Crow Tribe Water Resources

CROW MR&I SYSTEM
PILOT WATER TREATMENT PLANT
FINAL ENVIRONMENTAL ASSESSMENT
JULY 2015

CROW TRIBE

BARTLETT & WEST

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1.0 Purpose and Need

1.1 Introduction

The Crow Indian Reservation, the largest of the seven Indian reservations in Montana, is located in south-central Montana, bordered by Wyoming to the south and the Northern Cheyenne Indian Reservation to the east (Figure 1-1). The reservation encompasses approximately 2,300,000 acres, of which approximately 404,172 acres are owned by the Crow (Apsáalooke) Tribe (Tribe). The reservation is primarily rural with a number of dispersed small towns. Towns include Crow Agency (reservation headquarters), Fort Smith, Hardin, Lodge Grass, Pryor, St. Xavier, and Wyola.

The reservation includes the northern end of the Bighorn Mountains, Wolf Mountains, and Pryor Mountains. The Bighorn River is the largest hydrologic feature on the reservation. The Bighorn River flows north through the center of the reservation. The Little Bighorn River, a tributary, joins the Bighorn River just outside the town of Hardin, Montana, and the Bighorn River continues north to its confluence with the Yellowstone River. Part of the western reservation boundary runs along the ridgeline separating Pryor Creek and the Yellowstone River, and the city of Billings is approximately 10 miles northwest of this reservation boundary.

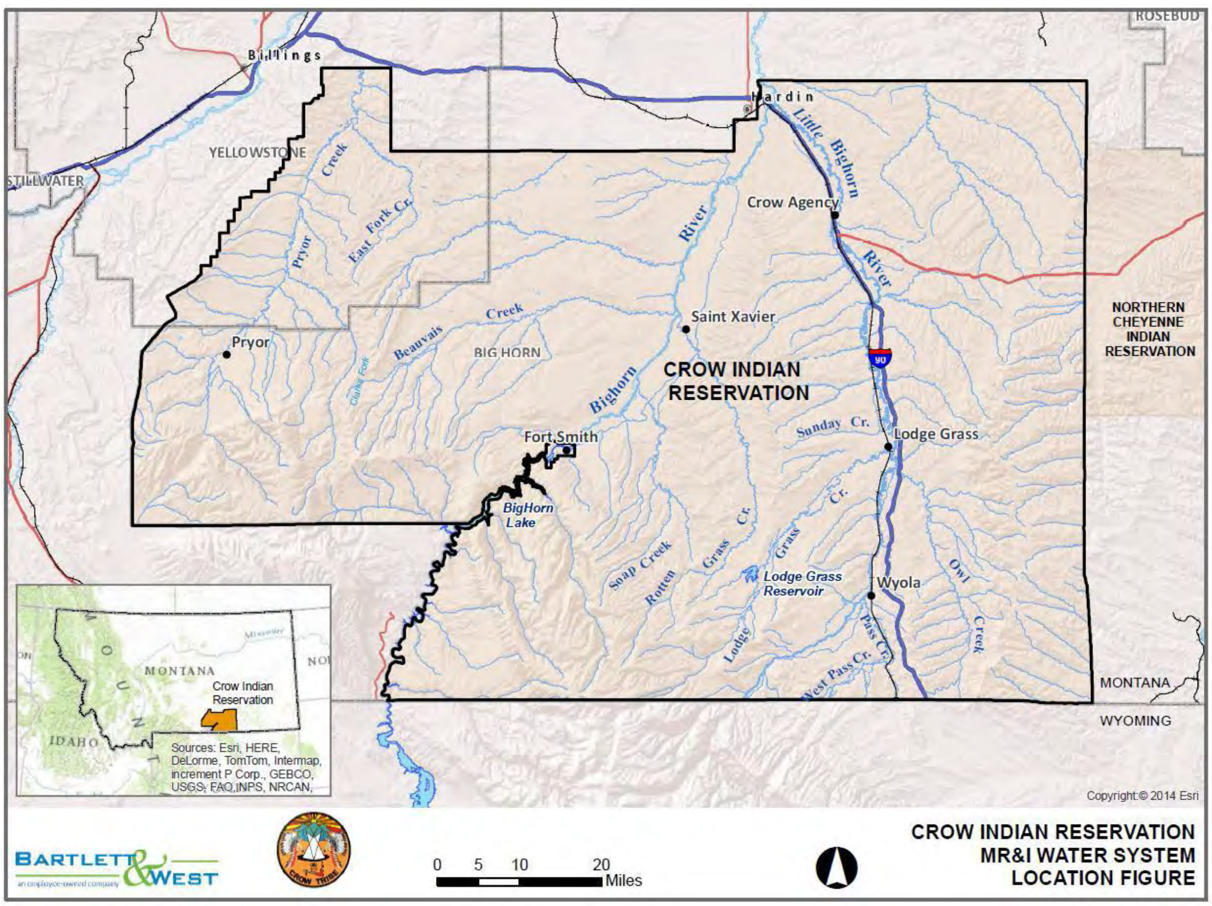

Figure 1-1: General Location of Project Area

Currently, communities on the reservation meet their drinking water needs via surface water or ground water wells and rural residents are served by ground water wells. Many of these ground water sources are believed to be influenced by surface water and have had numerous deficiencies documented by the Indian Health Service's Sanitation Deficiency System and in Community Data Sheets and Sanitary Surveys completed by the U.S. Environmental Protection Agency (EPA) and Montana Department of Environmental Quality (MTDEQ). In a review of this data, MSE HKM (1999) summarized these deficiencies, which vary from lack of enough water to serve existing populations to noncompliance with federal drinking water standards including chlorine contact time, turbidity removal, and testing frequencies. High levels of *E. coli* bacteria have been recorded at the Crow Agency water treatment facility intake, indicating an elevated risk of *Cryptosporidium* contamination (Eggers et al. 2011). The water quality of rural wells ranged from poor to good. Testing of these rural wells indicated levels of alkalinity, hardness, sodium adsorption, sulfate, nitrogen, and, in some instances, uranium that were higher than regulatory drinking water standards (MSE HKM 1999). Very high levels of total dissolved solids and positive coliform tests were found in more than 50% of the wells investigated and multiple wells had manganese levels higher than EPA standards (Eggers et al. 2011). Additionally, large areas of the reservation are uninhabitable because the groundwater is either too low in quality or quantity to provide a reliable source of water.

