2 Scope of Work Summary

MWH was tasked with evaluating the impact of the change in the anticipated influent characteristics and annual volumes on the previous design completed by MWH in terms of potential changes in treatment plant processes, operational period, as well as if a package plant system would also be feasible. MWH performed the following tasks as part of this evaluation.

- Determine the potential impacts on the previous design, based on the anticipated influent characteristics and flow;
- Develop conceptual designs for a permanent plant and a package plant that could be utilized to meet the anticipated discharge limits. The conceptual designs included a brief review of available technologies that would be effective in treating the main constituents of concern;
- Develop comparative cost estimates of the conceptual permanent and package plant designs. The comparative cost estimates included capital costs and operation and maintenance cost over a 30 year duration;
- Facilitate a workshop to present the results of the previous tasks and to assist USACE in comparing the conceptual designs based on criteria previously provided by USACE. Based on the comparison of the conceptual designs, USACE was to determine which design option was the most appropriate for the site needs; and
- Prepare a report to document the outcome of all of the tasks.

3.0 IMPACTS TO PREVIOUS DESIGN

The first component of the conceptual design evaluation was to determine if the change to the anticipated CDF operation had an impact on the previously completed WWTP design that was prepared by MWH in November 2008. The following section presents a summary of the evaluation of the impacts to the previous WWTP and facility design based on the revised influent characteristics and flow rate. For ease of comparison, this section discusses the major components of the WWTP from the existing design and discusses the potential impact of the revised influent characteristics on that component. In addition, this section also discusses how the overall impacts to the WWTP will affect the other site features.

3.1 Revised Wastewater Characteristics and Flows

Changing the CDF to a ponded operation impacts the influent characteristics and the volume of water to be treated. The anticipated water characteristics of the WWTP influent are summarized in Table 1. Table 1 also shows influent characteristics used in the previous design prepared by MWH, for comparison. The concentration ranges for ponded operation were provided by USACE, and take into account dilution from net precipitation, settling analysis and volatilization predictions as a result of longer holding times in the CDF cells before treatment. The variability of the concentrations, as indicated in Table 1, is based on a factor that was derived from the comparison of data collected from previous studies. The comparison between the concentrations used in the previous design and the revised values shows concentrations of several key parameters are significantly lower for ponded operation. This includes total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), and ammonia. Table 2 summarizes the anticipated National Pollution Discharge Elimination System (NPDES) discharge limits, based on the limits that were issued for the IGWTP.

The anticipated volume of water to be treated will decrease for the ponded CDF operation due to the expected higher evaporation loss (longer holding time and larger area for evaporation). In addition, a certain volume will be retained in the cells and utilized for the following year's operation. Based on the precipitation data provided by USACE, the anticipated average treatment volume is 25 million gallons per year for the ponded CDF scenario. It was determined that the 99^{th} percentile net precipitation volume of approximately 61 million gallons per year would be used for the conceptual designs because this would allow for yearly fluctuations in annual precipitation and generated dredge water. Anticipating a 6 month operating period (primarily during the spring and summer months) for each year of operation, the required revised WWTP flow rate is 250 gallons per minute. A system designed for this flow rate will have the flexibility to treat the fluctuations anticipated by decreasing or increasing the operating period. For comparison, the flow rate used for the previous design was 380 gallons per minute.

The following table summarizes the flow rates and key constituent concentrations that were used as the basis for the conceptual designs.

Parameter	**Average Anticipated Influent Concentration**	**Maximum Anticipated Influent Concentration**	**Anticipated Monthly Average Effluent Concentration[1]**	**Anticipated Daily Maximum Effluent Concentration[1]**
Flow	250 gpm	250 gpm	Report	Report
Benzene	0.1 ug/L	0.31 ug/L	--	5 ug/L
Oil & Grease	1.8 mg/L	2.9 mg/L	10 mg/L	15 mg/L
Naphthalene	1 ug/L	16.7 ug/L	--	10 ug/L
BTEX	NS	NS	--	100 ug/L
Lead	120 ug/L	384 ug/L	--	22 ug/L
PCBs	0.072 ug/L	1.9 ug/L	--	ND
Phenol	1 ug/L	1.5 ug/L	Report (mg/L)	Report (mg/L)
Ammonia	8.1 mg/L	16.2 mg/L	1.1 mg/L (summer) 1.25 mg/L (winter)	2.2 mg/L (summer) 2.5 mg/L (winter)
Endrin	0.02 ug/L	0.03 ug/L	--	0.6 ug/L
Chlordane	0.05 ug/L	0.2 ug/L	--	ND (ug/L)
Heptachlor	0.02 ug/L	0.06 ug/L	--	ND (ug/L)
pH	7.9	7.9	--	8 S.U.
Total Residual Chlorine	NS	NS	0.009 mg/L	0.018 mg/L

Notes:
1. Anticipated effluent limits are based on the NPDES permit obtained for the IGWTP.

gpm – gallons per minute
mg/L – Milligrams per Liter
ND – Non-Detect
NS – No sample analyzed for this compound
ug/L – Micrograms per Liter

3.2 Impacts to Previous WWTP Process Design

The revisions to the CDF operation will have significant impacts to the process design of the IHC WWTP that was completed in November 2008. In general, the WWTP, as previously designed, would be oversized to handle the revised flows and concentrations. For example, several of the tanks were sized to have a specified hydraulic retention time (HRT) at the maximum flow rate of 380 gpm. These tanks would be reduced in size to maintain the same HRT at 250 gpm. Chemical dosing is paced off of the system flow rate. Therefore, chemical usage would be reduced based on the reduced system flow. The previous design included flocculating clarifiers for solids and metals removal. While this is still a viable option, the reduced flows and concentrations make other technologies more comparable.

In addition, MWH believes that the expected changes in wastewater characteristics will mean that some components of the process may no longer effectively or efficiently treat the constituents to meet their discharge limits. Biological treatment using Sequencing Batch Reactors (SBRs) was selected in the previous design to treat the ammonia concentrations in the influent stream. The ammonia concentrations anticipated for ponded operation are lower, but are still above the anticipated ammonia discharge limits, requiring that an ammonia removal stage be included. However, the lower influent ammonia concentrations, along with lower influent biochemical oxygen demand (BOD) concentrations, make biological treatment (in SBRs or other configurations) more difficult and open up the possibility that other processes may be more reliable and efficient.

3.3 Impacts to Previous Facility Design

Based on the revisions to the anticipated process design, there will also be several impacts to the facility design. The initial evaluation of the design revisions indicate that the size of the WWTP building would have a smaller footprint. In addition to the WWTP fooptrint, the size of the tank foundations may also decrease as the tank sizes and weights decrease.

The previous design included an administration building and maintenance shop. After the submission of the previous WWTP design, USACE determined that these buildings were not essential and removing them would greatly reduce the overall cost of the WWTP facility. Therefore, these features were removed from the conceptual design evaluation. In place of these buildings, space was provided for two 24-foot by 60-foot trailers that would be utilized for administrative functions and storage.

Modifications to the overall facility footprint (WWTP building, tank foundations, removal of the administration building and maintenance shop, and parking lot) impact stormwater management on the site. Due to the site constraints, the previous WWTP design utilized most of the work limits for the facility footprint and associated features which did not allow for stormwater runoff to be managed via overland flow to the canal. Decreasing the overall facility footprint will allow for more flexibility to manage stormwater runoff via overland flow and limit the need for the storm sewer system.

Other site features from the previous design that were also included in the conceptual designs and the associated cost estimates are the access road and security components, decontamination station, the material storage pad, and management of runoff from the crane pad drain pipe to the CDF. There are no significant changes from the previous design to these features but slight modifications were addressed in the conceptual designs. The other major site features are discussed briefly in the following paragraphs.

The decontamination station will be constructed for use in washing vehicles and equipment having come in contact with dredged material or other potentially contaminated material in the CDF cells. The station will be similar to a manual car wash with a high-pressure water wash wand. The station will be sized to accommodate trucks, tractor-trailers, and large equipment. Wash water will be collected in a sump beneath a steel grate. The wash water will drain by gravity to a stormwater wet well and then be pumped to the CDF. Solids will be periodically removed and placed in the CDF.

The material storage area will be constructed for use as an area to store construction and other materials. The area will be a 50-foot by 100-foot fenced gravel pad. The pad will be accessed directly from the perimeter maintenance road. The pad will be sloped so that any stormwater that comes in contact with the pad will be drained away from the perimeter maintenance road and flow overland to the canal.

The project also provides site improvements such as electrical service, water service, site grading, access roads, paving, and walks in the vicinity. Similar features elsewhere within the CDF site will be included in other design packages.

4.0 PROCESS EVALUATION AND CONCEPTUAL DESIGNS

This section presents a summary of MWH's evaluation of processes to treat the revised anticipated WWTP influent characteristics. In addition, this section provides the conceptual designs of a permanent plant that would remain onsite year round and of a treatment system comprised of mobile equipment that would be brought to the site when treatment and discharge are required and removed from the site at the end of each treatment season. This section discusses the conceptual process designs with a discussion of the site features at the end of this section. Figures 1A through 5A show the conceptual layout and process for the permanent plant. Figures 1B through 4B show the conceptual layout and process for the package plant.

4.1 Process Options Evaluation

After reviewing the revised influent parameters and the anticipated discharge limits, MWH has determined that solids/metals and ammonia are still the main concerns of the required treatment process. Several options for treatment of these constituents were preliminarily evaluated based on operation flexibility, relative cost, availability, and regulatory issues. Below is a summary of these options ranked in their order of appropriateness for this wastewater. Table 3 provides a brief summary of the process options that were evaluated.

4.1.1 Solids/Metals Removal

Chemical precipitation/clarification is still considered the most suitable process for solids/metals removal based on the influent criteria, the flexibility of operation, and the relative ease of operation. The options evaluation for the solids/metals removal involved a review of different types of physical-chemical equipment used to accomplish treatment.

1. Lamella Clarifiers – Lamella clarifiers are compact units that use inclined plates to provide the surface area needed to settle and remove flocculated materials from the water. Lamella clarifiers would be shop fabricated and delivered to the site, only requiring pipe and electrical connections and anchoring to the supports. Lamella clarifiers can be obtained with integrated flash mix and flocculation chambers, eliminating the need for the separate flash mix tank required for the flocculating clarifiers. However, these units have a limited capacity to store the sludge generated from solids/metals coagulation and require supplemental sludge storage to assure proper operation. Sludge would be pumped to the backwash holding tank or directly to the CDF to address this concern. Due to the smaller volume of water in the units, freezing may also be an issue for operations in the colder months of early spring and late fall. This could be resolved with insulation. One other common drawback of the Lamella clarifiers is that they do not have the same capacity to handle surges in the influent flow as the conventional clarifiers. However, this is not expected to be an issue in this case due to the large equalization capacity of the CDF cells, the surge tank and the control of the flow into the system. Another concern is solids buildup between

the inclined plates that could hinder and restrict settling. Solids buildup on the clarifier plates can require periodic cleaning which can be accomplished with a water jet. Since Lamella clarifiers are more compact than flocculating clarifiers, foundations, while still significant, are less substantial than for flocculating clarifiers.

2. Flocculating Clarifiers – Flocculating clarifiers were included in the previous design for solids/metals removal and would still be effective for the revised conditions. Based on the flow rate of 250 gpm, flocculating clarifiers were conceptually sized as two 34-foot diameter units with 10-foot diameter floc zones with an external flash mixer. As with the previous design, they will require more significant foundations compared to the Lamella clarifiers. Flocculating clarifiers would require field assembly that could require a significant time period to erect. The cost of the flocculating clarifiers, therefore, is expected to be appreciably higher than the cost of equivalent Lamella clarifiers.

Based on the evaluation of these options, MWH recommends that Lamella clarifiers would be the more appropriate option for the solids and metals removal.

4.1.2 Ammonia Removal

Several process options were considered for the ammonia removal. Their applicability to the revised flows and loadings is briefly summarized here along with a summary of other options that were evaluated.

1. Breakpoint Chlorination – Chlorination is a proven and widely utilized technology for ammonia removal. The previous technology evaluation indicated that breakpoint chlorination would be a viable option to treat the ammonia. In addition, breakpoint chlorination is currently being used by the interim groundwater treatment system. Chlorination, utilizing a sodium hypochlorite solution, will effectively remove the ammonia to the discharge criteria and can be flexible to handle potential increases in concentration with an adjustment in dosage. Also, the associated equipment is readily available and not very complicated. One drawback to this process is that it is chemical dependent and chemical costs will be dependent on the concentrations of ammonia in the influent, along with other constituents in the water that could also consume the chlorine. In addition, there are hazards associated with handling the required chemicals that would necessitate operator training. Also, ventilation would be required around the reaction tank to account for off-gassing of byproducts produced during the chemical reactions. Residual chlorine will need to be removed, either by chemical dechlorination (using sodium bisulfate or sodium metabisulfite (pyrosulsphite))or by GAC, as chlorine is a compound that will likely be regulated in the NPDES discharge limits, based on the IGWTP permit.
2. Ion Exchange – Ion exchange resins would remove the ammonia to the discharge limits and are readily available. In addition, higher ammonia concentrations could be handled by adding additional vessels. However, ion exchange units would create a reject stream and resin regeneration wastes or resin disposal that could require off-site disposal. Also, other compounds in the water, particularly calcium, would cause competition with the removal of the ammonia. The results of the previous treatability

study confirmed that calcium did have a preferential uptake on the resins used in the study. Specially formulated resins would be required to address this issue and could add cost to the operation of the treatment system.

3. Biological – The previous design included an activated sludge biological system (SBRs) to treat the influent ammonia concentrations to the anticipated discharge limits. Due to the relatively low anticipated influent BOD and COD concentrations, chemical addition systems (methanol and ferric chloride) were included to help maintain the biological growth and aid in solids settling. The even lower revised influent concentrations will cause these chemical requirements and costs to increase and will reduce the process efficiency and stability. Additionally, the size of biological unit will remain fairly large due to the hydraulic requirements of this type of system.
4. Air Stripping – Air stripping is a proven technology for removing ammonia from water streams. However, it is most suited for much higher ammonia concentrations. Operation of air strippers require very stringent conditions to meet the removal efficiency required in the anticipated discharge requirements. In addition, freezing would be a concern if the system were to be operated in the early spring or late fall. Also, an air permit would likely be required.
5. Aeration of the CDF Cells – One option that was considered was to utilize the CDF cells to treat the ammonia, with the goal of eliminating the need for additional process tanks and equipment. However, this would require the addition of biological material specific for ammonia removal in the CDF cells. In addition, the aerators would interfere with the settling of solids, requiring larger clarification units. The aerators could also increase the volatilization of other constituents that would be undesirable. Additional earthwork could be performed in the CDF cells that would act as biological reactors and leave the rest of the cell for solids settlement. This would add cost to the construction and would require additional design efforts for the cells. Furthermore, process control would be very limited.

Based on the evaluation of the options, MWH recommends that the most suitable process for ammonia removal is breakpoint chlorination.

4.2 Permanent Plant Conceptual Design

Based on MWH's evaluation of several process technology options to treat the dredge water waste stream, the permanent plant will include the following unit operations:

- an influent equalization/surge tank,
- chemical storage and feed systems,
- chemical precipitation and clarification,
- chlorination/dechlorination units,
- monomedia filters, and
- carbon adsorption units.

Associated piping and pumping facilities, sludge handling equipment, other electrical and mechanical equipment, instrumentation and controls are included to operate the above units as a system that achieves the required treatment objectives.

Large tanks and the Lamella clarifiers will be located outdoors, while smaller tanks, pumps, and related equipment would be housed within a weatherproof building shell. The building also will include an operator's office/control room, a small lab for sample preparation and treatability testing, an electrical room, and a restroom. The proposed layout of the WWTP building in the conceptual permanent plant design is provided in Figure 1A.

Because of the holding capacity of the CDF cells and the anticipated seasonal operation of the treatment system, the conceptual design presented herein incorporates limited redundancy and automation. In typical municipal or industrial treatment systems, redundant equipment is provided for each process and the control system is set up to automatically switch over equipment or bypass failed process to avoid any interruptions. For this proposed system however, redundancies will be limited to the clarifiers so that treatment system could still operate at a lower flow rate for hours or days as maintenance is performed on one of these units. Pumps and blowers will be provided with inline spares but they will need to be switched manually by the operator. All other instruments and equipment will be shelf spares and will require the affected process to be shutdown (or operated manually, if feasible) in order to replace the malfunctioning component.

4.2.1 Influent Surge Tank

The influent surge tank is designed for a 30 minute hydraulic retention time (HRT) at 250 gpm. This tank is meant to provide limited surge storage capacity and act as the recipient of miscellaneous ancillary flows in addition to the influent wastewater flow from the CDF cells. It also serves as the wet-well for the process feed pumps at the head of the system. The tank contents will be pumped to the Lamella clarifiers. A continuous level element/controller will control level alarms and influent pumps and send a signal to the CDF pumping system, to be designed by USACE. Coordination of the operation of the WWTP and the CDF pumping system will be required as the designs of both proceed forward.

4.2.2 Lamella Clarifiers

Water will be pumped from the influent surge tank into a flash mix tank and flocculation tank that are integrated with Lamella clarifier. Ferric chloride and sodium hydroxide will be added to the wastewater at the required dosages in the flash mix tank to precipitate metals and coagulate settleable solids. The flash mix tank will have a retention time of 3 minutes for a flow rate of 125 gpm (50% of total flow) and 2 minutes for a flow rate of 175 gpm (70% of total flow). An anionic polymer will be introduced into the flocculation tank to enhance flocculation and formation of larger settleable flocs. The flocculation tank will have a retention time of approximately 30 minutes and a slow mixing rate.

Sludge from the clarifiers will be pumped to a backwash holding tank or directly to the CDF. The holding tank will have the capacity to store two days worth of the sludge generated from the clarifiers. A small portion of sludge may need to be recycled to the flash mix tank to aid in the solids and metal removal. Sludge from the holding tank along with the sand filter and carbon tower backwash water will also be pumped back to the CDF.