A report titled "Crow Indian Reservation Municipal, Rural, and Industrial Water System Engineer Report" was prepared by DOWL-HKM (July 2008; updated December 2009) to support the, then proposed, federal legislation to approve a settlement for the Tribe's reserved water rights. This document provided a preliminary assessment of the water demands of the reservation and described a potential water delivery and treatment system to improve the Tribe's domestic water supplies that could meet current and future needs. Based in part upon the DOWL-HKM report, Title IV of the Claims Resolution Act of 2010 (Public Law 111-291) authorized $246,381,000 for the design and construction of a Municipal, Rural, and Industrial Water System (MR&I System) on the Reservation. The Tribe intends to construct a reservation-wide water system capable of reliably distributing up to 4.5 million gallons per day (MGD) of high quality water.

1.2 Purpose and Need for Action

To help facilitate the design of the MR&I System, information is needed to demonstrate the ability of various water treatment techniques to effectively treat the proposed source water and produce water which would meet the water quality needs of the Tribe.

The Tribe has identified a need to produce water which would:
1) Meet EPA drinking water quality standards (both primary and secondary);
2) Produce 4.5 MGD with the option to expand to 6.7 MGD;
3) Be cost effective to the Tribe and, ultimately, the water users.

By gathering the needed information, the Tribe would be able to more thoroughly compare the available treatment methods in order to select a preferred treatment process for full-scale operation which would meet their needs, and provide the Tribe an opportunity to optimize equipment and minimize costs.

1.3 Decisions to be Made

Public Law 111-291, which authorized the design and construction of the MR&I System, also identified the Bureau of Reclamation (Reclamation) as the lead federal agency with responsibility for:
- Providing funding and technical oversight of the project, including ensuring that the project meets applicable industry standards;
- Considering the equitable distribution of water and improving the cost effectiveness of the project;
- Protecting and conserving trust assets of the Tribe and of Tribal members, including providing

oversight of the expenditure of appropriated federal project funds to best serve the interests of the Tribe and its members; and
- Making decisions regarding the project as part of environmental review under the National Environmental Policy Act (NEPA) of 1969 (as amended, 42 U.S.C. Section 4221-447).

Because the proposed action would cross lands held in trust by the federal government for the Tribe, the Bureau of Indian Affairs (BIA), the federal agency responsible for decision-making related to these trust lands, is a cooperating agency with responsibility for:

- Protecting and conserving trust assets of the Tribe and of Tribal members, including providing oversight of the expenditure of appropriated federal project funds to best serve the interests of the Tribe and its members;
- Deciding whether to issue a surface use agreement (SUA) to the Crow Tribe Water Resources Department (CTWRD) under 25 CFR 162 to facilitate legal access and implementation of the Tribe's proposed action;
- Deciding whether to issue a right-of-way (ROW) request for utility and access under 25 CFR 169 to facilitate the Tribe's legal access to the proposed project location.

BIA decision-making for SUA and ROW requests is established by the BIA's responsibility under 209 DM 8, 230 DM 1, 3 IAM 4 (release No. 00-03), 10 BIAM 4, as amended.

NEPA requires Federal agencies to consider the potential environmental consequences of their actions and any reasonable alternatives, before deciding whether and in what form to take an action. The responsible official for making the federal decision is the Regional Director, Great Plains Region, Reclamation.

If appropriate, this Environmental Assessment will culminate in a Finding of No Significant Impact and Decision Document, wherein Reclamation will document its determination that the selected/authorized action will have no significant environmental impacts.

Alternatively, Reclamation may determine that the proposed project would have significant environmental impacts and, as a result, work will begin on an Environmental Impact Statement (EIS). Once the EIS is prepared, the NEPA process would conclude when a Record of Decision is issued.

2.0 Proposed Action and Alternatives

2.1 No Action Alternative

Under the No Action Alternative, the Tribe would proceed with design of the MR&I System after evaluating and refining the available treatment alternatives using theoretical and laboratory testing methods, such as graphical/flow chart modeling and bench-scale testing, and without the use of on-the-ground pilot studies.

Graphical/flowchart modeling uses several pieces of information to predict the quality of water expected to be produced by specific water treatment methods or equipment. The first step in graphical/flowchart modeling is to periodically collect raw water (water in its natural state, prior to any treatment) samples from the proposed source water. Raw water samples provide baseline information on the presence and amount of various materials in the source water. The second modeling step is to estimate the efficiency of various treatment methods and equipment at removing unwanted materials from the raw water. The efficiency of removing the unwanted materials is estimated using manufacturer provided data. Typically, manufacturers calculate the efficiency of their equipment based upon an average of the equipment's past performance. Some manufacturers use little or no raw water information in their efficiency calculations, while other manufacturers use a computer system where customers input their raw water data to get a more specific efficiency estimate. The final step is to calculate the amount of water each treatment method or equipment is capable of producing after the treatment process is complete, including water which would meet the desired quality standards (commonly known as "finished water") and water that is not intended for distribution and consumption (commonly known as "waste water"). These output results are highly dependent upon the raw water data and efficiency data. Inaccurate information related to chemical doses, mixing speeds, contact time, useful lifetime of media/filters, interactions between processes, efficiency data, and variations in raw water (due to conditions such as seasonal temperature fluctuations, changes in contaminant levels as a result of spring season or irrigation season runoff, etc.) can produce inaccurate output results. If one component of the treatment process does not perform as expected, the error would be carried through to all following processes, compounding the errors.

Bench-scale testing is a small, laboratory scale method of studying the effectiveness of different water treatment chemicals, in a range of doses, in removing unwanted materials from the raw water source. The output from bench-scale testing is an estimate of the amount of unwanted material(s) removed from the raw water at a singular step in a series of water treatment steps. Bench-scale testing is essentially a snapshot of each treatment process, rather than a film that illustrates the chain of treatment process. Because bench-scale testing only provides a snapshot in time, this method does not fully characterize the removal of unwanted material for processes that build upon each other. For example, if the chemical dose, mixing speed, or contact time is not representative of the full treatment process, the results would not be indicative of the full scale treatment plant.

While graphical/flow chart modeling and bench-scale testing methods have the benefits of being relatively low cost and able to provide results in weeks, rather than months, there also are disadvantages to these methods, particularly when their results are not validated and further refined through a pilot plant study process. If the Tribe proceeded with design of the MR&I System without verifying the calculated or estimated efficiency of the treatment method alternatives through an on-the-ground pilot study, the Tribe could incur startup delays, significant retrofitting costs, and an inability to meet drinking water standards once the project reaches full-scale operation. Thus, this alternative would not meet the purpose and need for the project because it would not provide the level of information necessary to be reasonably certain the MR&I System would be able to produce water which would meet EPA drinking water standards. While the No Action Alternative does not meet the purpose or need, it is presented here for purposes of comparison and as a baseline with which to compare the environmental effects of the Proposed Action (see Section 3.0).

2.2 Pilot Plant Alternative (Preferred Alternative/Proposed Action)

This alternative would include graphical/flow chart modeling and bench-scale testing, followed by an on-the-ground pilot plant study. Pilot plant testing is the standard industry preferred method for testing water treatment processes because pilot studies can characterize interactions between different processes and allow testing of treatment processes that are difficult to accurately determine through graphical/flow diagrams or bench-scale tests. A pilot plant study builds upon theoretical methods to create the most complete understanding of treatment processes to allow for accurate design of a full scale treatment facility which can meet the Tribe's needs.

The proposed pilot plant would treat the proposed source water for the MR&I System (Bighorn River - ground water under the influence of surface water) to demonstrate the varying effectiveness of each proposed technology, to provide a basis for comparing alternatives from a performance perspective, and to allow optimization of equipment to ensure all EPA limits and standards are met (EPA discharge permit, filed for and approved by the EPA on February 18, 2015, see Appendix A). Pilot plant construction is expected to begin in summer 2015. The pilot plant study would be operated for three months during variable and seasonal source water conditions and decommissioning of the plant would be completed by the end of 2015.

2.2.1 Project Location and Components

The pilot plant would be located in the NE ¼ of Section 23, Township 4 South, Range 32 East on lands owned by the Tribe (Figure 2-1). The location would be approximately ¼ mile west and ¾ mile north of St. Xavier, Montana.

Raw source water would be drawn from an intake well on the east bank of the Bighorn River near St. Xavier, Montana and pumped to a treatment plant building via a supply pipeline installed on the ground surface (Figure 2-1). There are two potential pipeline routes that differ in how they cross the NE ¼ of Section 23, although the west end of both routes is identical.

The selection of a pipeline route is based on land access availability through the NE ¼ of Section 23. The preferred route (the northern of the two) runs east-west approximately through the center of the north half of Section 23. The Tribe has completed negotiations to purchase the land and a deed has been issued to the Crow Tribe. If this route is used, an SUA between the Tribe and the BIA would be required. The alternate route (the southern of the two routes) parallels the preferred route about 1/8 mile south on a combination of tribal trust land and fee land. It runs north-south from the pilot plant, east-west through the middle of Section 23 and diagonally back to join the preferred route (Figure 2-1). To cross the fee portion of this route, an easement would be required between the Tribe and the fee owner.

Allotted lands: lands that are held in trust by the federal government for the use of individual Indians or their heirs.

Tribal trust land: lands that are held in trust by the federal government for the use of the communal/entire Tribe.

Fee land: lands that are held by an owner, whether Indian or non-Indian.