As was the case for the flocculating clarifiers in the previous design, the inclined plate clarifiers will be sized so that they can handle 70% of the 250 gpm flow (175 gpm each). This will allow the system to operate near the design capacity in case that one of the clarifiers must be taken offline for servicing.

4.2.3 Breakpoint Chlorination

The other major constituent of the wastewater that needs to be treated is ammonia. The previous design utilized SBRs to biologically remove the ammonia. Review of the revised anticipated wastewater characteristics has indicated that a biological system would be difficult to maintain without a significant chemical feed system to maintain the biological growth. In addition, this type of system would be very susceptible to fluctuations in the influent concentrations. Therefore, breakpoint chlorination and dechlorination was selected to remove the ammonia to the anticipated discharge limits. Dechlorination could be achieved by chemical addition or by GAC vessels. Chemical addition was selected for this evaluation to avoid any potential regulatory issues regarding the use of the polishing GAC vessels for this purpose.

The chlorination and dechlorination system would consist of:

- Storage tanks for the chlorination and dechlorination solutions, sodium hypochlorite and sodium bisulfate or sodium metabisulfate, respectively;
- Metering pumps to control the dosage of the solutions;
- In-line static mixers to disburse the chemicals into the wastewater to facilitate chemical reaction; and
- A chlorine contact tank, baffled to provide a minimum of one minute of contact time at the design flow rate (250 gpm) for the breakpoint chlorination reaction.

Some of the active chlorine provided by the sodium hypochlorite will be consumed by residual reducing compounds present in the water. Therefore, excess sodium hypochlorite will need to be added to satisfy this demand before the breakpoint chlorination reaction can proceed. COD represents an indication of the concentration of the chlorine demand of the reducing compounds in the water. Based on the anticipated COD in the influent, the estimated sodium hypochlorite requirement will be approximately 12 lbs per pound of NH_3-N, compared to 8 lbs based on the stoichiometry of the breakpoint chlorination reaction. However, the actual dosage of sodium hypochlorite will need to be determined from field sampling during the final design phase and by process monitoring during operation of the system.

Based on the rapid rate of reaction for the dechlorination reaction, it is anticipated that the reaction can be accomplished within the piping as the wastewater is pumped to the filtration units. Thus, no reaction vessel is expected to be necessary for completing the dechlorination reaction.

If regulatory requirements allow the granular activated carbon to be moved ahead of the chlorination/dechlorination step, this may remove additional organics that could potentially consume the chemicals and increase the operating cost. Further evaluation is recommended to determine if this arrangement would be technically and financially beneficial.

4.2.4 Filtration/Granular Activated Carbon

Sand filters will remove residual suspended constituents from the clarifier effluent prior to activated carbon towers. The chlorination/dechlorination effluent will be split between two sand filters. The system will have a spare third filter that will remain idle until a backwash is initiated in one of the operating filters. It is estimated that the sand filters will need to be backwashed 2 to 3 times a day, with each backwash lasting about 20 minutes. Timers will indicate when a filter requires backwashing. The timers will be off-set so that there is no overlap in the backwash cycles. Once a sand filter (or carbon tower, as discussed below) has begun a backwash cycle, the remaining sand filters and carbon towers will not be allowed to backwash until the current cycle is completed.

Granular activated carbon (GAC) towers will be used to remove contaminants remaining in the water prior to discharge to the canal (or used as backwash supply water). Two 20,000 pound carbon adsorbers in series (with lead-lag capability) will be used. Service water and plant air will be utilized to slurry the carbon when a changeout is required. A pressure relief valve will be installed in the carbon tower influent line to prevent excessive pressure from building up in the line.

It is estimated that the carbon towers will need to be backwashed once a week or less. Timers will regulate the carbon tower backwash cycles. Differential pressure sensors/controllers will monitor the line pressure to indicate that a carbon tower has become clogged and requires a backwash prior to the scheduled backwash. The backwash effluent water will be sent to the backwash holding tank and then pumped to the CDF.

4.2.5 Effluent Holding Tank

The effluent holding tank will receive the carbon tower effluent (or the sand filter or carbon tower bypasses) prior to final discharge to the canal, water reuse for plant utilities, or recycling back to the CDF. Effluent water stored in the effluent holding tank will be used for general plant operation needs, including flushing sludge piping and backwashing the sand filters and carbon towers. Water not used for backwash or flushing would be discharged out of the effluent line to the canal.

4.2.6 Effluent Sampling

An automatic sampler will sample the effluent flow in proportion to the flow rate. The effluent will also be monitored by the operators manually for quality. If the operator monitoring or the effluent indicates a potential exceedence of the discharge limits outlined in the NPDES permit, the off-spec water will be returned to the CDF by manually activating recycle pumps. Effluent will be sent to the CDF until the cause of the non-conformance is rectified and effluent quality is back to the desired level.

4.2.7 System Utilities

It is anticipated that the utilities for the permanent plant will be electricity, natural gas for heating, potable water, sanitary sewer, and telecommunications. These utilities are discussed further in the Site Layout and Features section below. Treated effluent will be recycled and used for backwash and as service water, as appropriate.

4.3 Package Plant Conceptual Design

Three vendors who supply portable package plants were contacted to submit a proposal for the IHC treatment system. These vendors included Great Lakes Carbon, Siemens Water, and AVANTech Incorporated. The following is a summary of the systems that these three vendors provided.

The process that Great Lakes Carbon submitted included chemical precipitation/flocculation using Lamella clarifiers, bag filters, GAC, and ion exchange for ammonia removal. Discussions with Great Lakes indicated that they may also consider including chlorination/dechlorination to ensure ammonia removal. Great Lakes provided a preliminary site layout and rough costs but did not include a process flow diagram, equipment sizing or more detail on the thought process for selecting the proposed treatment process. MWH requested further information, however, Great Lakes did not provide any additional information.

Siemens Water provided information on a package plant system that included chemical precipitation/clarification using a Lamella clarifier, air stripping supplemented by sodium hypochlorite addition for ammonia removal, sand filters, and GAC. The initial indication from Siemens was that the majority of this equipment is trailer mounted. Additional information, including further description of their system operation, a process flow diagram, a general arrangement drawing, and equipment sizing was requested. However, Siemens did not provide any additional information.

AVANTech proposed a package plant system similar to the conceptual permanent plant process design, discussed above. However, AVANTech's package plant process utilizes ultra-filtration membranes to replace the chemical precipitation and clarification for the gross solids/metals removal. Also, a set of four GAC towers are utilized ahead of the chlorination/dechlorination step in order to remove organics that may consume the chemicals. Similar to the conceptual permanent plant, the AVANTech system utilizes treated water for backwashing of its components, as opposed to using potable water. However, this backwash water is maintained in the ultra-filter filtrate tank and not in the effluent tank. An effluent holding tank would still be included to store any off-spec water that would need to be pumped to the CDF.

Because AVANTech provided a detailed proposal in time to be properly evaluated, the conceptual package plant design includes the equipment layout and process flow diagram information provided by ANANTech. However, the package plant equipment layout will be dependent on the type and size of the equipment proposed by the USACE selected vendor.

4.3.1 Permanent Features

The following equipment and components are considered permanent features of the package plant system and will remain on the site all year round. These features, with the exception of the equipment pad, could also be provided by the package plant vendor. However, they were included as permanent features here because that would be the most cost effective approach over the 30 year duration of the project.

4.3.1.1 Influent Surge Tank

Similar to the conceptual permanent plant, an influent surge tank, designed for a 30 minute hydraulic retention time (HRT) at 250 gpm, will be supplied for the package system. This tank will be used to control the CDF pumping by level controls in the tank. This will eliminate the need for a new contractor to tie their equipment controls into the CDF pump controls. The tank will have a flanged effluent pipe that the package plant vendor will connect their equipment to at the beginning of each season. The package plant vendor will supply a system feed pump that will pump the inlet surge tank contents to the package treatment equipment supplied by the vendor. Because this tank would remain year round, the tank will need to be emptied at the end of each dredging season to prevent damage caused by freezing of stored water.

4.3.1.2 Effluent Holding Tank

The effluent holding tank will receive the treated effluent prior to final discharge to the canal, or recycling back to the CDF. If needed, this water could also be used for general plant operations, such as, cleaning or line flushing. This tank will also allow for some emergency storage capacity and would serve as a pump tank in the event that effluent would need to be recycled back to the CDF. This tank could also be provided by the selected vendor, although over the overall duration of the project, purchasing the tank would be less expensive. This tank may not be required based on the configuration of the selected vendor’s treatment system. However, the selected vendor would need to ensure that they have an adequate method for returning off-spec effluent to the CDF. In addition, the selected vendor would need to provide the discharge pipe or hose to the canal regardless if they provide the effluent tank or deem that the tank is not required.

4.3.1.3 Effluent Sampling

An automatic sampler will sample the effluent flow in proportion to the flow rate. The effluent will also be monitored by the operators manually for quality. If the operator monitoring or the effluent samples indicate a potential exceedence of the discharge limits outlined in the NPDES permit, the off-spec water will be returned to the CDF by manually activating the recycle pumps. Effluent would be sent to the CDF until the cause of the non-conformance is rectified and effluent quality is back to the desired level.

4.3.1.4 Work Area

All package plant equipment would be stored on a gravel or concrete equipment pad. A 50' x 75' equipment pad, based on the information provided by AVANTech, was shown in Figure 1B and utilized for the cost estimate, summarized below. Other vendors may require a larger or a smaller pad, depending on the supplied equipment or configuration. Due to the open space on the southend of the facility, the package plant vendor would have sufficient space to accommodate more equipment or a different package plant configuration. Figure 1B also indicates the total anticipated area that a package plant vendor would have to place their equipment. In addition the area for the equipment pad, there is also sufficient room surrounding the equipment pad to allow the vendor to load and unload their equipment, as needed.

4.3.1.5 Required Utilities

The proposed package plant will require electricity and potable water for the administration trailers. No sanitary sewer would be provided. Portable toilets would be used for sanitary waste.

4.4 Site Layout and Features

This section provides an overview of the conceptual design for the site civil aspects of the IHC WWTP for both the permanent and package plant alternatives. To facilitate easy comparison with the previous WWTP design, the following section is organized with the same structure as the previous Design Analysis Report, Section 4.0 Civil Design (submitted by MWH in November 2008).

4.4.1 Overview

The site layout and features are the same for the permanent and package plant designs in most cases. The discussion below will specifically call out the differences between the two designs, if there are any. In general, the main difference between the permanent and package plant is that the permanent plant will have a physical building and associated tanks and equipment, as shown on the drawings. The package plant design will include proposed limits for the treatment plant equipment and will provide a concrete or gravel pad and hook-ups for connection of the package equipment to the influent and effluent tanks.

Because the treatment plant equipment will be provided by a vendor and will vary based on the selected vendor, the equipment is not shown in any detail on the drawings.

The other main difference between the conceptual permanent and package plant designs is related to utilities. The package plant will not have sanitary sewer service but will have potable water to feed fire hydrants on the site. Portable toilets will be used to handle sanitary waste. The permanent plant will have both potable water and sanitary sewer service. A detailed description of each feature is provided below.

4.4.2 Design Assumptions

The assumptions for the conceptual designs are consistent with the previous WWTP design except where noted below. The previous design assumptions are outlined in detail in Section 4.1 of the previous Design Analysis Report.

- Overall contractor work limits for the WWTP are reduced because the overall footprint of the WWTP and associated features have decreased as compared with the previous design. Conceptual work limits have been provided on Figures 1A and 2A and Figures 1B and 2B.

- The conceptual design shall provide space for conference rooms, offices and file storage using temporary trailers. The trailers will replace the administration and maintenance buildings that were included in the previous design.

4.4.3 Description of Concepts and Features

4.4.3.1 Site Layout

The site layout for the conceptual WWTP designs is similar to the previous design with some modifications. The project consists of the WWTP with a gravel access road running along the northern boundary of the site, visitor parking at the eastern end and decontamination and material storage areas at the western end. Between the WWTP and the visitor parking lot is space for temporary trailers to house the meeting, office, and file storage space. Based on conversations with USACE, the space for temporary trailers should be at a minimum the same size as the meeting, office, and storage space that was provided in the previous design. The conceptual designs include room for two double-wide trailers 24 feet by 60 feet, a total of 2880 square feet of space. The previous design provided 1900 square feet of space. The trailer space is indicated on the drawings with rectangle denoting the exterior limits of the double-wide trailers.

The overall footprint of the WWTP building (for the conceptual permanent plant) and tanks is smaller due to changes in the process design. The layout of the tanks and building have been modified to allow for a short distance between sequential process equipment. The conceptual site layout for the permanent plant can be seen in Figures 1A and 2A.

4.4.3.2 Access Road

The access road is the same for the conceptual design as in the previous WWTP design.

4.4.3.3 Visitor Parking Lot

The size of the visitor parking lot in the previous design was based on the anticipated building use and the expected visitors to the site. USACE has decided not to include the administrative and maintenance buildings, but instead wants to utilize trailers for meeting, office, and file space. Since the overall function and expected number of visitors has not changed, the same number of parking spaces are provided in the conceptual design as were included in the previous design. The only change to the parking lot is a slight modification to the layout to coordinate better with the revised WWTP building layout. The parking lot is planned to remain asphalt and have a cross section identical to the previous design.

4.4.3.4 Maintenance Vehicle Parking and Storage

Based on conversations with USACE, there is still a need for parking space for maintenance vehicles and miscellaneous equipment within the secured site, despite the removal of the administrative and maintenance buildings. To meet this need, an area for parking and storage of maintenance vehicles has been provided inside the secured site just north of the trailer space. The size of the area is the same as was provided in the previous design. The parking area will be made of gravel to be consistent with the adjacent WWTP delivery and loading area.

4.4.3.5 WWTP Delivery and Loading Area

The conceptual design for the WWTP includes access for the delivery and loading of chemicals and equipment to the facility. Delivery and loading of materials and equipment will be accomplished by use of two 20-foot wide gravel access roads that will be provided on either side of the WWTP and allow vehicles to access the building. The access roads will connect to the existing gravel access road which runs along the southern end of the WWTP site on the south side of the existing drainage ditch. The delivery access roads will also provide a way for vehicles to turn around while inside the operation zone. Refer to the site drawing on Figures 1A and 1B for more details.

4.4.3.6 Decontamination Station and Material Storage Pad

The decontamination station and material storage pad shall remain the same in the conceptual designs as was presented in the previous design. Wash water from the decontamination station will be collected and pumped over to the CDF.

4.4.3.7 Site Security

Site security for the conceptual designs is provided in the same manner as the previous design with an 8-foot high permanent fence that will be installed around the WWTP site.

The fence will serve as the barrier between the operations zone and the public zone and will have a roller gate that will be used to control access to the site.

4.4.4 Site Drainage

Conceptual site drainage for the conceptual designs has been developed based on the same principles as the previous design with a few changes, as summarized below:

- The site development approach is to maximize overland flow of the stormwater to the E/W drainage ditch (by others) and to minimize infiltration, as this would have an impact on the operation of the Gradient Control System.
- Stormwater, in general, is considered to be clean and can be directed via overland flow to the perimeter drainage ditches with the exception of water falling on the decontamination station and the crane pad (by others).
- Drainage for the decontamination station and the crane pad shall be collected and directed to a wet well for pumping to the CDF.
- It has been assumed that the existing E/W drainage ditch (by others) has been sized to accommodate flow from the entire WWTP site.

4.4.4.1 Grading Plan

A detailed grading plan has not been developed for the conceptual designs; however, the site grades have been considered in the conceptual site civil design and are intended to meet the goals as outlined below:

- Direct stormwater away from the WWTP area and towards the E/W drainage ditch, with the exception of at the decontamination station;
- For the decontamination station, wash water and stormwater will be sent to a wet well for pumping into the CDF;
- Avoid ponding;
- Maintain the existing RCRA cap thickness for all undeveloped areas; and
- Avoid the need for storm sewer on the site.

These goals above are the same as presented for the previous design with the exception that the conceptual design has been developed with the goal of avoiding the need for a storm sewer system. A preliminary review of the site layout and existing site grades indicate that stormwater will be adequately handled via overland flow by setting the site grades to allow stormwater to be directed around the WWTP and tank foundations. Existing grade is assumed to be the same as presented in the previous design.

4.4.4.2 Wastewater Treatment Plant

The WWTP building shall be set at an elevation that allows the preservation of the existing RCRA cap thickness and allows stormwater to be directed via overland flow to the E/W drainage ditch. The conceptual design indicates that a finish floor of EL 592.5 would meet these requirements. This elevation should be revised and finalized during a detailed design phase. Roof drainage from the WWTP building will be directed to the south face of the building and then to external downspouts which will direct the stormwater toward the E/W drainage ditch (by others).

4.4.4.3 Other Areas

Drainage from the parking lot, WWTP delivery and loading area, maintenance vehicle parking and storage, and material storage pad are considered to be clean and will be directed via overland flow to the E/W drainage ditch. The design of the decontamination station will be consistent with the previous design. A trench drain will collect wash water and stormwater from the station and carry it to a wet well where it will be pumped to the CDF.

4.4.5 Storm Sewer

The conceptual site civil design takes advantage of a smaller footprint for the WWTP and associated tanks to eliminate the need for a storm sewer system to manage stormwater runoff from the site. The only remaining components from the storm sewer are the lift station that shall pump water from the decontamination station and the crane pad (by others) to the CDF. The lift station and pump size will be significantly reduced from the size included in the previous design.

4.4.6 Utilities

4.4.6.1 Potable Water

Potable water service is required for both the permanent and package plant designs. In the permanent plant, potable water is required for the WWTP building, decontamination station, and for fire protection. In the package plant design, there will not be indoor plumbing but potable water is still required for the decontamination station and fire protection. Potable water would also be needed during start-up and shut-down activities for both.