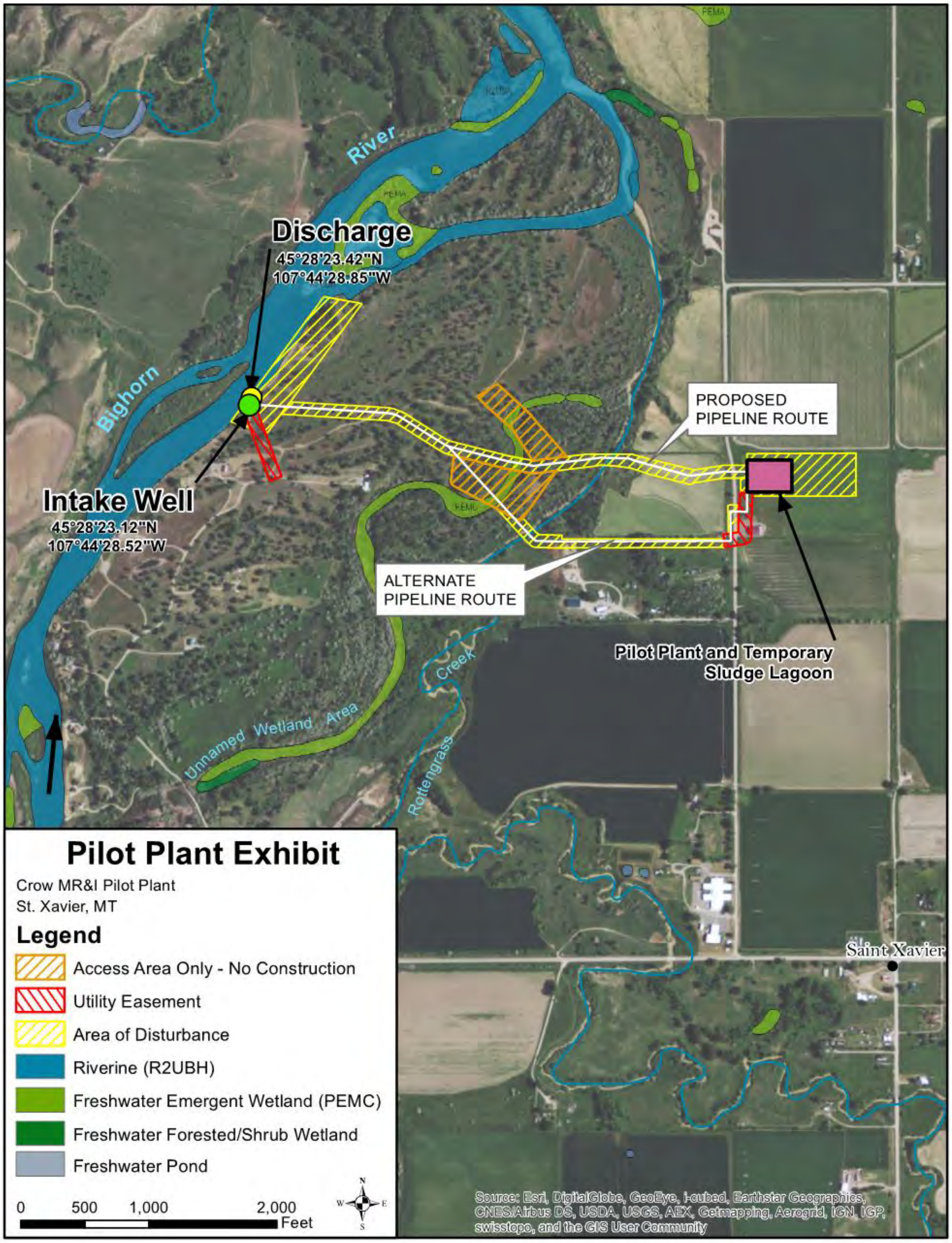

Figure 2-1: Pilot Plant Exhibit. Proposed location of pilot plant and other project components, areas of access and disturbance, and utility easements. Also denoted on the map in blue text is Rottengrass Creek and an unnamed wetland drainage channel.

The Pilot Plant Alternative would include the following components and associated construction work activities, which are further described in the following sub-sections and in Table 2-1:

- Aquifer test wells;
- Intake;
- Supply pipeline;
- Utility easements;
- Treatment plant;
- Discharge pipeline and outlet; and
- Sludge ponds.

The maximum area of surface disturbance would be approximately 55 acres if the preferred pipeline route was used or 57 acres using the alternate pipeline route. Within the “area of disturbance” and “access areas,” (Figure 2-1), a skid steer may be used to move materials for installation of various project components. No access roads would be created. All gravel used in the project would be from a location presented to and approved by the BIA prior to obtaining and placing.

Table 2-1: Summary of Project Components, Maximum Disturbance Dimensions, and Activities

Project Component	Location	Width (feet)	Length (feet)	Area (acres)	Cause of Disturbance
Aquifer Test Wells	Eastern bank of Bighorn River	Irregular	Irregular	29.9	Drill rigs gaining access to observation/supply well locations, drilling and development of observation/supply wells, aquifer testing
Intake	Eastern bank of Bighorn River	---	---	---	Disturbance due to the intake would be part of the aquifer test well work
Supply Pipeline ROW	*Preferred Route* Running east from intake well to pilot plant	50	4136	4.75	Skid steer traffic, foot traffic, constructing pipe on the ground surface
	Alternate Route Running east and south from intake well to pilot plant	50	4823	5.54	Skid steer traffic, foot traffic, constructing pipe on the ground surface
Utility Easements	Easement to intake well	50	570	0.65	Installation of electrical service by Big Horn County Electric
	Easement to pilot plant	50	507	0.58	Installation of electrical service by Big Horn County Electric
Treatment Plant	Pilot plant structure	28	36	0.02	Excavation/cut and fill, construction of pilot plant structure
	Parking area	100+ irregular	300+ irregular	0.77	Smoothing area surrounding pilot plant structure, surfacing
	Buffer area	Irregular	Irregular	3.6	Excavation/cut and fill as determined necessary, but area to be limited

Table 2-1: Summary of Project Components, Maximum Disturbance Dimensions, and Activities

Project Component	Location	Width (feet)	Length (feet)	Area (acres)	Cause of Disturbance
Discharge Pipeline ROW and Outlet	*Preferred Route* Running west from pilot plant to river	50	4146	4.76	Skid steer traffic, foot traffic, constructing pipe on the ground surface
	Alternate Route Running northwest from pilot plant to river	50	4833	5.55	Skid steer traffic, foot traffic, constructing pipe on the ground surface
Sludge Ponds	East of Pilot plant	615	150	2.1	Excavation of sludge ponds, including earth moving equipment and material storage
Access Area	Northern area	Irregular	Irregular	3.23	Potential disturbance due to skid steer traffic
	Southern area	Irregular	Irregular	5	Potential disturbance due to skid steer traffic

Aquifer Testing and Intake Well

Prior to operation of the pilot plant, aquifer testing would occur near the eastern bank of the Bighorn River. This testing would include development of the intake well, drilling of seven observation wells, placement of two drive point streambed piezometers, and placement of a stilling well (Figure 2-2). These facilities would be used to monitor aquifer drawdown and hydraulic connectivity of groundwater and surface water. The stilling well would monitor river stage prior to, during, and after aquifer testing.