The potable water main design shall be consistent with the previous design and include a 10-inch water main that runs in the east-west direction just south of the access road. The water main is designed based on fire flow requirements set forth by the City of East Chicago Fire Department. A detailed description of the water main sizing is presented in the Design Analysis Report, Section 4.0 Civil Design 4.2.3.2 Potable Water. The water main shall connect to the City of East Chicago’s existing 16-inch water main located on the east side of Indianapolis Boulevard and extend to the location of the WWTP. A 1-inch service line shall extend west towards the decontamination station. In the case of the permanent design, a 1-inch service line shall also connect to the WWTP building.

The City of East Chicago requires fire hydrants be placed no more than 500 feet apart and at a minimum at least one fire hydrant shall be provided at the IHC site even for a package plant. The conceptual designs include two standard fire hydrants with one located on the east side of the site, just within the work limits boundary and one located outside the WWTP facility (permanent or package). The cost of a second standard fire hydrant is minimal compared with the benefit of having a redundant access to fire protection. A third ground hydrant shall also be provided at the dead-end of the water main at the decontamination station to provide an opportunity for routine flushing of the line. Routine flushing will minimize water quality problems typical of dead-end mains.

4.4.6.2 Sanitary Sewer

Sanitary sewer service shall be provided for the permanent plant design only. The package plant shall have portable washroom facilities and will not need sanitary sewer service. Sanitary sewer design for the permanent plant design is consistent with the previous design. The small sanitary sewer flows combined with the long distance from the project site to the existing sanitary sewer manhole at Indianapolis Boulevard and Riley Road make it difficult to use a conventional gravity sewer to convey wastewater to the City of East Chicago's system. A lift station and force main are needed to carry the sanitary sewer from the WWTP building to the City of East Chicago's sewer system. Sewer flows are anticipated to be significantly lower than in the previous design because the shower and locker room facilities as included in the administrative building are no longer included in the design. The lift station and force main shall be designed to handle flows from one restroom facility and a small laboratory.

4.4.6.3 Other Utilities

Electricity and telephone will be required for the permanent and package plant designs. In addition, the permanent plant will also require natural gas for heating. The design approach to these utilities is consistent with the previous design and will be similar to what was included in the previous design. The electrical and natural gas service, however, will need to be re-sized based on the final design selected and necessary loads.

4.5 Foundation Design

The foundation design for the previous WWTP design was controlled by three main factors. The first controlling factor was the existing subsurface conditions on the project site. The presence of numerous buried obstructions and abandoned utilities on the site required extensive excavation and replacement of existing fill prior to construction of the foundations. The second controlling factor was the large weight of many of the tanks that required deep foundations. The third factor controlling the foundation design was the small settlement tolerances that are allowed for the design. The combination of these factors resulted in foundations that were significant in terms of depth and composition. In addition, piles were included for most of the tank foundations in the previous design.

The existing site conditions have not changed and will still require the excavation and replacement of existing unsuitable fill with suitable material. However, a preliminary foundation analysis performed by MWH as part of this evaluation indicates that the excavation may be closer to four feet below ground surface (bgs) in depth as opposed to the six feet bgs estimated for the previous design. Further analysis during the next phase of design would need to be done to determine the actual depth of excavation. The small settlement tolerances are anticipated to be the same for the conceptual permanent plant design as they were for the previous design and would need to be accounted for in the excavation and fill evaluation.

The weights of the tanks have decreased because the size of the tanks decreased with the changes in the process design. As a result, the tank foundations will be required to carry a lower load. The preliminary foundation analysis has indicated that piles are not required to handle the loads of the tanks in the conceptual designs and that 2 foot thick concrete slabs may be sufficient.

The WWTP building has also decreased in size and the conceptual design includes a lighter, pre-engineered steel building. Because the actual weight of a pre-engineered steel building for this application is not known, the analysis assumed that the new building would weigh 75% of the WWTP building weight from the previous design. For this reason, the foundation of the WWTP building will also be less sizable. The preliminary analysis indicated that 2 foot wide footings placed 3 to 4 feet bgs should handle the building weight. The building slab could be 1 foot thick, with the tank slabs being 2 foot thick and isolated from the building slab.

Based on information provided by the package plant vendor, it is anticipated that the package plant equipment could have a loading of less than 1000 pounds per square foot. This loading would not require a foundation. However, mat foundations to distribute the load or compacted gravel or a small concrete pad would likely be sufficient to handle the equipment.

The results of the preliminary foundation analysis were based on preliminary equipment sizes and a number of assumptions. Actual equipment sizing and weights would need to be used to verify or modify this preliminary analysis during the next phase of design. This would confirm the assumptions that were used for the preliminary analysis.

5.0 COST ESTIMATE

This section presents MWH's Opinion of Probable Construction Cost (OPCC) prepared for the conceptual permanent plant and conceptual package plant designs. The OPCC for both designs include both anticipated capital costs and anticipated operation and maintenance (O&M) costs. The OPCC was prepared to the Association for the Advancement of Cost Engineering (AACE) Industry Standards for a Class 4 estimate (ANSI Standard Reference Z94.2-1989 Order of Magnitude Estimate) and is intended to be an order of magnitude cost for each plant design. Class 4 costs are customarily prepared for evaluation of feasibility of available options during the conceptual phase of the project. These costs are based on conceptual designs of various options and do not incorporate the additional knowledge and refinements developed during the detailed engineering and design phases that follow. The expected accuracy range variations of this Class 4 OPCC are as follows: low is -15% to -30% and high is +20% to +50%.

MWH has no control over costs of labor, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or other factors likely to affect the probable cost of the construction, all of which are and will unavoidably remain in a state of change, especially in light of the high volatility of the market. The OPCC is a "snapshot in time" and the reliability of this engineering opinion of probable construction cost will inherently degrade over time. Proposals, bids, project construction costs, or cost of operation or maintenance will likely vary substantially from this good faith Class 4 cost estimate.

5.1 General Assumptions

The following is a list of general assumptions that were made in the preparation of the OPCC.

- The processes, equipment type, equipment sizes, site features, etc. included in the cost estimates are conceptual. Further design of whichever system is selected may result in modification to the process, selection of different equipment types and/or sizes, or modification of the site features.
- The electrical service delivered to the site is capable of providing the required power (both in current and voltage), with all transformers, equipment, and gear greater than 480 VAC being supplied and installed by others.
- An overexcavation of 4'-0" and engineered backfill was included in both design approaches, along with the anticipation of encountering obstructions/refuse, but not requiring consideration for shoring, excessive groundwater, deep foundations, hazardous materials or remediation. The actual overexcavation depth will need to be determined in the next phase of design.
- The foundations for the buildings and tanks do not require piles.
- All buy-out equipment costs were derived from an MWH equipment database, either by selection or extrapolation of similar items.

- All skidded equipment packages are anticipated to be pre-piped/pre-valved and pre-wired/pre-switched by the manufacturer to the maximum extent possible.
- All pumps will be located in the WWTP building and will not require weatherproofing.
- No piping or tanks will be insulated or heat traced for winterization. Only the caustic system and a bare minimum of water stub-ups will be insulated and heat traced.
- For all process and chemical pumps and blowers, in-line spares have been provided in the event of failure of the primary equipment. However, switch over between equipment will be done manually.
- The operating period used for the cost estimates was 6 months and a total annual treatment volume of approximately 61 million gallons. The precipitation data provided by USACE indicated that the average volume would approximately 25 million gallons. The 61 million gallons represents the 99th percentile of anticipated annual precipitation. This higher volume was used as it was more conservative and provided cost estimates on the upper end of what could be incurred.
- The permanent treatment system plant building has a bridge hoist system.
- Both designs have a truck unloading pad. The truck unloading pad for the permanent system has containment and a coating to handle any spills of bulk chemicals that are brought to the site.
- The life cycle costs over a 30 year period were estimated on an inflation rate of 1.5% and an escalation rate of 3.5%. The net present value (NPV) was estimated based on a discount rate of 4%.
- With this class of OPCC, a 20% scope/design contingency was included with the intent of providing coverage for any potential omissions or unforeseen conditions or requirements.

5.2 Permanent Plant Conceptual Design Cost Estimate

5.2.1 Capital Costs

The capital costs for the permanent plant were broken down into the following categories: site development; concrete (with overexcavation); miscellaneous metals; chemical area concrete coatings; WWTP building and interior structures; field-erected steel tanks; process flow system (installed with pipe and electrical); chemical systems (installed with pipe and electrical); truck decontamination station; sanitary pump station system; and power distribution and process control equipment. Table 4 includes a brief summary of what is included in the capital cost. Site development includes excavating the work areas to a depth of four feet and replacing with suitable fill, the gravel pads for the Material Storage Pad and the office trailers, gravel roads, fencing, survey and soil testing, site grading, and landscaping.

Concrete work includes building slabs and tank slabs, sidewalks, chemical tank containment walls, and sumps. Metal work includes miscellaneous features including platforms, walkways, stairs, ladders, and gratings/coverplates. Coatings includes the application of a chemical resistant coating to the WWTP floor, the chemical storage area, the truck offload area, and all sumps. WWTP building and interior structures includes the pre-engineered metal building, the interior rooms, lighting, ventilation, and fire protection. Field-erected tanks includes the purchase and construction of the backwash holding tank and the effluent holding tank and all associated appurtenances. The influent surge tank will be a pre-fabricated fiberglass reinforced plastic (FRP) tank due to its size.

Process flow system includes the process pumps and instrumentation, including the installation of all appropriate piping and electrical connections. The chemical system includes the chemical storage tanks and pumps in addition to all associated appurtenances, piping, and electrical connections. The truck decontamination station includes the foundations, pumping system, and associated appurtenances. Power distribution and process control equipment includes the electrical power and control wiring purchase and installation.

Table 5 summarizes the capital cost for the conceptual permanent plant. The total capital cost for this system is $8,772,863.

5.2.2 Operation and Maintenance Costs

In addition to estimating the anticipated capital cost for purchase and installation of equipment, MWH also estimated the cost for operating and maintaining the system over a 30 year period. The operation and maintenance costs includes labor, repair and maintenance of the equipment and facilities, chemical and material usage, and electrical usage. Table 4 includes a brief summary of what is included in the O&M cost.

The labor cost assumed that the WWTP would be manned for a shift and a half (12 hours), 7 days a week. During the other shift and a half, the operator would be alerted remotely to any issues with the system requiring immediate attention. The labor cost estimate also included time for supervisory labor and administration labor. Chemical usage costs were estimated based on the anticipated dosing rates to treat the revised influent characteristics at the revised flow rate. Electrical usage costs were based on $0.08/kWhr.

Table 6 summarizes the operating and maintenance costs for the conceptual permanent plant. The total net present value (NPV) cost for operation and maintenance is $18,634,070. Including a 20% contingency, the total NPV cost for the conceptual permanent plant is $32,888,320.

5.3 Package Plant Conceptual Design Cost Estimate

5.3.1 Capital Costs

The capital costs for the package plant were broken down into the following categories: site development; concrete (with overexcavation); miscellaneous metals; chemical area concrete coatings; WWTP slab area; field-erected steel tanks; process flow system (installed with pipe and electrical); truck decontamination station; and power distribution and process control equipment. Table 4 includes a brief summary of what is included in the capital cost. Site development includes excavating the work areas to a depth of four feet and replacing with suitable fill, the gravel pads for the Material Storage Pad and the office trailers, gravel roads, fencing, survey and soil testing, site grading, and landscaping.

Concrete work includes building slabs and tank slabs, sidewalks, and sumps. Metal work includes miscellaneous features including platforms, walkways, stairs, ladders, and gratings/coverplates. Coatings includes the application of a chemical resistant coating to the WWTP slab. The WWTP slab area includes the equipment pad and associated sump. Field-erected tanks included the purchase and construction of the effluent holding tank and all associated appurtenances. The influent surge tank will be a pre-fabricated FRP tank due to its size.

Process flow system includes the process effluent recycle pumps and control instrumentation associated with the influent surge and effluent holding tanks, including the installation of all appropriate piping, pipe stubs, and electrical connections. The truck decontamination station includes the foundations, pumping system, and associated appurtenances. Power distribution and process control equipment includes the electrical power and control wiring purchase and installation.

Table 7 summarizes the capital costs for the conceptual package plant. The total capital cost for this system is $2,900,726.

5.3.2 Operation and Maintenance Costs

In addition to estimating the anticipated capital cost for purchase of equipment and the construction, MWH also estimated the cost for operating package system and maintaining the site features over a 30 year period. The operation and maintenance costs included the mobilization/demobilization costs, labor rates, monthly equipment rental rates, and chemical/material usage rate as provided by AVANTech, Inc. As noted previously, AVANTech provided the most comprehensive information, therefore, their cost information was used to estimate the O&M costs. Table 4 includes a brief summary of what is included in the O&M cost.

In addition, electrical usage is based on electrical load information provided by AVANTech. AVANTech indicated that their monthly equipment rental rate of $17,450 would be applied on an annual basis, whether the equipment was onsite or not. This would allow the equipment to be dedicated to the project and available each year at the beginning of the operating period.

Table 8 summarizes the operation and maintenance costs for the conceptual package plant. The total NPV cost for operation and maintenance is $28,195,463. Including a 20% contingency, the total NPV cost for the conceptual package plant is $37,315,427. The cost provided by the equipment vendors likely includes some contingency based on the unknowns in the anticipated influent data. Once more accurate data is compiled on the dredge water concentrations and annual treatment volumes, the accuracy of costs provided by vendors will also become more accurate.

6.0 APPROACH TO DESIGN ALTERNATIVE SELECTION

This section presents the outcome of the Alternatives Evaluation Workshop. This workshop was held to review the conceptual designs and their associated cost estimates and to evaluate which design was the most appropriate. This evaluation was based on selected criteria and the relative weighting of these criteria for each design, determined by USACE.

6.1 Summary of Evaluation Process

A systematic process was used to evaluate the conceptual designs and help USACE in making a decision on which design concept was the most beneficial. The process has the following components:

a. Review designs
Review the conceptual designs and known assumptions and limitations

b. Establish evaluation criteria
Review evaluation criteria developed by MWH based on the Scope of Work and discussions with USACE. The set of criteria were intended to represent the major issues that USACE would like to consider in the evaluation of the permanent and package plant designs.

c. Develop tradeoff weights
The tradeoff weights are the values assigned to each of the criteria which illustrate its level of importance in the overall process of selecting an alternative. The term “trade-off” is used because the weights reveal the relative trade-off the decision team is willing to make between paired alternatives and the level of importance of one criterion over another.

d. Score designs
The permanent and package plant options were assigned a score on a scale of 1 - 10 with 1 being less favorable and 10 being the most favorable score. A process was used to take the metrics for each criterion, such as cost, number of days or relative scale (low to high) and assign these to a score of 1-10.

e. Review results
A final result was generated for each option by taking the score of each criteria and multiplying it by the tradeoff weight developed for that criteria. The scores from each criterion for one design was added together for a final score.

f. Refine weights and scores as necessary
The group should then review the final outcome to determine if it passes the "gut" test. Weights and scores can be refined to ensure the result is one that the group is confident with.

g. Final decision on selected design
Confirm the final design to proceed with.

A detailed review of the above process conducted during the workshop follows.

6.2 Review and Evaluation of Conceptual Permanent and Package Plant Designs

The workshop group proceeded to use the process described above to evaluate the two designs with the goal of determining which option USACE would utilize to treat the CDF water. The workshop group consisted of Dave Wethington, Jay Semmler, Richard Saichek, Le Thai, Jennifer Miller, Joe Schulenberg, Lisa Chavel, Damian Allen, Leslie Bowles, and Satch Damaraju from USACE. From MWH, Catherine Hurley, Khalid Nazeer, Jon Pohl, and Katelyn Zollos participated in the workshop.

6.2.1 Review Designs

MWH reviewed the conceptual permanent and package plant designs.

6.2.2 Review and Establish Evaluation Criteria

MWH provided a table summarizing the design criteria and providing some details on how each criteria relate to the permanent and package designs. That table is provided as Table 9 of this report.

Based on the discussion, the workshop group decided to combine anticipated schedule and availability of service into one criteria. Operational control was also dropped as it was considered by the group to be included in criteria already listed (operational flexibility). It was also decided that effectiveness of treatment and regulatory would not be evaluated for each design. These criteria are considered to be design criteria and each of the two conceptual designs already meet these requirements. The final list of criteria used in the evaluation is as follows.

- Capital Cost
- O&M Cost
- Anticipated Schedule / Availability of Service
- Implementability (i.e. Contracting)
- Operational Flexibility
- Potential Risks

6.2.3 Develop Tradeoff Weights

USACE personnel met as a group prior to the workshop and assigned the tradeoff weights based on their review of the project evaluation criteria. Using the phrasing: **"Criteria A is ____________ important than Criteria B",** a score from the Scoring Table was selected and input the Tradeoff Weights Table. For example, "Capital Cost (A) is <u>slightly more</u> important than O&M Cost (B)", therefore, a score of "3" was input as shown below. The resulting tradeoff weights based on the USACE discussions before and during the workshop were input into the tool and are summarized below. The total tradeoff weight assigned to each criterion is based on the geometric mean of individual tradeoff weights. The geometric mean is utilized to average ratios.

Tradeoff Weights

Project Evaluation Criteria		A	B	C	D	E	F	Weight
Capital Cost	A	1	3	3	1	1/5	1/3	0.92
O&M Cost	B	1/3	1	1/3	1/3	1/5	1/3	0.37
Anticipated Schedule / Availability of Service	C	1/3	3	1	1/3	1/3	1	0.69
Implentability (i.e. Contracting)	D	1	3	3	1	1/3	1	1.20
Operational Flexibility	E	5	5	3	3	1	3	2.96
Potential Risks	F	3	3	1	1	1/3	1	1.20

Scoring Table

Evaluation	**Score**	**Evaluation**	**Score**
Extremely more	9	Slightly less	1/3
Much more	7	Moderately less	1/5
Moderately more	5	Much less	1/7
Slightly more	3	Extremely less	1/9
Equally	1		

The criterion most important to USACE is operational flexibility and this importance is reflected in a tradeoff weight of 2.96. Flexibility is an important issue because there are so many unknowns with respect to the wastewater characteristics and flow rate that will need to be treated. Contracting and potential risks are tied for the second most important criteria with capital cost as the next most important criteria.

6.2.4 Score Designs

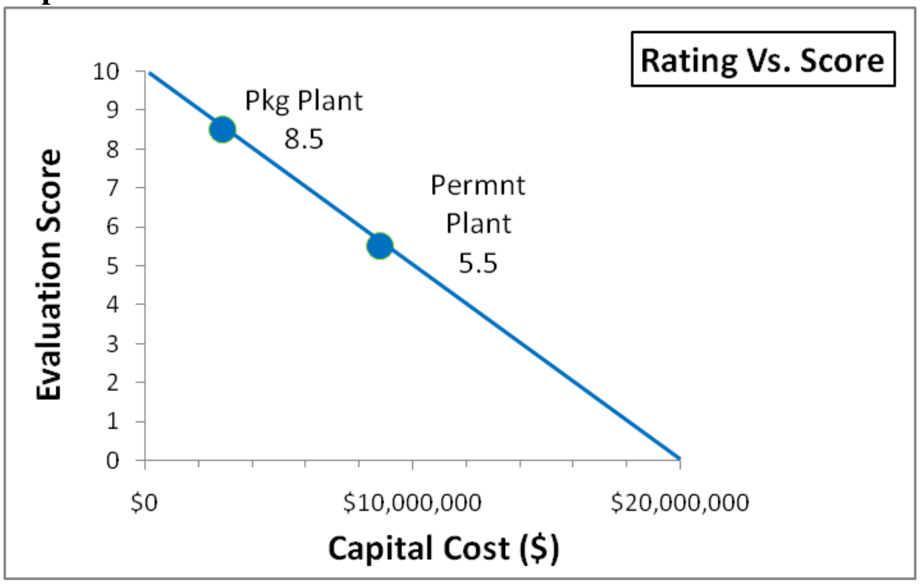
The workshop group evaluated each design and used simple charts to relate the evaluation criteria metric rating to an evaluation score of 1 – 10 with 1 being less favorable and a

10 being most favorable. The results of the scoring process are provided in the following tables and graphs. The graphical representations of each criteria are also provided.

Conceptual Permanent Plant Design				
Criteria	**Project Evaluation Criteria**	**Rating**	**Units**	**Evaluation Score**
A	Capital Cost	$8,772,863	Dollars	5.5
B	O&M Cost	$18,634,070	Dollars	5.5
C	Availability of Service / Anticipated Schedule	280	Days to Construct	6
D	Contracting (i.e. Implentability)	5	Relative Scale	5
E	Operational Flexibility	7	Relative Scale	3
F	Potential Risks	6	Relative Scale	4

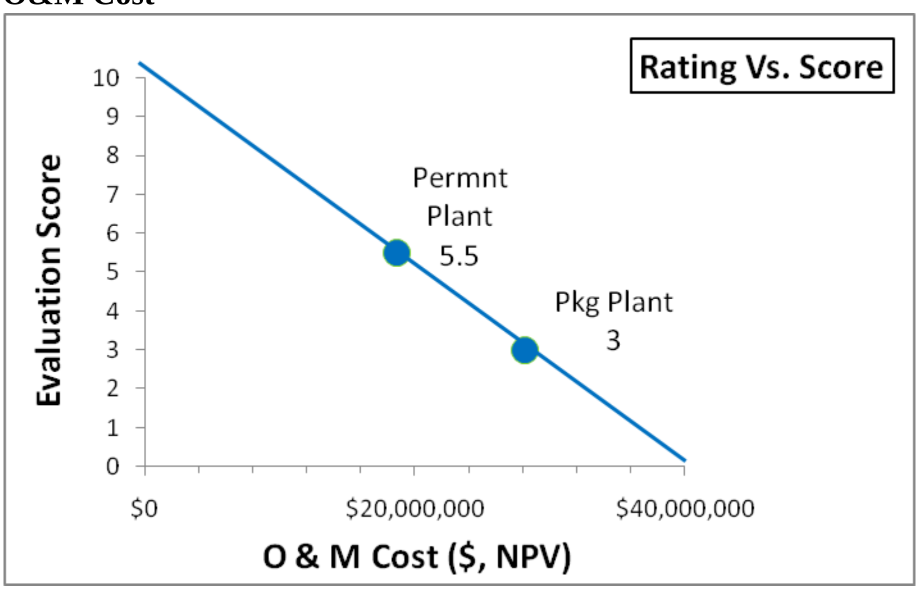
Conceptual Package Plant Design				
Criteria	**Project Evaluation Criteria**	**Rating**	**Units**	**Evaluation Score**
A	Capital Cost	$2,900,726	Dollars	8.5
B	O&M Cost	$28,195,463	Dollars	3
C	Availability of Service/Anticipated Schedule	217	Days to Construct	7
D	Contracting (i.e. Implentability)	7	Relative Scale	3
E	Operational Flexibility	5	Relative Scale	5
F	Potential Risks	6	Relative Scale	4

Capital Cost



The capital costs from the OPCC was used for this criteria. The maximum value on the horizontal scale was selected to be $20,000,000 because this number was determined to be a realistic upper limit used for planning purposes based on the cost of the previous design. A linear relationship was used to map the capital cost to an evaluation score of 1 to 10. The design that receives the higher evaluation score is more favorable.

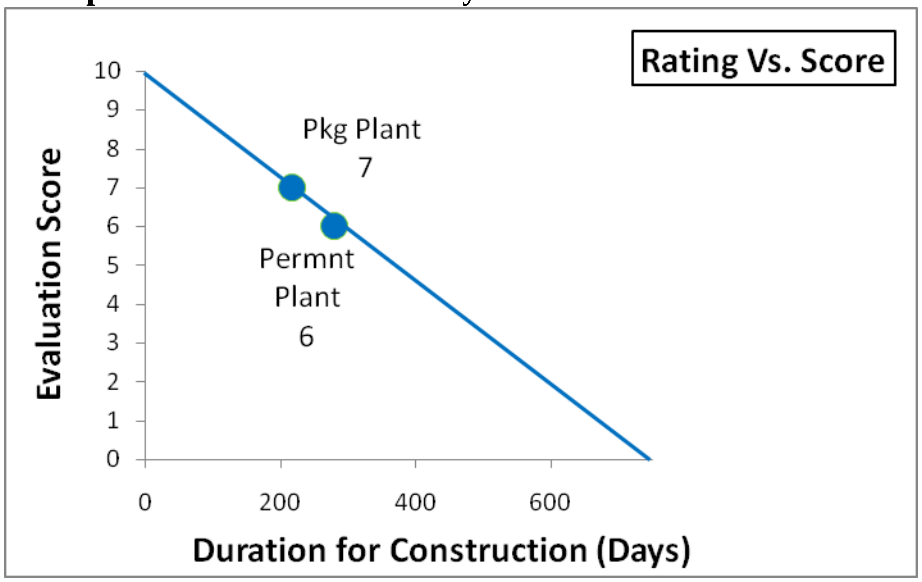
O&M Cost



The O&M costs from the OPCC were used for this criteria. The maximum value on the horizontal scale was selected to be $40,000,000 because this number was determined to be $10,000,000 (the difference between the two O&M costs) above the highest of the O&M

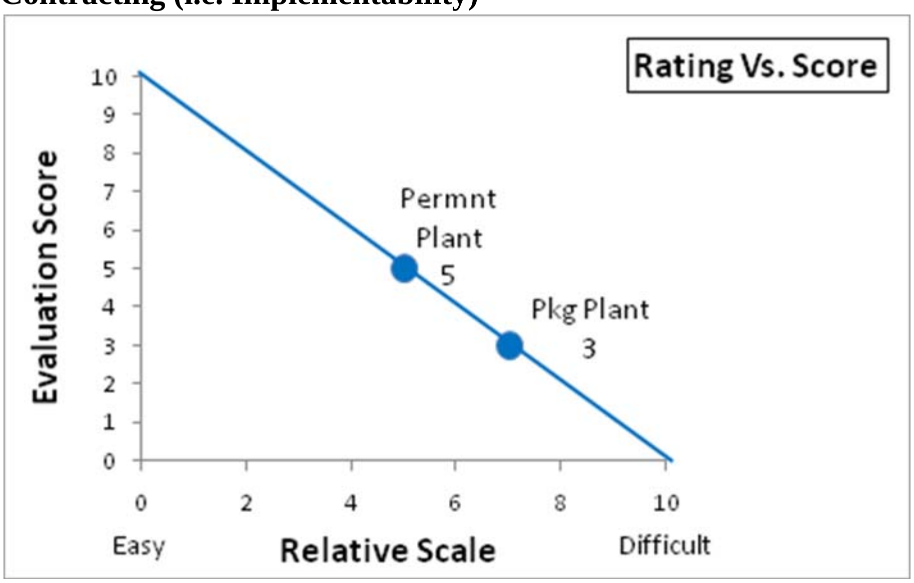
costs. A linear relationship was used to map the O&M cost to an evaluation score of 1 to 10. The design that receives the higher evaluation score is more favorable.

Anticipated Schedule / Availability of Service



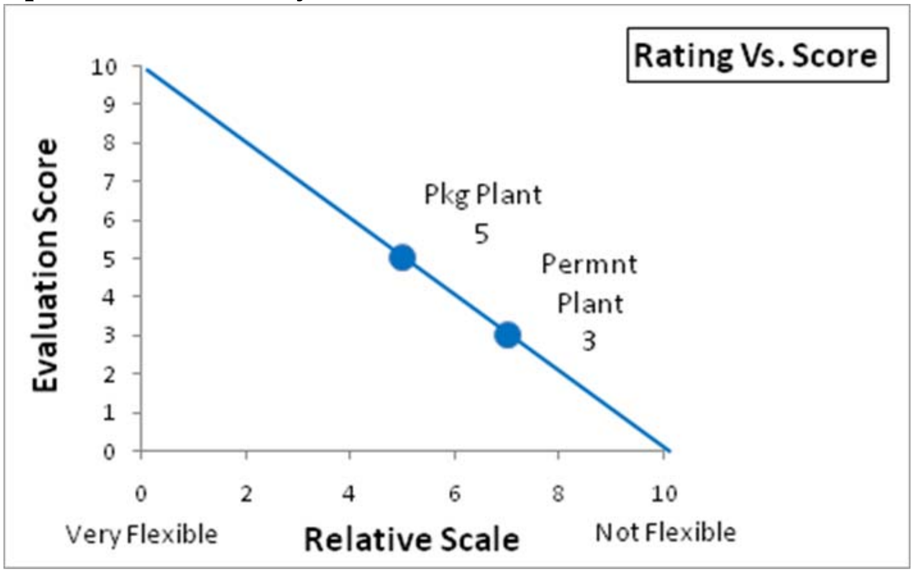
The number of estimated days to construct each option was selected as the metric for this criteria. The maximum value on the horizontal scale was chosen to be 700 days which was the planned construction schedule for the previous design. A linear relationship was used to map the construction duration to an evaluation score of 1 to 10. The design that receives the higher evaluation score is more favorable.

Contracting (i.e. Implementability)



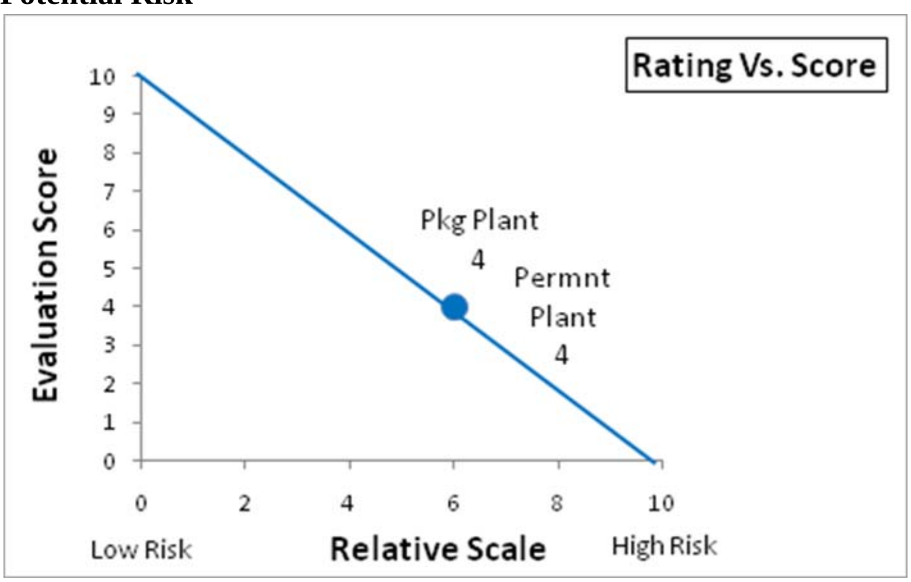
Contracting (or implementability of a contract) was measured using a relative scale of 1 to 10 with 1 being easy to implement and 10 being difficult to implement. A linear relationship was used to map the relative scale of ease of contracting to an evaluation score of 1 to 10. The design that receives the higher evaluation score is more favorable.

Operational Flexibility



Operational flexibility was measured using a relative scale of 1 to 10 with 1 being very flexible and 10 being not flexible. A linear relationship was used to map the relative flexibility of operation to an evaluation score of 1 to 10. The design that receives the higher evaluation score is more favorable.

Potential Risk



Potential risk was measured using a relative scale of 1 to 10 with 1 being low risk and 10 being high risk. A linear relationship was used to map the relative risk of each design to an evaluation score of 1 to 10. The design that receives the higher evaluation score is more favorable.

Applying the tradeoff weights to the evaluation scores for each criteria, a final score for each conceptual design was developed. The results are shown in the table below:

Final Scoring							
	Capital Cost	**O&M Cost**	**Anticipated Schedule/Availability of Service**	**Contracting**	**Operational Flexibility**	**Potential Risk**	**Sum**
Permanent Plant	5.1	2.0	4.2	6.0	8.9	4.8	30.9
Package Plant	7.8	1.1	4.9	3.6	14.8	4.8	37.0
Total Available Points	9.2	3.7	6.9	12.0	29.6	12.0	73.4

The results of the final evaluation show that the package plant received a higher score than the permanent plant by 6.1 points. However, compared to the total number of possible points, the permanent and package plants received a 42% and 50%, respectively. The total points are based on the assumption that each criterion would achieve a score of 10. The results show that while the package plant received a higher score, the permanent plant could still be a viable option.

6.2.5 Refine Weights and Scores/Final Decision

The results from the process described above are similar to what USACE had in mind prior to the workshop; however, the point totals for each design were closer than initially anticipated by members of the workshop group. USACE personnel anticipated that the results would more clearly point to the package plant as the more favorable option. However, after discussion at the workshop on risks, flexibility, and contracting, it was realized that both options have similar issues in many of the evaluation criteria. The group decided not to go back and make any refinements in the scoring and USACE team determined that the final decision is to move forward with the package plant option.

7.0 PATH FORWARD AND ANTICIPATED SCHEDULE

The primary outcome of the Alternatives Evaluation Workshop, was USACE's decision to select a package wastewater treatment system to treat ponded water in the CDF cells. The primary advantage of the package system is that it has an increased operational flexibility compared to the permanent plant, which was determined to be the most important criterion. Based on discussion with USACE during the alternatives evaluation workshop, MWH recommends completing the design and construction of the south end features in two phases. The first phase would be to design and construct the necessary site features and the second phase would be to develop a performance-based specification for the vendor-supplied package treatment system and its operation. Prior to preparing any design documents or bid packages, MWH believes that it would be beneficial for USACE to engage IDEM with the planned path forward to determine if there would be any regulatory issues that should be addressed. The following summary of the anticipated path forward and schedule is based on the assumption that IDEM will not have any issue with USACE storing dredge water while the characteristics are being further assessed.

7.1 Site Civil Features

The site features would include the decontamination station, material storage pad, access roads, parking area, site fencing, site lighting, potable water supply, maintenance vehicle parking and storage pad, and gravel pad for the administrative trailers. These features, for the most part, would be common to both designs and would not be affected by upgrading to a permanent system in the future. The previous design included detailed designs of these site features along with construction specifications. Therefore, it is anticipated that the details and specifications from the previous submittal could be utilized to prepare the construction package. However, modification to the details and specifications will be required to account for the changes resulting from the revised CDF operation.

7.2 Process Site Features

The features that are dependent on the type of system are the WWTP pad and tanks along with the associated pads. The WWTP pad for a permanent system would be sized to hold a pre-engineered building, sand filters, granular activated carbon, chemical storage tanks, interior rooms, electrical and control equipment, and other equipment and appurtenances. Piping would be run underneath this pad. Therefore, the concrete would need to be more robust than the pad for the package equipment that would only store process equipment. In addition, penetrations for pipes would need to be laid out. The pad for the package plant would only need to be sized for the vendor's equipment. The package plant interconnections would be accomplished with temporary piping or hose that would run on top of the pad, eliminating the need for penetrations.

USACE has indicated that the site features should be designed such that they could also accommodate a permanent system if that was determined to be a more suitable option in the future. All site features will be able to accommodate the future use of a permanent system, if deemed appropriate, with the exception of the WWTP pad and tank pads. MWH recommends providing a compacted gravel pad, similar to the pad for the interim groundwater treatment plant. This gravel pad could be used for the package equipment for the initial operation. If USACE then decided to utilize a permanent system that would involve burying pipes below the slab, a concrete pad would not need to be removed to install piping.

The tank pads are also dependent on the type of system used are the tanks, in particular the effluent holding tank. The effluent holding tank for the permanent plant was sized to provide backwash water to the sand filters and carbon towers. For the package system, AVANTech's information used for this evaluation indicated that their backwash water would be supplied by one of their interim process tanks. Therefore, the effluent holding tank would not need to be as large. However, other vendors may require a water source for backwashes or other plant operations. In addition, an effluent holding tank would be beneficial as it serves as a pump tank for effluent pumping in the event that the effluent did not meet the discharge limits and would need to be recycled back to the CDF. Further design of the influent surge tank, the effluent holding tank, and any other tanks that may be part of the permanent site features (i.e. if a backwash tank is determined to be required) will need to be performed. In addition, design of the associated tank foundations will also need to be performed.