Installation of the intake well would involve drilling a 10-inch wide borehole and advancing a 14-inch wide steel well casing and 10-inch wide steel casing plus screen 30 feet below ground surface into the water table. As the 14-inch casing is removed, a gravel filter pack would be placed behind it, followed by coated bentonite chips until the static water level is reached, then non-coated bentonite chips above that level. Following well installation, water would be pumped until it ran clear and turbidity measurements became relatively consistent. Installation of the monitoring well would include drilling a six-inch wide borehole, advancing a six-inch wide steel casing (which would be removed during well construction), and installation of a two-inch polyvinyl chloride (PVC) screen and a filter pack consisting of silica sand topped with coated bentonite chips below the water table and non-coated bentonite chips above. Piezometers would be placed into the streambed of the Bighorn River by driving 3/4-inch diameter screened points 1.5-2 feet below the streambed surface. The piezometers would be removed once aquifer testing is complete. A stilling well would be installed within the Bighorn River by attaching a PVC pipe (housing a transducer) to a steel fence post and driving the post into the streambed. The stilling well would be removed immediately after testing.

Access to the intake well site would be via an existing access road on fee land. Verbal approval has been obtained from the landowners; an executed agreement is being developed concurrently for access and development of the intake well.

Figure 2-2: Aquifer Testing Facility Map. Location of proposed observation wells, drive point streambed piezometers, and stilling well. Also indicates location of existing boreholes. (NewFields 2015)

<u>Supply Pipeline</u>

For either pipeline route option, three-inch diameter PVC Yelomine would rest on the ground surface with the exception of three areas: the Mission Loop road crossing, Rottengrass Creek, and an unnamed wetland.

The Mission Loop road crossing, immediately west of the proposed pilot plant, would be shallow trenched at approximately two feet wide by two feet deep for a total length of 50 feet. Placement and removal of the pipes is expected to take one day and interruptions to traffic are expected to be minimal. There would be no disturbance to normal traffic flow during the time when the pilot plant is in operation. No changes to the roadway would occur, although resurfacing would be completed, as needed. The gravel surface would be monitored and repaired during the project to maintain the road crossing to its existing condition.

The pipeline would also cross an unnamed wetland area and Rottengrass Creek in the N ½ of Section 23, over which the pipeline would be suspended from two posts on either side of the features so as not to disturb surface soils or vegetation. The pipeline suspended over the unnamed wetland and Rottengrass creek would be conveying raw ground water to the pilot plant. As such, if a break in the suspended line were to occur, the water leaked would not contain any chemicals or substances that would be damaging to the wetland or creek. If a leak were to occur, it would be detected due to loss in supply pressure and the line would be checked and any necessary corrective action taken.

Power Supply

Power to the supply well and the pilot treatment facility would be supplied via Big Horn County Electric or by on site generators. If Big Horn County Electric provided power service, three temporary utility easements would be required (indicated on Figure 2-1). Two of the easements are adjacent to each other and provide utilities to the intake (area denoted near intake) but are considered two easements because of different land ownership; the third easement, located next to the treatment plant, is on Tribal land. All three easements would be for either buried or overhead electrical services, to be determined by Big Horn County Electric based on the existing power supply. If on site generators were utilized, operation, maintenance, and fueling would be done in accordance with a site specific spill prevention plan or storm water pollution prevention plan (to be determined based on the particular generators used). Maintenance and fueling would be done by trained individuals and in designated areas.

Treatment Plant, Discharge Pipeline and Outlet, and Sludge Ponds

The pilot plant treatment process would create two outputs: finished water and sludge waste. The clean, treated water would be discharged to the Bighorn River via a two-inch diameter PVC Yelomine pipeline running parallel to the supply pipeline, also laid on the ground surface. The location of the discharge pipeline would follow whichever supply pipeline route was selected, indicated on Figure 2-1. The discharge pipeline would be installed across Mission Loop road and would be suspended across Rottengrass Creek and the unnamed wetland area following the same procedures and monitoring as the supply pipeline (See above sub-heading “Supply Pipeline”). Potential leaks in the discharge pipeline would be detected from loss in pressure and would be fixed as necessary.

The structure used to discharge finished water into the Bighorn River would consist of the pipe laid on the ground surface and extending 12 inches (horizontally) from the normal low water line of the riverbank. The pipe would be supported by two t-posts, which would be driven into the riverbank a minimum of 24 inches. Discharge would occur above the water surface, but in sufficiently deep water to prevent erosion and sedimentation along the river bank or river bed.

The sludge waste would be held onsite in a temporary sludge lagoon next to the pilot plant (Figure 2-1). The outdoor lagoon would collect the backwash and sediment produced (34 gpm) during the flocculation/sedimentation treatment processes. This waste would be held in the lagoon and water from the waste would be allowed to evaporate and/or infiltrate into the soil. After the pilot study, the remaining sludge would be evaluated and disposed of either though incorporation into the existing soil or at the nearest appropriate landfill. The lagoon would be backfilled and returned to the original land use, unless otherwise requested by the landowner.

2.2.2 Pilot Testing/Studies

The treatment methods proposed for pilot testing include: oxidation, coagulation/flocculation and settlement in a plate settler, ultrafiltration, low pressure reverse osmosis membranes, and biological media filtration. These methods were chosen based on raw water quality and anticipated treatment needs to meet desired effluent quality (For further detail, refer to *WTP Alternative Process Design Report* by Bartlett & West June 15, 2015, Appendix B). The flow schematic shown in Figure 2-3 illustrates each treatment step, indicated within boxes, along with additions of treatment chemicals and the flow of water throughout the process. The testing of these particular treatment processes are described in more detail below.

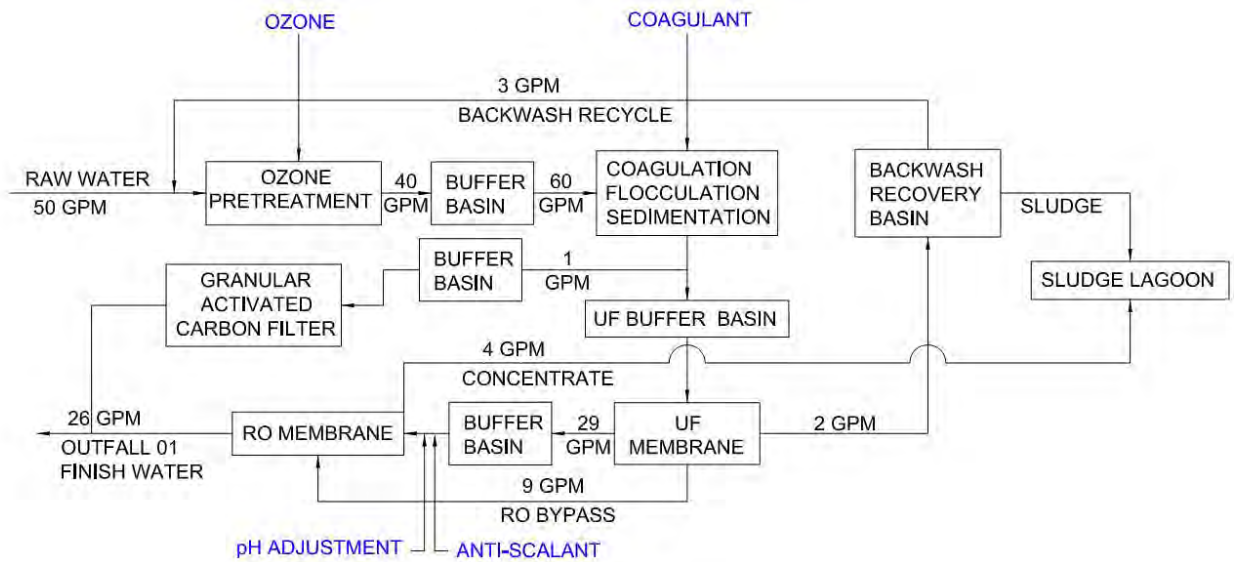

Figure 2-3: Flow Schematic of MR&I Pilot Plant. Treatment steps are indicated within boxes. The inflow of raw water begins in the upper left corner. The flow continues as indicated by arrows to the right, then down (with a branch in the flow), then to the left, with the treated water outflow in the lower left corner. Estimated inflow/outflow rates in gallons per minute (GPM) are shown between applicable treatment steps. Chemical additions are indicated in blue text. UF=ultrafiltration; RO=reverse osmosis

Pretreatment oxidation is the first step in the treatment process. During bench-scale testing, sodium hypochlorite and permanganate would be tested to determine which is a more effective oxidant. The more effective chemical of the two, along with ozone, would be used during the pilot study. The pilot testing of oxidants would determine if oxidation is a necessary component of the overall treatment process and whether it aids in the removal of iron, manganese, and undesirable tastes and odors.

Secondly, a plate settler would be used to perform coagulation, flocculation, and settlement of solids. A plate settler is recommended, rather than a sediment basin, due to footprint size and retention times necessary for settlement. Different coagulates (alum and ferric chloride) would be tested during bench-scale testing and the chemical shown to be most effective would be pilot tested. Pilot testing would demonstrate the level of effectiveness of the plate settler to remove iron, manganese, and turbidity.

Following the plate settler, the flow would split to feed the biological media filtration and ultrafiltration processes. Biological media filtration would be used to remove iron, manganese, and total organic carbon. Constituents would be removed from the water via adsorption by the activated carbon media and the biological growth media cap. The remaining portion of water would pass through ultrafiltration.

Ultrafiltration, the third process in the treatment chain, would be utilized to remove iron, manganese, total organic carbon, turbidity, and microorganisms. The removal of constituents is achieved through filtering water through a membrane. The level of removal depends upon the size of the constituents and the membrane pore size. Ultrafiltration and microfiltration both were considered for piloting, but ultrafiltration was decided upon because its smaller membrane pores would result in a greater removal efficiency and better removal of viruses. Ultrafiltration would be included as a pre-filtration process for the final treatment step.

The final step of treatment would be reverse osmosis and would target removal of hardness, total dissolved solids, alkalinity, sulfate, iron, manganese, aluminum, total organic carbon, and dissolved organic carbon. Reverse osmosis needs ultrafiltration upstream in the treatment process to increase the performance of reverse osmosis, as well as to protect the membranes by removing all larger particulates. Nanofiltration also was considered, but reverse osmosis was preferred due to the lower life cycle costs on similar projects.

Disinfection testing would be done in small contained units separate from the pilot treatment train to avoid the possibility of sodium hypochlorite or ammonia entering the water to be discharged to the Bighorn River. The disinfection options potentially tested in the pilot study include ozone, free chlorine, and chloramines.

2.2.3 Other Treatment Options Not Piloted

Lime softening is not part of the pilot study because the physical footprint and equipment required to do so would be prohibitive. In addition, lime softening would produce large quantities of sludge to be handled. Lime softening would be bench-scale tested to allow for partial comparison to reverse osmosis softening.

Ultraviolet radiation for oxidation or disinfection was considered, but traditionally is not pilot tested because calculations yield the same results.

The feasibility and availability of equipment resulted in other treatment processes being dropped from consideration for the pilot study. Further discussion about other treatment methods and flow schematics not proposed for piloting are included in the *WTP Alternative Process Design Report* by Bartlett & West (June 15, 2015, Appendix B).

2.2.4 Decommissioning and Reclamation

Details of proposed decommissioning and reclamation actions are provided in the *Decommissioning and Reclamation Plan* in Appendix C and summarized below.