7.3 Performance-Based Specifications

During the alternatives evaluation workshop, there was significant discussion regarding the unknowns associated with the anticipated system influent characteristics. The anticipated influent characteristics that were utilized for the conceptual designs were based on gross assumptions of the effect of extending the holding time of the dredge water. It was recognized that the treatment system may be either oversized or undersized for various constituents requiring treatment, depending on variations in the climatic conditions (rainfall and evaporation) as well as the nature of the dredged material. Because of the large volume capacity of the CDF cells, particularly in the first several years of operation, USACE determined that it would be beneficial to store the first year to two years of dredge water before treating and discharging the water. This would allow USACE to collect further data on the water quality characteristics that the package system will need to treat. In addition, more information could be collected on the actual water volumes that will be generated each year.

Therefore, MWH recommends that during a second phase of work, a performance-based specification package be prepared for the package plant based on the current understanding of the influent characteristics and volumes. MWH suggests that this package should be completed but not be put out to bid until after dredging has begun and further data have been collected. At that point, the package would have more current influent characteristics and any revisions those characteristics might have on the treatment requirements. However, this package could be prepared using the current data and the contract and/or permit could be revised with the more current data. According to USACE, the existing NPDES permit is up for renewal in 2011. It has been indicated that the discharge of treated dredge water will be included in this permit revision.

7.4 Anticipated Schedule

An anticipated schedule for these steps is detailed below.

- Present planned path forward to IDEM for regulatory input – 4^{th} Quarter 2009

First Phase

- Finalize water balance and dam safety analysis (by USACE) – 1^{st} Quarter 2010
- Modify design of site features – 1^{st} Quarter– 2^{nd} Quarter 2010
- Prepare bid package, advertise and award contract – 2^{nd} Quarter – 3^{rd} Quarter 2010
- Construct site features – 2^{nd} Quarter – 4^{th} Quarter 2011

Second Phase

- Prepare performance-based specifications – 1^{st} Quarter 2010
- Collect CDF collected water samples – 3^{rd} Quarter 2011 and 1^{st} Quarter 2012
- Prepare bid package for package plant – 2^{nd} Quarter – 3^{rd} Quarter 2012
- Select package plant contractor – 4^{th} Quarter 2012
- Begin operating package plant – 2^{nd} Quarter 2013

This schedule is preliminary based on MWH's current understanding of the project. This schedule is subject to change based on input from USACE, contractors, and any unforeseen conditions.

If IDEM is not agreeable to USACE storing dredge water in the CDF cells while the characteristics are being assessed, the recommended approach outlined in this report and the anticipated schedule will need to be re-evaluated.

TABLES

Table 1
Estimated IHC CDF WWTP Influent Concentration Ranges
Indiana Harbor and Canal
East Chicago, Indiana

Analyte Name		Previous Estimated WWTP Influent Conc.[1]	Revised Estimated WWTP Influent Conc. (Avg.)[2]	Revised Estimated WWTP Influent Conc. (Max.)[2]
General Chemsitry (mg/L)				
Color, color unit	color unit	150	**120**	**120**
pH, pH unit	pH unit	7.93	**7.9**	**7.9**
Total Volatile Solids	mg/L	280	**2.8**	**6.3**
Total Dissolved Solids	mg/L	220	**176**	**398**
Total Suspended Solids	mg/L	180	**1.8**	**30**
Bromide	mg/L	0.28	**0.2**	**0.4**
Chloride (As Cl)	mg/L	10 U	**8**	**18**
Fluoride	mg/L	1	**0.8**	**2**
Nitrogen, Nitrate (As N)	mg/L	0.015 U	**16**	**36**
Nitrogen, Nitrite (As N)	mg/L	0.015 U	**55**	**124**
Nitrogen, Ammonia (As N)	mg/L	81	**8.1**	**16.2**
Sulfate (As SO4)	mg/L	5.9	**4.7**	**11**
Cyanide, Amenable To Chlorination	mg/L	0.017	**0.002**	**0.004**
Phosphorus, Total (As P)	mg/L	0.82	**0.4**	**0.9**
Sulfide	mg/L	0.1 U	**0.001**	**0.002**
Sulfite (As SO_3)	mg/L	2 U	**0.020**	**0.045**
Biologic Oxygen Demand	mg/L	12 J	**1.2**	**2.7**
Carbonaceous Biochemical Oxygen Demand	mg/L	9.6	**1.0**	**2.2**
COD - Chemical Oxygen Demand	mg/L	110	**33**	**74.5**
Oil & Grease	mg/L	18	**1.8**	**2.9**
Total Organic Carbon	mg/L	38	**11.4**	**22.0**
Surfactants	mg/L	0.12	**0.01**	**0.03**
Hardness (As $CaCO_3$)	mg/L	150	**120**	**192**
Metals (µg/L)				
Aluminum	ug/L	2000	**400**	**1280**
Antimony	ug/L	9.5 U	**7.6**	**30.4**
Arsenic	ug/L	16	**12.8**	**40.96**
Barium	ug/L	55	**44**	**140.8**
Beryllium	ug/L	0.95 U	**0.76**	**2.43**
Boron	ug/L	130	**104**	**332.8**
Cadmium	ug/L	1.1	**0.88**	**2.82**
Chromium	ug/L	59	**47.2**	**151.04**
Chromium, III	ug/L	59	**47.2**	**151.04**
Chromium, VI	ug/L	5 U	**4**	**12.8**
Cobalt	ug/L	6.4 U	**5.12**	**16.38**
Copper	ug/L	48	**38.4**	**122.88**
Iron	ug/L	17000	**13600**	**43520**
Lead	ug/L	150	**120**	**384**
Magnesium	ug/L	17000	**13600**	**43520**
Manganese	ug/L	260	**208**	**665.60**
Mercury	ug/L	0.17	**0.085**	**0.27**
Molybdenum	ug/L	19	**15.2**	**48.64**

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Analyte Name		Previous Estimated WWTP Influent Conc.[1]	Revised Estimated WWTP Influent Conc. (Avg.)[2]	Revised Estimated WWTP Influent Conc. (Max.)[2]
Metals (µg/L) (continued)				
Nickel	ug/L	18	**14.4**	**46.08**
Selenium	ug/L	6.4 U	**5.12**	**16.38**
Silver	ug/L	0.64 U	**0.512**	**1.64**
Strontium	ug/L	120	**96**	**307.2**
Thallium	ug/L	3.2 U	**2.56**	**8.19**
Tin	ug/L	55	**44**	**140.8**
Titanium	ug/L	41	**32.8**	**104.96**
Vanadium	ug/L	9.5 U	**7.6**	**25.6**
Zinc	ug/L	730	**584**	**1868.8**
PCBs (µg/L)				
Arochlor 1016	ug/L	0.1 U	**0.02**	**0.53**
Arochlor 1221	ug/L	0.1 U	**0.02**	**0.53**
Arochlor 1232	ug/L	0.1 U	**0.02**	**0.53**
Arochlor 1242	ug/L	0.1 U	**0.02**	**0.53**
Arochlor 1248	ug/L	0.36	**0.072**	**1.92**
Arochlor 1254	ug/L	0.1 U	**0.02**	**0.53**
Arochlor 1260	ug/L	0.1 U	**0.02**	**0.53**
Total PCBs	ug/L	0.36 J	**0.072**	**1.92**
Pesticides (µg/L)				
Aldrin	ug/L	0.05 U	**0.02**	**0.059**
alpha-BHC	ug/L	0.05 U	**0.02**	**0.03**
alpha-Endosulfan	ug/L	0.05 U	**0.02**	**0.03**
beta-BHC	ug/L	0.05 U	**0.02**	**0.03**
beta-Endosulfan	ug/L	0.05 U	**0.02**	**0.03**
Chlordane	ug/L	0.13 U	**0.052**	**0.23**
delta-BHC	ug/L	0.05 U	**0.02**	**0.03**
Dieldrin	ug/L	0.025 U	**0.01**	**0.015**
Endosulfan sulfate	ug/L	0.05 U	**0.02**	**0.03**
Endrin	ug/L	0.05 U	**0.02**	**0.03**
Endrin aldehyde	ug/L	0.05 U	**0.02**	**0.03**
Heptachlor	ug/L	0.05 U	**0.02**	**0.059**
Heptachlor epoxide	ug/L	0.05 U	**0.02**	**0.03**
Lindane	ug/L	0.05 U	**0.02**	**0.03**
Methoxychlor	ug/L	0.05 U	**0.02**	**0.03**
Mirex	ug/L	0.05 U	**0.02**	**0.03**
p,p'-DDD	ug/L	0.05 U	**0.02**	**0.03**
p,p'-DDE	ug/L	0.05 U	**0.02**	**0.03**
p,p'-DDT	ug/L	0.05 U	**0.02**	**0.03**
Toxaphene	ug/L	2.5 U	**1**	**1.5**
PAHs (µg/L)				
2-Methylnaphthalene	ug/L	5 U	**1**	**16.69**
Acenaphthene	ug/L	5 U	**1**	**16.69**
Acenaphthylene	ug/L	5 UJ	**1**	**16.69**
Anthracene	ug/L	1 UJ	**0.2**	**12.28**
Benzo(a)anthracene	ug/L	0.54	**0.108**	**6.63**

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PAHs (μg/L) (continued)				
Benzo(a)pyrene	ug/L	1.4	**0.28**	**3.8**
Benzo(b)fluoranthene	ug/L	2.2 J	**0.44**	**1.5**
Benzo(g,h,i)perylene	ug/L	1.1 J	**0.22**	**0.26**
Benzo(k)fluoranthene	ug/L	0.74	**0.15**	**0.8**
Chrysene	ug/L	0.94	**0.19**	**1.9**
Dibenz(a,h)Anthracene	ug/L	0.12 UJ	**0.024**	**0.67**
Fluoranthene	ug/L	0.73 J	**0.15**	**2.43**
Fluorene	ug/L	0.7 U	**0.14**	**2.34**
Indeno(1,2,3-cd)pyrene	ug/L	0.89	**0.18**	**0.53**
Naphthalene	ug/L	5 UJ	**1**	**16.69**
Phenanthrene	ug/L	0.36 J	**0.072**	**1.2**
Pyrene	ug/L	1	**0.2**	**3.34**
VOCs (μg/L)				
1,1,1-Trichloroethane	ug/L	1 U	**0.1**	**0.15**
1,1,2,2-Tetrachloroethane	ug/L	1 U	**0.1**	**0.15**
1,1,2-Trichloroethane	ug/L	1 U	**0.1**	**0.15**
1,1-Dichloroethane	ug/L	1 U	**0.1**	**0.15**
1,1-Dichloroethene	ug/L	1 U	**0.1**	**0.15**
1,2,4-Trimethylbenzene	ug/L	1 U	**0.1**	**0.75**
1,2-Dibromoethane	ug/L	1 U	**0.1**	**0.15**
1,2-Dichlorobenzene	ug/L	1 U	**0.1**	**0.15**
1,2-Dichloroethane	ug/L	1 U	**0.1**	**0.15**
1,2-Dichloropropane	ug/L	1 U	**0.1**	**0.15**
1,3,5-Trimethylbenzene	ug/L	1 U	**0.1**	**0.75**
1,3-Dichlorobenzene	ug/L	1 U	**0.1**	**0.15**
1,3-Dichloropropene	ug/L	1 U	**0.1**	**0.15**
1,4-Dichlorobenzene	ug/L	1 U	**0.1**	**0.15**
2-Chloroethyl Vinyl Ether	ug/L	5 U	**0.5**	**0.75**
4-Methyl-2-Pentanone	ug/L	10 U	**1**	**1.5**
Acetone	ug/L	25 U	**2.5**	**3.75**
Acrylonitrile	ug/L	10 U	**1**	**1.5**
Benzene	ug/L	1 U	**0.1**	**0.31**
Bromodichloromethane	ug/L	1 U	**0.1**	**0.15**
Bromoform	ug/L	1 U	**0.1**	**0.15**
Bromomethane	ug/L	1 U	**0.1**	**0.15**
Carbon disulfide	ug/L	5 U	**0.5**	**0.75**
Carbon tetrachloride	ug/L	1 U	**0.1**	**0.15**
Chlorobenzene	ug/L	1 U	**0.1**	**0.15**
Chloroethane	ug/L	1 U	**0.1**	**0.15**
Chloroform	ug/L	1 U	**0.1**	**0.15**
Chloromethane	ug/L	1 U	**0.1**	**0.15**
cis-1,2-Dichloroethene	ug/L	1 U	**0.1**	**0.15**
Dibromochloromethane	ug/L	1 U	**0.1**	**0.15**
Ethylbenzene	ug/L	1 U	**0.1**	**0.15**
Methyl ethyl ketone	ug/L	10 U	**1**	**1.5**

Table 1
Estimated IHC CDF WWTP Influent Concentration Ranges
Indiana Harbor and Canal
East Chicago, Indiana

Analyte Name		Previous Estimated WWTP Influent Conc.[1]	Revised Estimated WWTP Influent Conc. (Avg.)[2]	Revised Estimated WWTP Influent Conc. (Max.)[2]
VOCs (µg/L) (continued)				
Methyl tert-butyl ether	ug/L	5 U	**0.5**	**0.75**
Methylene chloride	ug/L	5 U	**0.5**	**0.75**
Styrene	ug/L	1 U	**0.1**	**0.15**
Tetrachloroethene	ug/L	1 U	**0.1**	**0.15**
Toluene	ug/L	1 U	**0.1**	**0.17**
trans-1,2-Dichloroethene	ug/L	1 U	**0.1**	**0.15**
Trichloroethene	ug/L	1 U	**0.1**	**0.15**
Vinyl chloride	ug/L	1 U	**0.1**	**0.15**
Xylenes (total)	ug/L	3 U	**0.3**	**0.45**
SVOCs (µg/L)				
1,2,4-Trichlorobenzene	ug/L	5 U	**1**	**1.5**
1,2-Diphenylhydrazine	ug/L	5 U	**1**	**1.5**
2,4,5-Trichlorophenol	ug/L	5 U	**1**	**1.5**
2,4,6-Trichlorophenol	ug/L	5 U	**1**	**1.5**
2,4-Dichlorophenol	ug/L	5 U	**1**	**1.5**
2,4-Dimethylphenol	ug/L	5 U	**1**	**1.5**
2,4-Dinitrophenol	ug/L	20 U	**4**	**6**
2,4-Dinitrotoluene	ug/L	5 U	**1**	**1.5**
2,6-Dinitrotoluene	ug/L	5 U	**1**	**1.5**
2-Chloronaphthalene	ug/L	5 U	**1**	**1.5**
2-Chlorophenol	ug/L	5 U	**1**	**1.5**
2-Methylphenol	ug/L	5 U	**1**	**1.5**
2-Nitrophenol	ug/L	5 U	**1**	**1.5**
3,3'-Dichlorobenzidine	ug/L	5 U	**1**	**1.5**
4,6-Dinitro-2-methylphenol	ug/L	20 U	**4**	**6**
4-Bromophenyl Phenyl Ether	ug/L	5 U	**1**	**1.5**
4-Chloro-3-methylphenol	ug/L	5 U	**1**	**1.5**
4-Chlorophenyl Phenyl Ether	ug/L	5 U	**1**	**1.5**
4-Methylphenol	ug/L	5 U	**1**	**1.5**
4-Nitrophenol	ug/L	20 U	**4**	**6**
Benzidine	ug/L	100 U	**20**	**30**
Benzoic Acid	ug/L	5 U	**1**	**1.5**
Benzyl Butyl Phthalate	ug/L	5 U	**1**	**1.5**
Bis(2-Chloroethoxy) Methane	ug/L	5 U	**1**	**1.5**
Bis(2-Chloroethyl) Ether	ug/L	5 UJ	**1**	**1.5**
Bis(2-Chloroisopropyl) Ether	ug/L	5 U	**1**	**1.5**
Bis(2-Ethylhexyl) Phthalate	ug/L	5 U	**1**	**1.5**
Dibenzofuran	ug/L	5 U	**1**	**1.5**
Diethyl Phthalate	ug/L	5 U	**1**	**1.5**
Dimethyl Phthalate	ug/L	5 U	**1**	**1.5**
Di-N-Butyl Phthalate	ug/L	5 U	**1**	**1.5**
Di-N-Octylphthalate	ug/L	5 U	**1**	**1.5**
Hexachlorobenzene	ug/L	5 U	**1**	**1.5**
Hexachlorobutadiene	ug/L	5 U	**1**	**1.5**
Hexachlorocyclopentadiene	ug/L	5 U	**1**	**1.5**

Table 1
Estimated IHC CDF WWTP Influent Concentration Ranges
Indiana Harbor and Canal
East Chicago, Indiana

Analyte Name		**Previous Estimated WWTP Influent Conc.[1]**	**Revised Estimated WWTP Influent Conc. (Avg.)[2]**	**Revised Estimated WWTP Influent Conc. (Max.)[2]**
SVOCs (µg/L) (continued)				
Hexachloroethane	ug/L	5 U	**1**	**1.5**
Isophorone	ug/L	5 U	**1**	**1.5**
Nitrobenzene	ug/L	5 U	**1**	**1.5**
N-Nitrosodiisopropylamine	ug/L	5 U	**1**	**1.5**
N-Nitrosodimethylamine	ug/L	5 UJ	**1**	**1.5**
N-Nitrosodiphenylamine	ug/L	5 U	**1**	**1.5**
Pentachlorophenol	ug/L	5 U	**1**	**1.5**
Phenol	ug/L	5 U	**1**	**1.5**
Dioxins (ng/L)				
2,3,7,8-TCDD	ng/L	NA	**0.002**	**0.003**

Notes:
1. CDF drained annually. Based on *Treatability Testing Study Report – Final*, MWH, August 2005.
2. CDF ponded. Based on USACE estimation of settling and degradation factors.
Further evaluation is required to determine the actual concentrations.
J = Result is detected below the reporting limit and is an estimated concentration
U = Analyte is not detected at or above the indicated concentration
UJ = Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value, however the calibration was out of range. Therefore the concentration is estimated.