Following completion of the pilot plant study, the intake supply and observation wells would be capped in place. The supply and discharge pipelines, pilot plant building, and associated equipment would be removed from the ground surface and salvaged. The solid waste material from the sludge lagoons would be evaluated to determine if material can be incorporated into the soil or if the material should be excavated and hauled to the nearest appropriate landfill. Any disturbed soils, including the area of the pilot plant structure, sludge ponds, and other minor disturbed areas would be backfilled and recontoured approximately to original contours and returned to original land use, unless otherwise requested by owner. Disturbed features of surface hydrology and vegetation would be restored according to BIA requirements and Natural Resource Conservation Service (NRCS) recommendations, or landowner request, and monitored.

3.0 Affected Environment and Environmental Consequences

This section describes the existing conditions of nine environmental resources, as well as the potential effects of each alternative on those resources. Effects may be direct or indirect, positive (beneficial) or negative (adverse), and long term (permanent, long-lasting) or short term (temporary). Cumulative effects and measures that would be implemented to reduce, minimize or eliminate impacts (conservation measures) are discussed for each resource. A summary of impacts by resource issues for each alternative is provided in Table 3-1. The analysis of effects to each resource is described in terms of the maximum area which could potentially be disturbed under each alternative.

Several environmental factors would not be affected and are excluded from analysis. Factors excluded from this section include geology, visual resources/viewsheds, noise, air quality, floodplains, and social and economic conditions.

Table 3-1: Summary of Effects to Resources

	Proposed Action		
Resource	**Preferred Pipeline Route**	**Alternate Pipeline Route**	**No Action**
Soil and Vegetation Surface Disturbance	Surface disturbance due to pipe-laying and equipment access would be 55 acres. The disturbance would be limited to compaction of soils, flattening of plants, and removal of as few trees as possible.	Surface disturbance due to pipe-laying and equipment access would be 57 acres. The disturbance would be limited to compaction of soils, flattening of plants, and removal of as few trees as possible.	No effect.
Soil Excavation	Limited to eight acres in area for the pilot plant, sludge pond, and Mission Loop Road crossing.	Limited to eight acres in area for the pilot plant, sludge pond, and Mission Loop Road crossing.	No effect.
Surface and Groundwater	Limited groundwater removal during well development and aquifer testing. During operation, intake well would extract groundwater at 60 GPM and Bighorn River would receive treated drinking water at 26 GPM.	Limited groundwater removal during well development and aquifer testing. During operation, intake well would extract groundwater at 60 GPM and Bighorn River would receive treated drinking water at 26 GPM.	No effect.
Wetlands	No effect.	No effect.	No effect.
Land Use	Temporary use (one growing season) of eight acres of intermittent farmland for pilot plant/sludge lagoon site.	Temporary use (one growing season) of eight acres of intermittent farmland for pilot plant/sludge lagoon site.	No effect.
Fish and Wildlife	No effect to fisheries. Indirect wildlife habitat disruption and displacement would be minimal and last a maximum five months.	No effect to fisheries. Indirect wildlife habitat disruption and displacement would be minimal and last a maximum five months.	No effect.
Cultural	No effect.	Impacts to an identified cultural resource would be avoided by pipeline route and design aboveground with no surface disturbance. No effect.	No effect.
Paleontological	No effect.	No effect.	No effect.
Environmental Justice	No negative health or environmental effects to minority or low income populations are anticipated.	No negative health or environmental effects to minority or low income populations are anticipated.	No effect.
Indian Trust Assets	Positive effects to property and resources of Tribe. Precursor to full	Positive effects to property and resources of Tribe. Precursor to full	Poorly informed decision making

Table 3-1: Summary of Effects to Resources

Resource	Proposed Action		No Action
	Preferred Pipeline Route	Alternate Pipeline Route	
	scale drinking water treatment facility to benefit the Tribe and their assets. Informed decision making resulting in cost savings and reduced impacts to resources.	scale drinking water treatment facility to benefit the Tribe and their assets. Informed decision making resulting in cost savings and reduced impacts to resources.	with potential for significant costs to Tribe, startup delays of full scale plant, broader impacts to resources.

3.1 Summary of Effects of No Action Alternative

No effects would occur to soils, vegetation, water resources, wetlands, land uses, fish and wildlife, cultural resources, paleontological resources, or minority or low income communities as a result of the No Action Alternative. Effects from other existing natural disturbance regimes, human-induced disturbances, or management actions would continue to impact these resources. The No Action Alternative would likely result in a negative impact to Trust benefits and assets of the Tribe. The No Action Alternative represents poorly informed decision making which would likely result in significant costs for the Tribe or startup delays during full scale construction and operation. The lack of information and ability to plan may also result in greater impacts to the environment and resources on a broader scale, including Indian Trust Asset (ITA) resources, because of the more extensive project area and wider-ranging implications of the full scale plant.

3.2 Soil Resources

The 1981 Farmland Protection Policy Act (FPPA) requires examination of the effects of federally funded projects prior to the acquisition of farmlands classified by the NRCS as Prime, Prime if Irrigated, or Statewide/Locally Important Farmlands.

3.2.1 Existing Soils of the Project Area

The project area is comprised of five soil units (Figure 3-1) (USDA-NRCS 2015). The boundary delineated on Figure 3-1 is considerably larger than the project/disturbance area due to the limitations of the NRCS soil mapping application. The soil types are Alluvial land, Haverson and Glenberg soils, Haverson and Lohmiller wet soils, Kyle silty clay, and Riverwash. The Riverwash soil is along a small section of the riverbank that would not be disturbed by the project. The other four soils are further described below.

A majority of the supply and discharge piping would cross Haverson and Glenberg soils. The ability to perform shallow excavations in these soils can be somewhat limited due to the soil's flooding potential and the tendency to create dusty conditions, both of which results in unstable excavation walls. The tendency of these soils to erode in windy conditions is classified as moderate to considerable and the tendency to erode in water is classified as moderate. Haverson and Glenberg soils are moderately corrosive to concrete and highly corrosive to steel. These soils are designated "Prime if Irrigated" according to the NRCS (USDA-NRCS 2015). This area is currently not farmed or irrigated.