Table 2
Summary of Anticipated NPDES Discharge Limits
Indiana Harbor and Canal
East Chicago, Indiana

Parameter	Monthly Average Loading	Daily Maximum Loading	Monthly Average Concentration	Daily Maximum Concentration
Flow (MGD)	Report (MGD)	Report (MGD)		
Benzene	--	--	--	5 ug/L
Oil & Grease	--	--	10 mg/L	15 mg/L
Naphthalene	--	--	--	10 ug/L
BTEX	--	--	--	100 ug/L
Lead	--	--	--	22 ug/L
PCBs	--	--	--	ND
Phenol	--	--	Report (mg/L)	Report (mg/L)
Ammonia				
Summer	Report (lbs/day)	Report (lbs/day)	1.1 mg/L	2.2 mg/L
Winter	Report (lbs/day)	Report (lbs/day)	1.25 mg/L	2.5 mg/L
Endrin	--	--	--	0.6 ug/L
Chlordane	--	--	--	ND (ug/L)
Heptachlor	--	--	--	ND (ug/L)
pH	--	--	--	8 S.U.
Total Residual Chlorine	Report (lbs/day)	Report (lbs/day)	0.009 mg/L	0.018 mg/L

Notes:

MGD – million gallons per day

ug/L – micrograms per liter

Table 3
Process Options Evaluation Summary
Indiana Harbor and Canal
East Chicago, Indiana

Solids/Metals Removal

Equipment	Operational Flexibility	Relative Costs	Availability	Regulatory Issues	Other
Lamella Clarifier	Sized for 70% of flow, at 50% has higher capacity. These clarifiers do not have as much capacity to handle surges in flow. This is not an issue due to the large equalization capacity in the CDF cells. A third unit could be added to the system to handle increased loadings.	2 units, including flash mix & floc tanks w/mixers ~$140,000 (equipment costs only)	Available. Shop fabricated, would be delivered to site ready to be connected.	None	Less sludge storage capacity than floc. clarifier. A continuous sludge recycle may be required (approximately 10% of the system flow) to help promote flocculation.
Flocculating clarifier	Sized using a low loading rate, loading rate could be increased w/o affecting operation. Sized for 70% of flow, at 50% has higher capacity.	2 units ~$250,000 (equipment costs only)	Available but would require field erection	None	Require large foundations, require a separate flash mix tank and mixer

Ammonia Removal

Equipment	Operational Flexibility	Relative Costs	Availability	Regulatory Issues	Other
Breakpoint Chlorination	Higher flows or concentrations would require higher dosing. Substantially higher flow rates would also require larger contact chamber.	Cost would include pumps, static mixers for chemical injection, contact tank, and mixer. Chemical costs for chlorination and dechlorination would be dependent on the ammonia concentrations and required dosing.	Available		Would add TDS to the water.
IX	Clinoptilolite resins strongly prefer ammonium ions, so reliable removal can be achieved, but resins are susceptible to fouling, so strict control would be necessary to remove fouling materials prior to ion exchange units.	Costs would include ion exchange resins and vessels, pumps, regenerant and waste holding tanks as well as disposal costs for the spent regenerant and resin.	Available	Waste material would likely be corrosive, requiring disposal as hazardous waste.	Other ions (particularly calcium) in water could interfere with ammonium ion exchange, requiring softening upstream of ion exchange unit or specially treated resins (as evaluated in the previous treatability study).
Biological	Relatively simple operation would produce low effluent concentration, but could be upset/ inhibited by toxic compounds	Costs would include reactor tanks, aerators, pumps, etc. and the energy to run such equipment. Will likely require continuous supply of carbon source (e.g. MeOH).	Available but would require construction		Small amount of sludge wastage will need to be returned to the CDF for disposal.
Air Stipping	Removal efficiency could suffer if loadings are varied. May require an oversized unit or addition of additional unit	~$60,000 for air stripping equipment but would need pH and temperature control systems	Available	Would require an air permit	Would require an additional caustic dose to raise pH and an acid dose to lower effluent pH. Efficiency is reduced by drop in temperature. Would need to maintain a removal efficiency of 93% to meet discharge limit if influent is 16 mg/L
Aeration of CDF cells	Floating aerators could be used to aerate ammonia, promoting degradation. Additional aerators could be used.	Cost of aerators (~ $35,000/each) and electrical costs to operate.	Available. Would require some concrete work for the moorings.		The efficiency of ammonia removal in the large cells is not known. O&M of aerators is a factor. Limited ability to control process performance. Would interfere with solids settling in CDF.

Table 4
Summary of Conceptual Design Cost Components
Indiana Harbor and Canal
East Chicago, Indiana

	Conceptual Permanent Plant	Conceptual Package Plant
Total Capital Cost	**$8,772,863**	**$2,900,726**
Capital Costs include:	Material Storage Pad	Material Storage Pad
	- Excavation to 4'-0" and replace with fill	- Excavation to 4'-0" and replace with fill
	- Gravel Pad	- Gravel Pad
	- Security Fence	- Security Fence
	- Security Lighting	- Security Lighting
	Decontamination Station	Decontamination Station
	- Excavation to 4'-0" and replace with fill	- Excavation to 4'-0" and replace with fill
	- Concrete Pad and sump	- Concrete Pad and sump
	-Discharge Pump, Level Controls, and Electrical	-Discharge Pump, Level Controls, and Electrical
	General Site Features	General Site Features
	- Access Roads	- Access Roads
	- Parking Lot	- Parking Lot
	- Security Fencing	- Security Fencing
	- Sidewalk	- Sidewalk
	- Maintenance Vehicle Parking and Storage Area	- Maintenance Vehicle Parking and Storage Area
	- Office Trailer Pads	- Office Trailer Pads
	- Site Grading, Water & Drainage Control, and Landscaping	- Site Grading, Water & Drainage Control, and Landscaping
	- Security Lighting	- Security Lighting
	WWTP Building	WWTP Slab
	- Excavation to 4'-0" and replace with fill	- Excavation to 4'-0" and replace with fill
	- Foundation	- Foundation
	- Pre-Engineered Metal Building	Permanent Process Equipment
	- Power and Lighting	- Tanks (Influent, and Efflunt) and Foundations
	- HVAC	- Effluent Sampler
	- Interior Rooms	- Pumps and Instrumentation & Controls
	- Hoist System	
	Process Equipment	
	- Tanks (Influent, Backwash, and Effluent) and Foundations	
	- Lamella Clarifiers and Foundations	
	-Chemical Storage Tanks and Feed Systems	
	- Sand Filters	
	- Granular Activated Carbon	
	- Pumps and Instrumentation & Controls	
	- Effluent Sampler	
	- Chorine Contact Tank and Dechlorination Static Mixer	
	Sanitary Pump Station and Associated Piping & Electrical	

	Conceptual Permanent Plant	Conceptual Package Plant
Total Operation and Maintenance (NPV)	**$18,634,070**	**$28,195,463**
O&M Costs include:	- Electricity	- Electricity
	- Chemical Usage	- Contractor Equipment Rental
	- Labor	- Contractor Labor
	- Equipment Maintenance and Replacement	- Contractor Mobilization/Demobilization
		- Contractor Material/Chemical Usage

Table 5
Summary of Conceptual Permanent Plant Capital Costs
Indiana Harbor and Canal
East Chicago, Indiana

	Labor Cost	Construction Cost (Materials, Consumables, Labor, etc.)	Equipment/Material Cost	Total By Category
Site Development	$348,970	$480,007	$18,025	$847,001
Concrete (w/overexcavation)	$609,127	$404,937	--	$1,014,064
Miscellaneous Metals	$22,338	$8,204	$83,214	$113,756
Chemical Resistant Coating	$49,950	$47,222	--	$97,172
WWTP Building & Interior Structures	$383,370	$657,292	$107,853	$1,148,515
Field Erected Steel Tanks	$132,332	$59,009	$30,423	$221,763
Process Flow System	$527,815	$1,285,117	$1,426,309	$3,239,240
Chemical Systems	$161,916	$394,633	$193,531	$750,080
Truck Decontamination	$38,158	$96,234	$27,277	$161,669
Sanitary Pump Station	$22,213	$45,339	$53,780	$121,332
Power Distribution & Process Control Equipment	$101,916	$216,246	$740,107	$1,058,270
Subtotal	$2,398,106	$3,694,238	$2,680,519	

Total Capital Cost **$8,772,863**

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Table 6
Summary of Conceptual Permanent Plant Operation and Maintenance Costs
Indiana Harbor and Canal
East Chicago, Indiana

Year	Year Starting	Electrical	Labor	Repair and Replace	Chemicals	Total O&M
1	2010	$81,812	$181,350	$217,051	$133,688	$613,901
2	2011	$85,903	$190,418	$227,904	$140,373	$644,598
3	2012	$90,112	$199,748	$239,071	$147,251	$676,182
4	2013	$94,443	$209,350	$250,563	$154,329	$708,685
5	2014	$98,901	$219,232	$262,390	$161,614	$742,137
6	2015	$103,490	$229,402	$274,563	$169,112	$776,567
7	2016	$108,213	$239,871	$287,093	$176,829	$812,006
8	2017	$113,074	$250,648	$299,992	$184,774	$848,488
9	2018	$118,079	$261,743	$313,270	$192,953	$886,045
10	2019	$123,232	$273,165	$326,941	$201,373	$924,711
11	2020	$128,538	$284,926	$341,018	$210,043	$964,525
12	2021	$134,001	$297,037	$355,512	$218,971	$1,005,521
13	2022	$139,627	$309,508	$370,438	$228,164	$1,047,737
14	2023	$145,422	$322,351	$385,810	$237,632	$1,091,215
15	2024	$151,389	$335,579	$401,642	$247,384	$1,135,994
16	2025	$157,536	$349,204	$417,950	$257,428	$1,182,118
17	2026	$163,867	$363,239	$434,747	$267,774	$1,229,627
18	2027	$170,390	$377,697	$452,052	$278,432	$1,278,571
19	2028	$177,109	$392,592	$469,879	$289,413	$1,328,993
20	2029	$184,032	$407,938	$488,246	$300,726	$1,380,942
21	2030	$191,165	$423,750	$507,171	$312,382	$1,434,468
22	2031	$198,516	$440,044	$526,672	$324,393	$1,489,625
23	2032	$206,091	$456,834	$546,768	$336,771	$1,546,464
24	2033	$213,897	$474,138	$567,478	$349,527	$1,605,040
25	2034	$221,942	$491,972	$588,823	$362,674	$1,665,411
26	2035	$230,235	$510,353	$610,823	$376,225	$1,727,636
27	2036	$238,782	$529,300	$633,500	$390,192	$1,791,774
28	2037	$247,593	$548,832	$656,877	$404,590	$1,857,892
29	2038	$256,676	$568,966	$680,975	$419,433	$1,926,050
30	2039	$266,041	$589,725	$705,820	$434,736	$1,996,322
	Subtotal	**$4,840,109**	**$10,728,912**	**$12,841,042**	**$7,909,188**	**$36,319,251**

Total NPV **$18,634,070**

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Table 7
Summary of Conceptual Package Plant Capital Costs
Indiana Harbor and Canal
East Chicago, Indiana

	Labor Cost	Construction Cost (Materials, Consumables, etc.)	Equipment/ Material Cost	Total By Category
Site Development	$290,220	$417,595	$18,427	$726,062
Concrete	$452,535	$334,533		$787,068
Miscellaneous Metals	$11,195	$3,965	$39,180	$54,341
Chemical Resistant Coating	$39,894	$71,646	--	$111,540
WWTP Slab Area	$39,816	$97,275	--	$137,091
Field Erected Steel Tanks	$66,532	$27,981	$2,988	$97,501
Process Flow System	$104,667	$268,673	$169,492	$542,831
Truck Decontamination	$37,203	$95,049	$27,614	$159,866
Power Distribution & Process Control Equipment	$23,130	$43,954	$217,342	$284,427
Subtotal	$1,065,191	$1,360,071	$474,364	

Total Capital Cost **$2,900,726**

Table 8
Summary of Conceptual Package Plant Operation and Maintenance Costs
Indiana Harbor and Canal
East Chicago, Indiana

Year	Year Starting	Electrical	Labor	Repair and Replace	Chemicals	Miscellaneous	Total O&M
1	2010	$34,615	$591,500	$34,831	$22,932	$245,025	$683,878
2	2011	$36,345	$621,075	$36,573	$24,079	$257,276	$975,348
3	2012	$38,126	$651,508	$38,365	$25,258	$269,883	$1,023,140
4	2013	$39,959	$682,825	$40,209	$26,473	$282,856	$1,072,322
5	2014	$41,845	$715,056	$42,107	$27,722	$296,207	$1,122,937
6	2015	$43,787	$748,230	$44,060	$29,008	$309,949	$1,175,034
7	2016	$45,785	$782,376	$46,071	$30,332	$324,094	$1,228,658
8	2017	$47,842	$817,526	$48,141	$31,695	$338,655	$1,283,859
9	2018	$49,959	$853,713	$50,272	$33,098	$353,645	$1,340,687
10	2019	$52,140	$890,969	$52,466	$34,542	$369,078	$1,399,195
11	2020	$54,384	$929,329	$54,724	$36,029	$384,968	$1,459,434
12	2021	$56,696	$968,829	$57,050	$37,561	$401,331	$1,521,467
13	2022	$59,076	$1,009,505	$59,446	$39,138	$418,181	$1,585,346
14	2023	$61,528	$1,051,396	$61,913	$40,762	$435,534	$1,651,133
15	2024	$64,053	$1,094,541	$64,453	$42,435	$453,407	$1,718,889
16	2025	$66,653	$1,138,981	$67,070	$44,157	$471,815	$1,788,676
17	2026	$69,332	$1,184,758	$69,766	$45,932	$490,778	$1,860,566
18	2027	$72,092	$1,231,915	$72,543	$47,760	$510,313	$1,934,623
19	2028	$74,935	$1,280,497	$75,403	$49,644	$530,437	$2,010,916
20	2029	$77,864	$1,330,551	$78,351	$51,584	$551,172	$2,089,522
21	2030	$80,882	$1,382,125	$81,388	$53,584	$572,536	$2,170,515
22	2031	$83,992	$1,435,268	$84,517	$55,644	$594,551	$2,253,972
23	2032	$87,197	$1,490,033	$87,742	$57,767	$617,236	$2,339,975
24	2033	$90,500	$1,546,472	$91,066	$59,956	$640,616	$2,428,610
25	2034	$93,904	$1,604,640	$94,491	$62,211	$664,711	$2,519,957
26	2035	$97,412	$1,664,594	$98,021	$64,535	$689,547	$2,614,109
27	2036	$101,029	$1,726,392	$101,660	$66,931	$715,147	$2,711,159
28	2037	$104,757	$1,790,096	$105,412	$69,401	$741,536	$2,811,202
29	2038	$108,600	$1,855,769	$109,279	$71,947	$768,740	$2,914,335
30	2039	$112,562	$1,923,474	$113,266	$74,572	$796,787	$3,020,661
	Subtotal	**$2,047,850**	**$34,993,944**	**$2,060,654**	**$1,356,688**	**$14,496,012**	**$54,955,148**

Total NPV **$28,195,463**

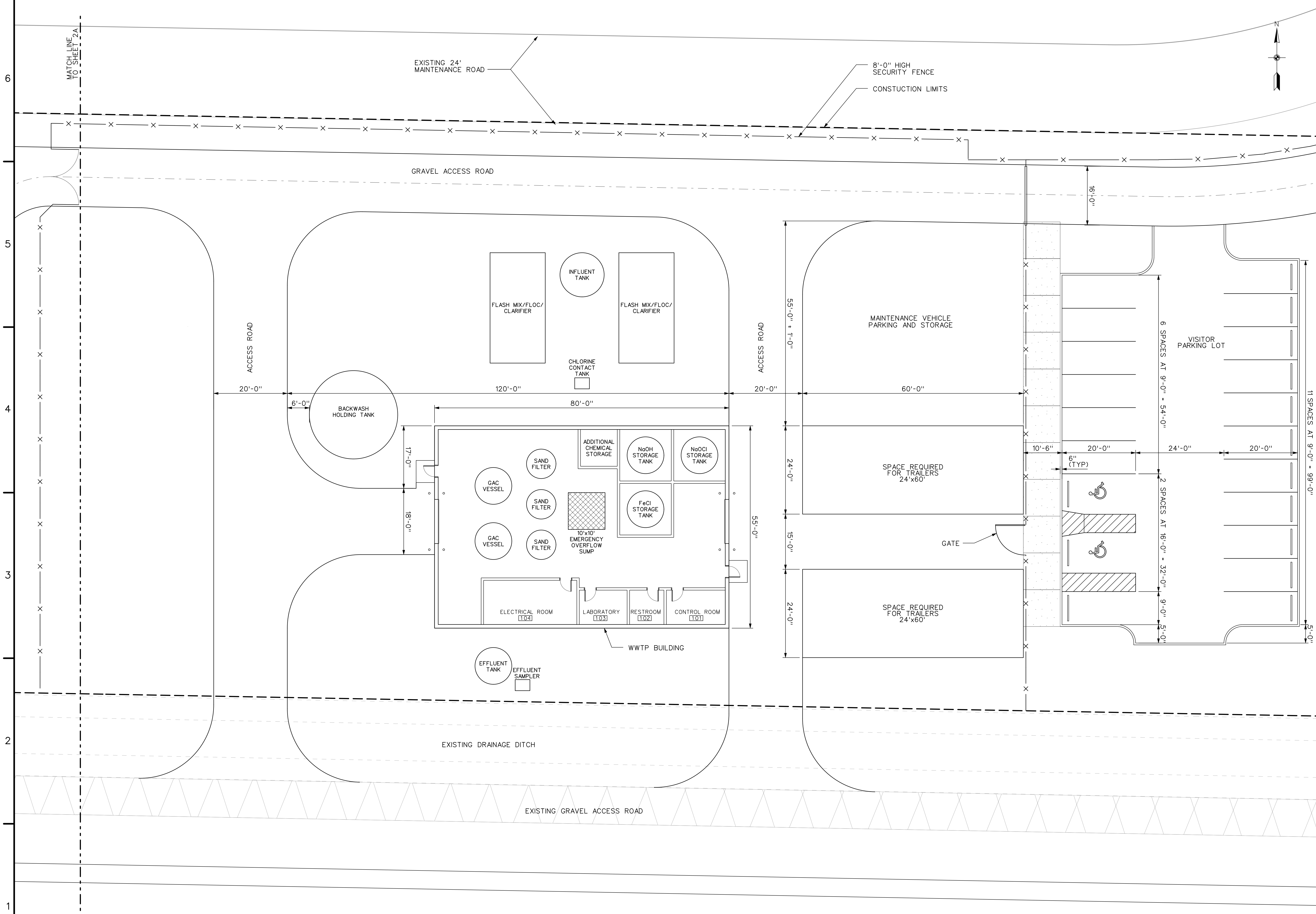
Table 9
Summary of Evaluation Criteria
Indiana Harbor and Canal
East Chicago, Indiana

	Conceptual Permanent Plant	Conceptual Package Plant
Cost		
Capital	$8,772,863	$2,900,726
Operation and Maintenance (NPV)	$18,634,070	$28,195,463
Total Cost (including 20% Contingency)	*$32,888,320*	*$37,315,427*
Anticipated Schedule	40 weeks	31 weeks
Implentability (i.e. Contracting)	The permanent plant would require a standard contract for the construction of the system and a contract for the system operators.	The package plant would require a contract for the construction of the site features and a performance based contract for the supply and operation of the package equipment to meet the NPDES discharge limits. Contract setup may limit the number of vendors bidding on the project.
Effectiveness of Treatment	The selected treatment process should be capable of treating the anticipated influent to meet the discharge limits.	The selected treatment process should be capable of treating the anticipated influent to meet the discharge limits.
Availability of Service	The treatment equipment is available and could be delivered to the site without excessive lead times.	The treatment equipment is available and could be delivered to the site without excessive lead times.
Operation Flexability	The WWTP could treat additional volume by extending the duration of operation. The WWTP should be designed to handle small variations in influent concentrations. However, a large increase in the influent concentrations could potentially require the addition of equipment. The current layout allows for addition of Lamella clarifiers and chlorination/dechlorination equipment, however, the building and tanks do not have excess room for additional expansion.	Additional volume and contaminant concentrations could be handled by modifications to the equipment on-site or by additional equipment provided by the vendor.
Operation Control	USACE has complete control on the overall system operation to meet the NPDES discharge limits.	Selected vendor is contractually obligated to meet the NPDES discharge limits. However, USACE has no control of operations that could effect meeting the discharge limits or impact the operating costs.
Regulatory	IDEM has indicated that they are not concerned of what components are utilized in industrial treatment systems. IDEM is only concerned that the system will meet the discharge limits.	IDEM has indicated that they are not concerned of what components are utilized in industrial treatment systems. IDEM is only concerned that the system will meet the discharge limits.

Table 9
Summary of Evaluation Criteria
Indiana Harbor and Canal
East Chicago, Indiana

	Conceptual Permanent Plant	Conceptual Package Plant
Potential Risks		
Uncertainty of Influent Characteristics	Permanent plant should be designed to handle some variation in the influent characteristics but would likely require substantial upgrades to the system if the influent characteristics vary greatly from the design data.	Package plant vendors will build some financial contingency into their operating costs to handle slight fluccuations in the influent characteristics. Any major changes to the influent characteristics would lead to an increase in equipment rental and operational costs.
Uncertainty of Annual Funding	If the WWTP were to not operate for a season, USACE would likely pay some minimal cost for the contracted operators and some maintenance of the WWTP.	Like the IGWTP, the package plant vendor would include a minimum annual cost for non-operation. This would likely include the entire equipment rental cost and a percentage of the material/chemical usage rate and the labor rate.
Uncertainty of Continuity of Service	There should be no issue with a lack of continuity of service for the permanent system. A change in contracted operators would not have any major impact on the system operation.	If the package plant were to establish a performance-based contract, a change in contractors and process equipment should not affect the system achieving the discharge limits. Different process configurations may require additional area and may generate different waste materials that may need to be handled differently.
Risk of Full Design of System vs. Performance-based Specifications	The design of the permanent plant will be based on the provided influent characteristics, anticipated annual volumes, and the anticipated discharge limits. Large variations in the influent characteristics from the design data could have significant impacts to the WWTP operation and/or equipment.	The design of the package plant will be based on the provided influent characteristics, anticipated annual volumes, and the anticipated discharge limits. Large variations in the influent characteristics from the design data could potentially be handled by adding additional treatment units to the system. This would have an impact on the required WWTP footprint, the operational costs, and generated wastes.

FIGURES



NOT FOR CONSTRUCTION

ENLARGED SITE PLAN

10' 5' 0 10'

SCALE: 1''= 10'-0"

NOTES:

1. REFER TO TECHNICAL MEMORANDUM NO. 2 FOR DESCRIPTION OF SITE. UTILITIES NOT SHOWN ON DRAWING.

US Army Corps of Engineers Chicago District

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SYMBOL	AMENDMENT DESCRIPTION	DATE	APPROVED

DESIGNED BY: JDP | DATE: JUNE 19, 2009
DRAWN BY: NJD | SCALE: AS SHOWN
CHECKED BY: DCS | CONTRACT NUMBER: W912P6-09-F-0006
CATHERINE HURLEY | SUBMITTED BY: | DATE:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS

MWH

INDIANA HARBOR AND CANAL
CONFINED DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT

CONCEPTUAL PERMANENT PLANT
SITE LAYOUT
SHEET 1 OF 2

SHEET REFERENCE NUMBER:
1A

SHEET 1 OF 5

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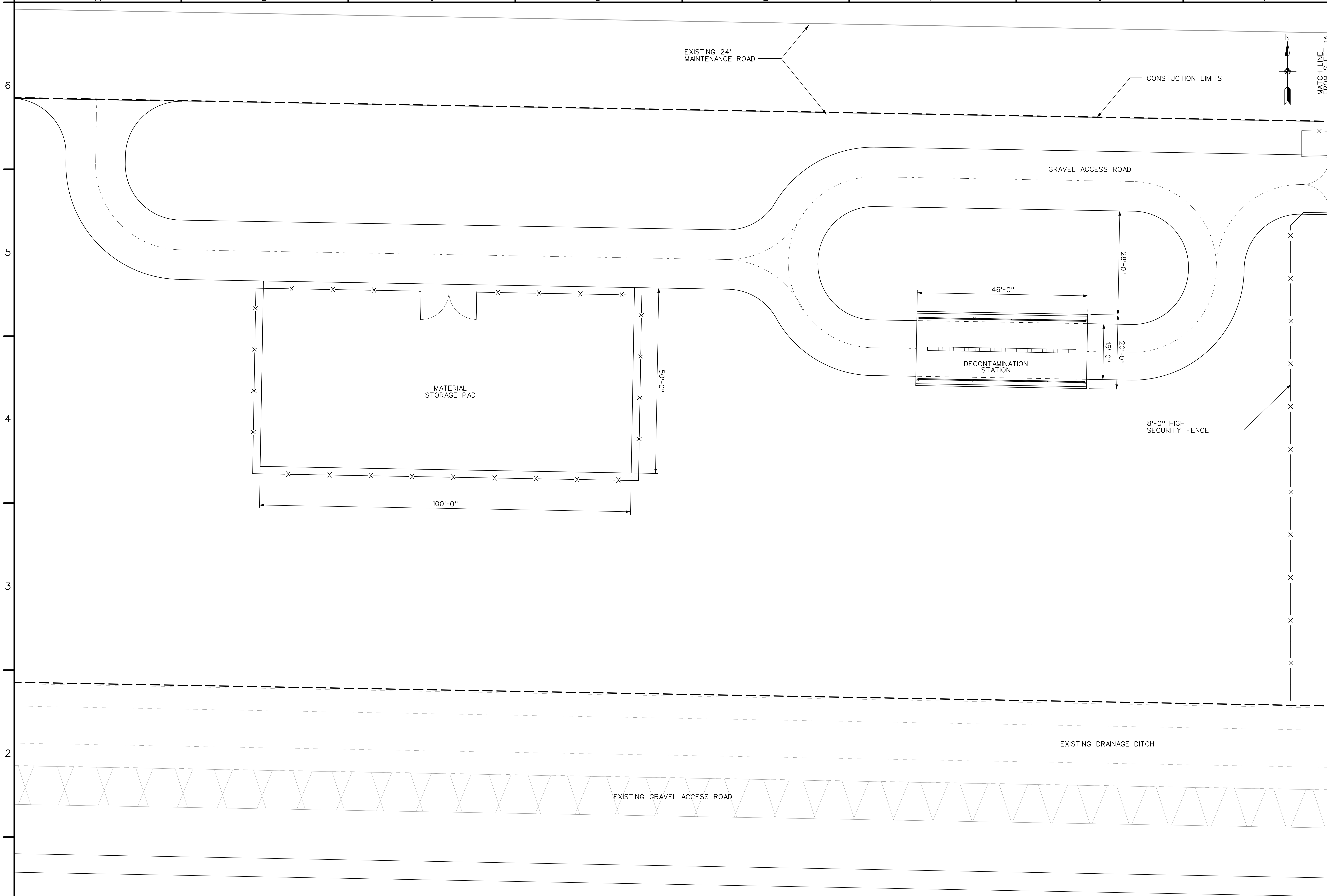

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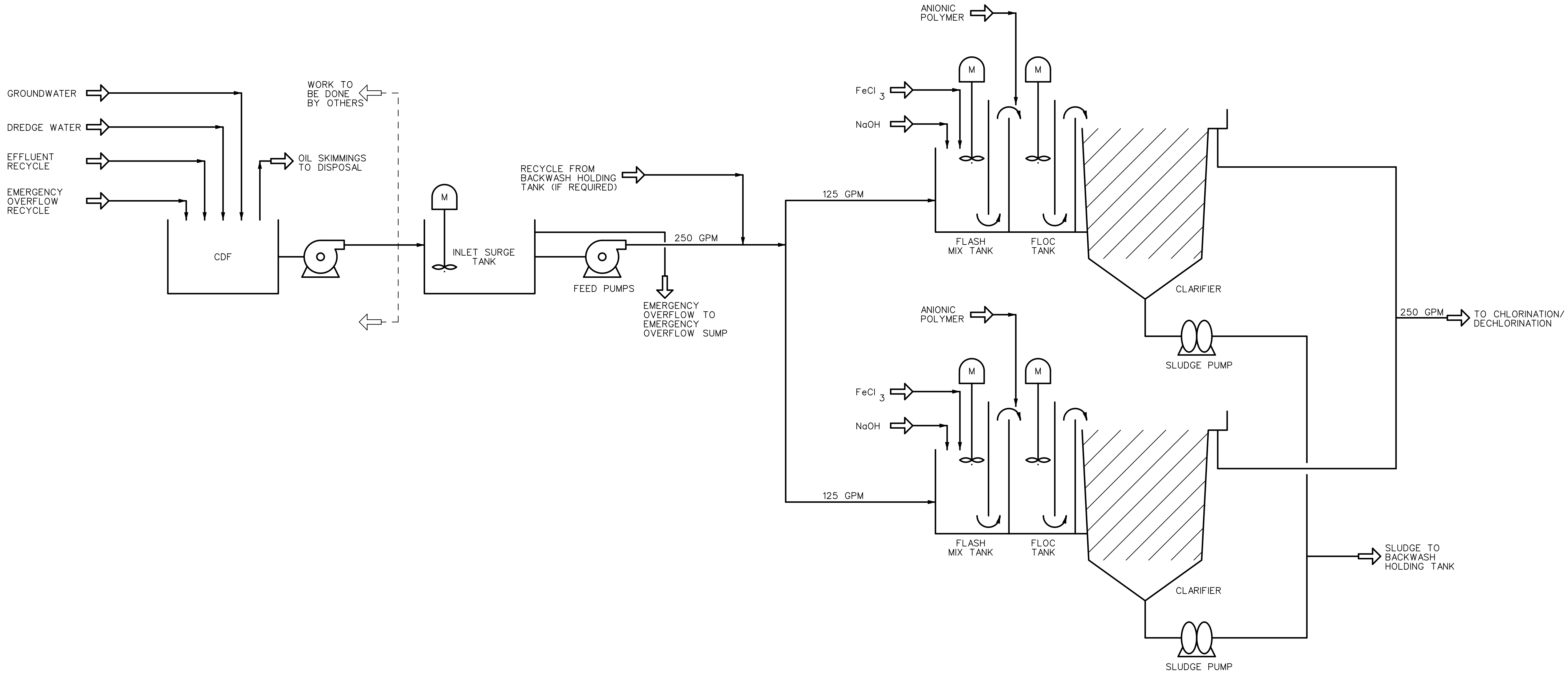
WASTEWATER TREATMENT PLANT
CONCEPTUAL PERMANENT PLANT
SITE LAYOUT
SHEET 2 OF 2

SHEET REFERENCE NUMBER:
2A

SHEET 2 OF 5



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INDIANA HARBOR AND CANAL
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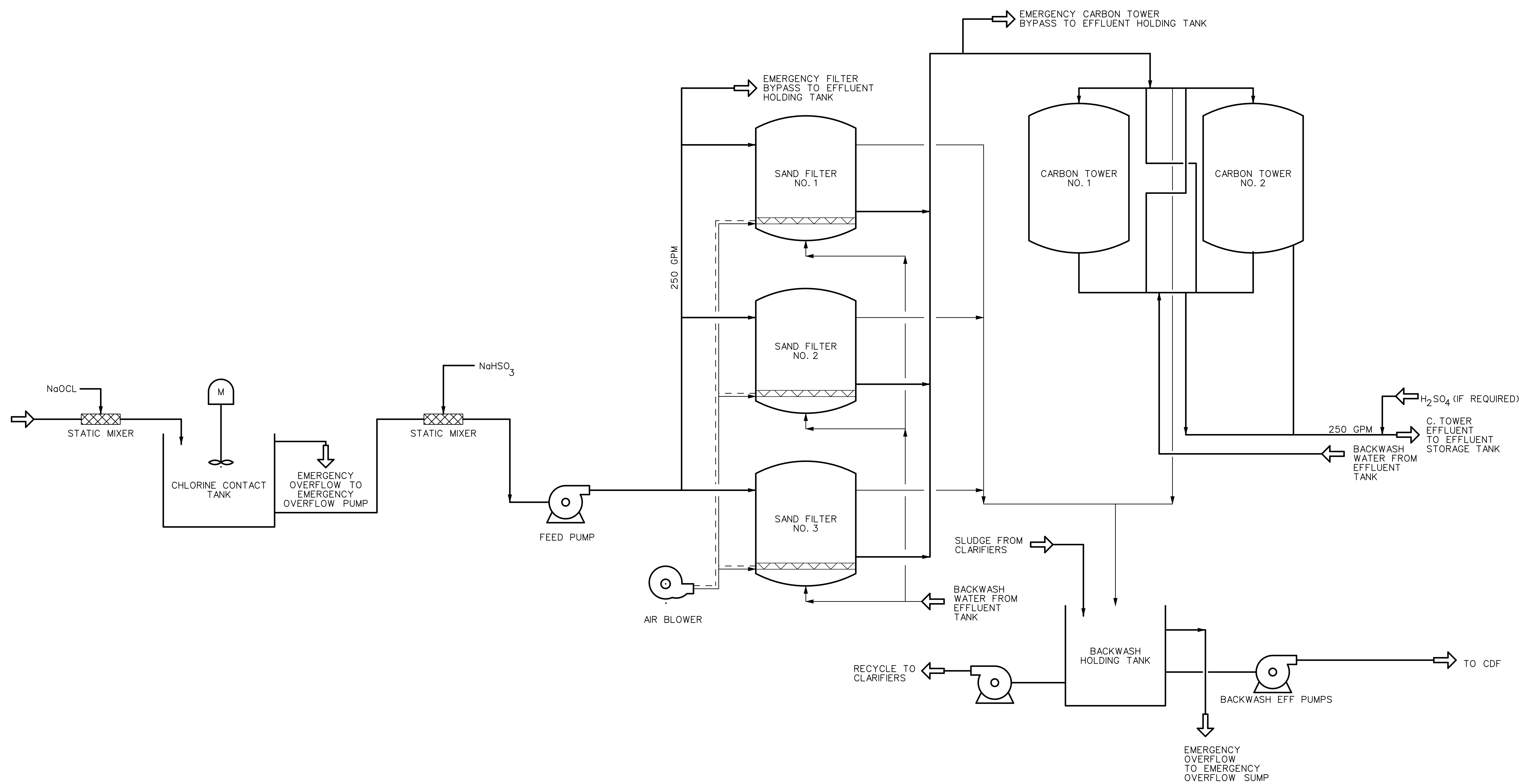
WASTEWATER TREATMENT PLANT
CONCEPTUAL PERMANENT PLANT
PROCESS FLOW DIAGRAM
SHEET 1 OF 3

SHEET REFERENCE NUMBER:
3A

SHEET 3 OF 5



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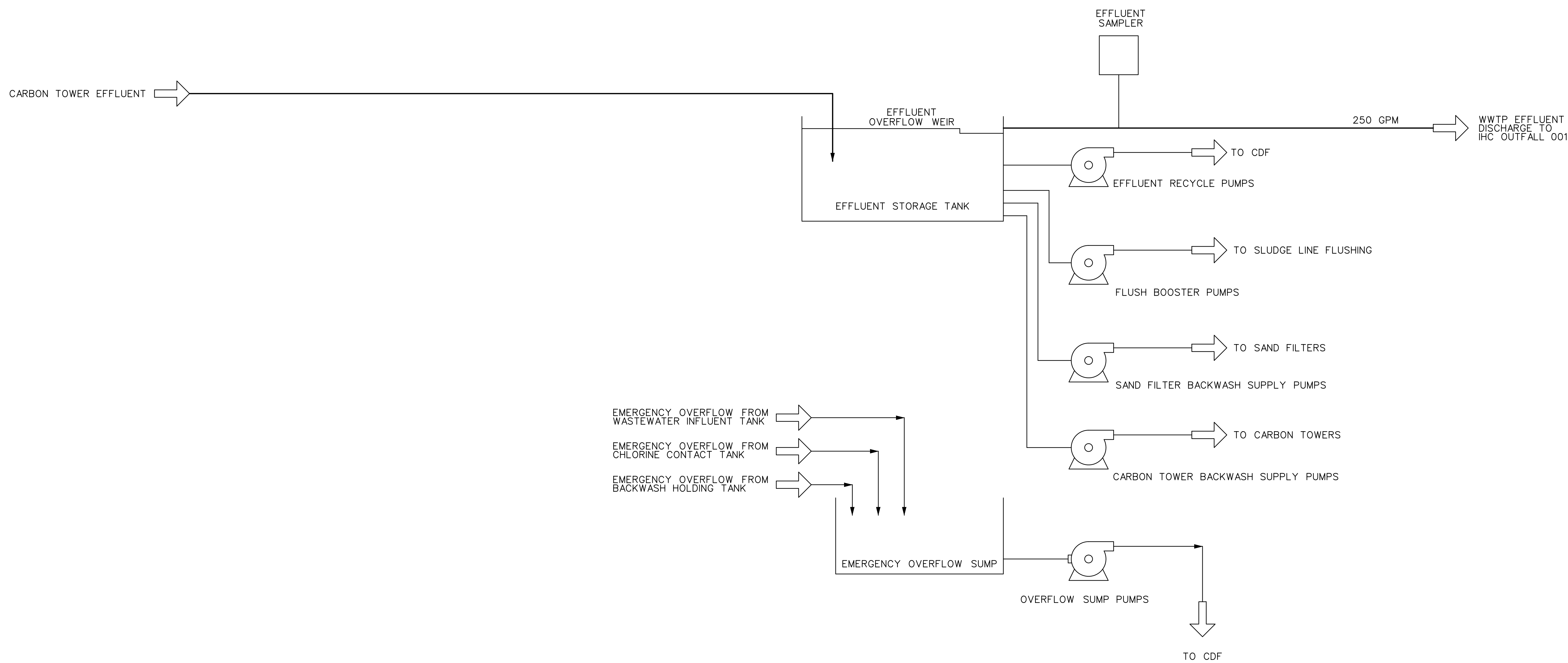
WASTEWATER TREATMENT PLANT
CONCEPETUAL PERMANENT PLANT
PROCESS FLOW DIAGRAM
SHEET 2 OF 3

SHEET REFERENCE NUMBER:
4A

SHEET 4 OF 5



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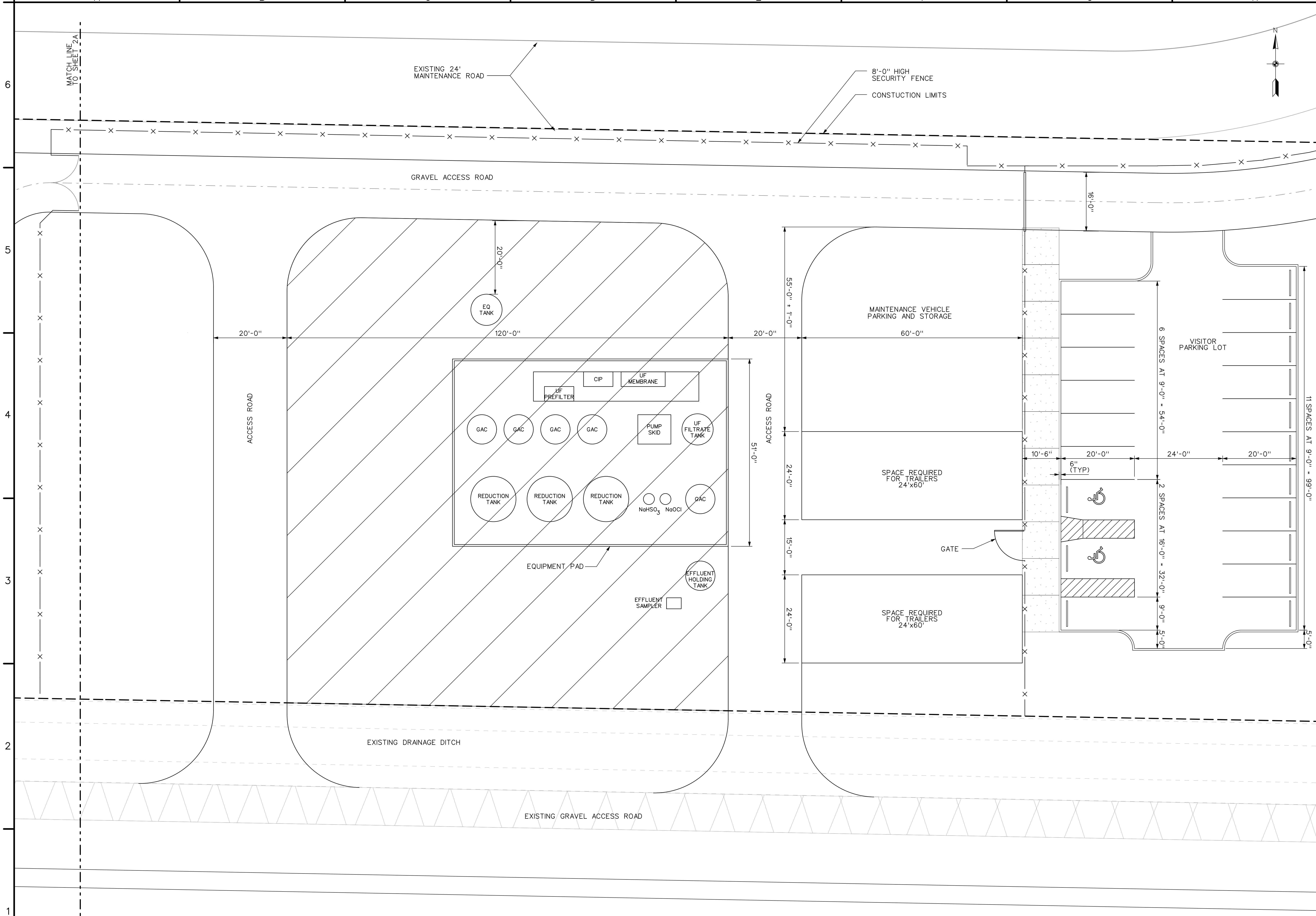
INDIANA HARBOR AND CANAL
CONFINED DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT

CONCEPTUAL PERMANENT PLANT
PROCESS FLOW DIAGRAM
SHEET 3 OF 3

SHEET REFERENCE NUMBER:
5A

SHEET 5 OF 5



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ENLARGED SITE PLAN

10' 5' 0 10'

SCALE: 1'' = 10'-0"

NOTES:

1. REFER TO TECHNICAL MEMORANDUM NO. 2 FOR DESCRIPTION OF SITE. UTILITIES NOT SHOWN ON DRAWING.
2. CONTROLS FOR THE PACKAGE PLANT WILL BE HOUSED IN THE TRAILER.
3. EQUIPMENT LAYOUT SHOWN BASED ON AVANTECH EQUIPMENT.
4. HATCHED AREA INDICATES TOTAL AREA AVAILABLE FOR PACKAGE EQUIPMENT.

US Army Corps of Engineers Chicago District

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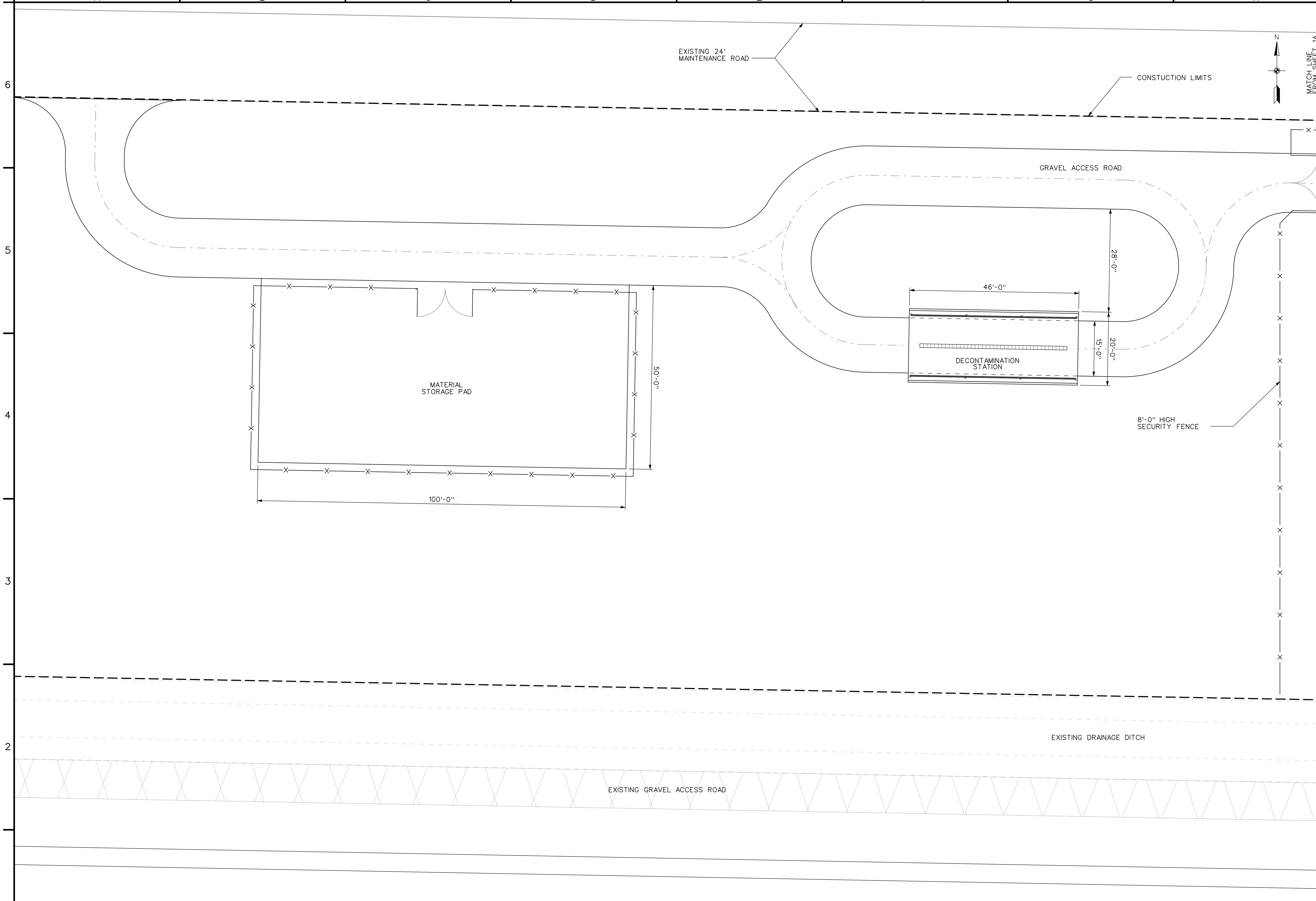
INDIANA HARBOR AND CANAL
CONFINED DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT

CONCEPTUAL PACKAGE PLANT
SITE LAYOUT
SHEET 1 OF 2

SHEET REFERENCE NUMBER:
1B

SHEET 1 OF 4



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INDIANA HARBOR AND CANAL
CONFINED DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT

CONCEPTUAL PACKAGE PLANT
SITE LAYOUT
SHEET 2 OF 2

SHEET REFERENCE NUMBER:
2B

SHEET 2 OF 4

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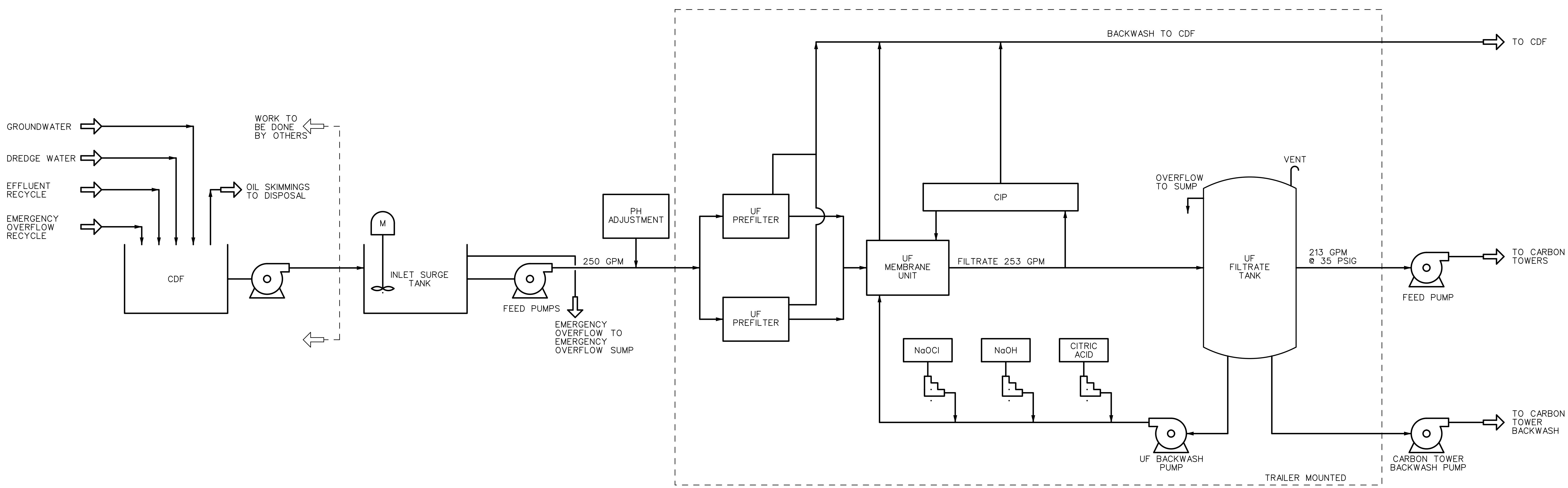

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CHICAGO, ILLINOIS

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SUBMITTED BY: CATHERINE HURLEY	DATE:

INDIANA HARBOR AND CANAL
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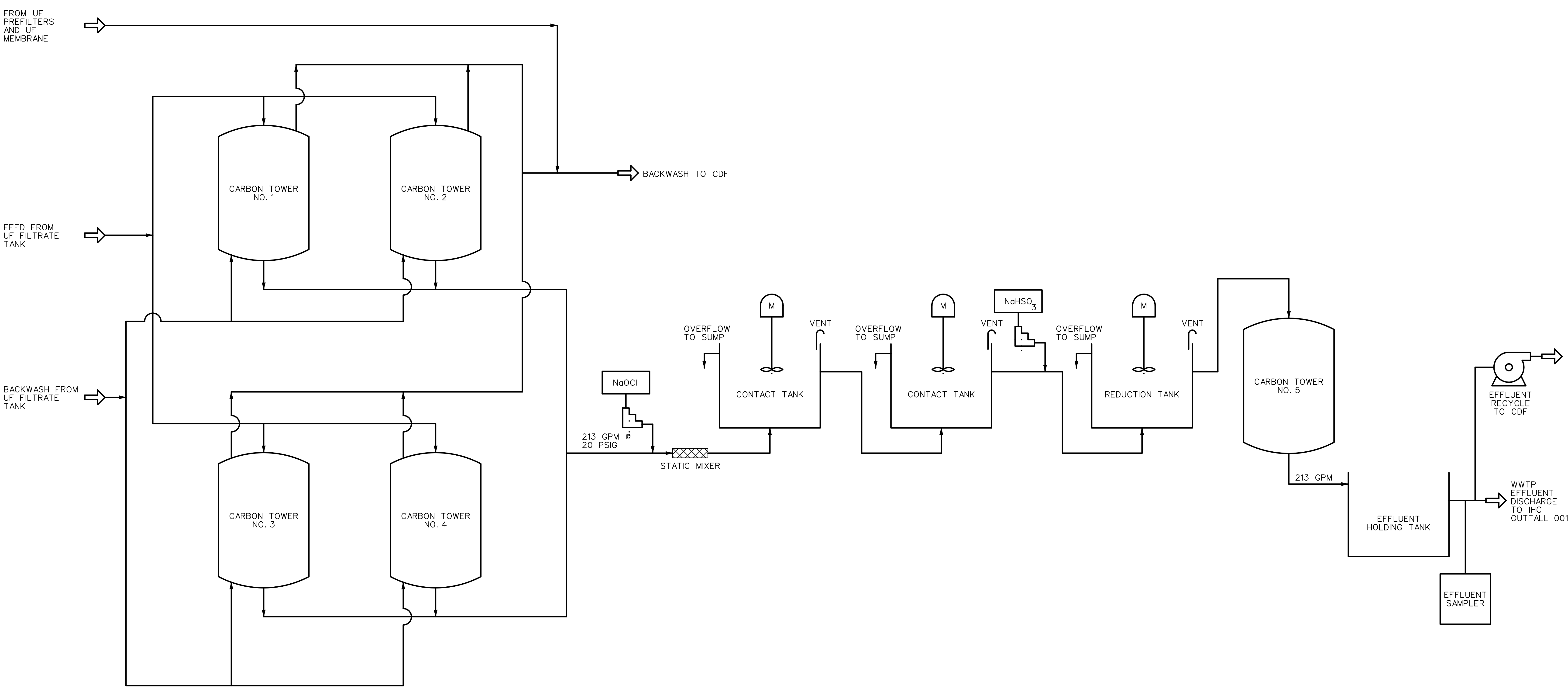
WASTEWATER TREATMENT PLANT
CONCEPTUAL PACKAGE PLANT
PROCESS FLOW DIAGRAM
SHEET 1 OF 2

SHEET REFERENCE NUMBER:
3B

SHEET 3 OF 4



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SHEET 4 OF 4