Rottengrass Creek and the unnamed wetland area to the west have soils classified as wet Alluvial land. The intake and discharge pipelines would cross through these soil bands. This material presents a high probability of steel corrosion. The wind erodibility of the soil is not classified and is low to moderately erodible by water. The Alluvial land is classified as somewhat limited for shallow excavations. This classification is based on the depth to the saturation zone, possibility of flooding, being dusty, and having unstable excavation walls.

If the alternate pipeline route is used, the pipeline would cross an area of soils classified as Haverson and Lohmiller wet soils. Soils of this classification are somewhat limited for shallow excavations due to depth of saturated zone, being dusty, and having unstable excavation walls. Wind erodability of the soil is low and moderate due to water. This soil is highly corrosive to concrete and steel.

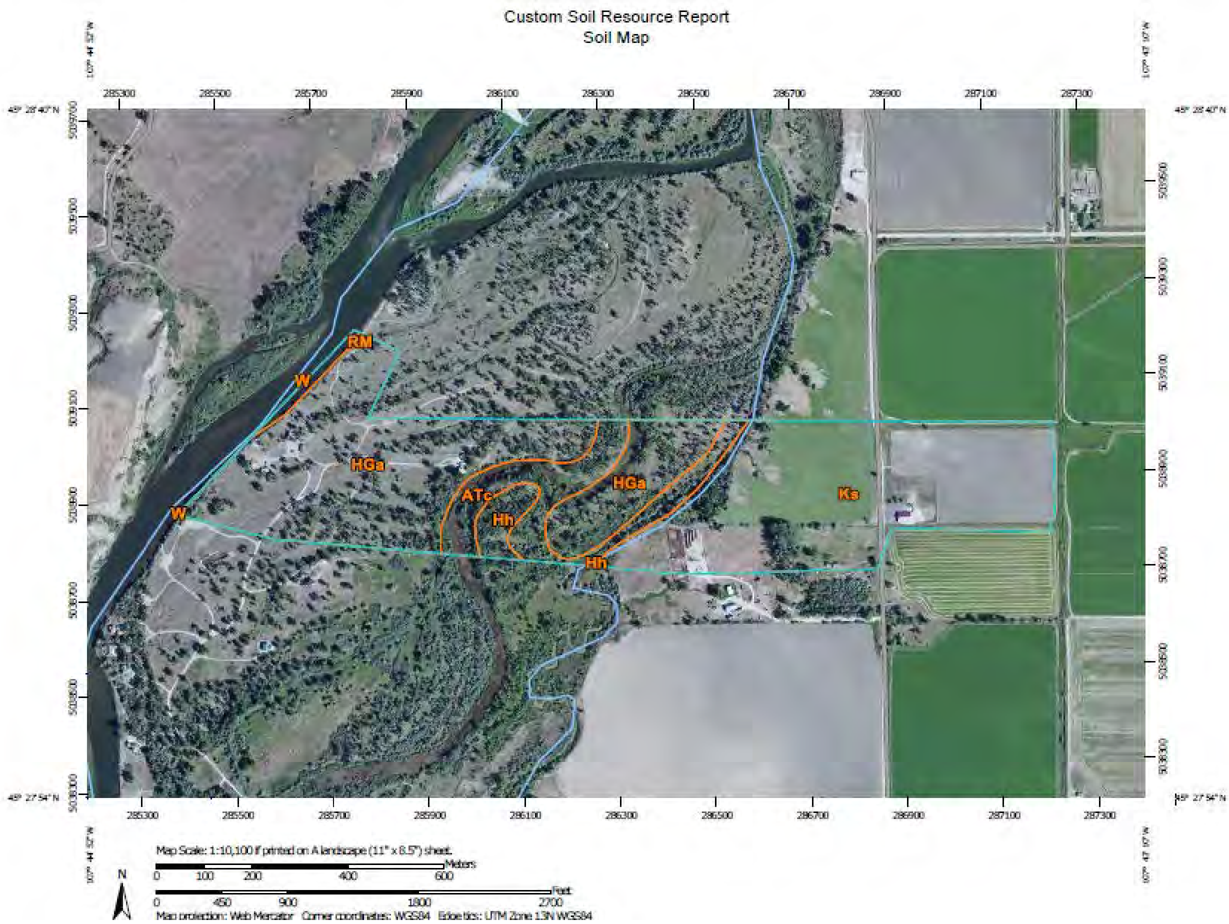

Figure 3-1: Soil Units of the Project Area. ATc – Alluvial land wet, HGa – Haverson and Glenberg soils, Hh - Haverson and Lohmiller wet soils, Ks - Kyle silty clay, RM – River wash, W - Water

The site proposed for the pilot plant and temporary sludge lagoon is classified as Kyle silty clay with slopes of 0-2%. This soil is well drained and rated as “not limited” for lagoons. The wind and water erodibility of the soil is classified as moderate and low, respectively. Kyle silty clay presents a moderate concern for concrete corrosion and a high concern for steel. This soil group is classified as somewhat limiting for shallow excavations based on unstable excavation walls, having too high of a clay content, and being dusty. The pilot plant/lagoon site is within an agricultural field and thus the upper soil horizons have been previously disturbed via cultivation.

3.2.2 Direct, Indirect and Cumulative Effects to Soils from the Pilot Plant Alternative

If the proposed pipeline route was used, approximately 1,800 feet of the pipeline would cross Haverson and Glenberg soils designated “Prime if Irrigated,” and if the alternate pipeline route was used, approximately 1,600 feet would cross these soils. Since these soils are not currently farmed or irrigated, and since the pipeline would be temporarily laid on the soil surface, there would be no conversion of the use or purposes of these soils. Therefore, the project would have no impact to farmland soils of importance protected under the FPPA.

Potential effects to soils would include temporary disturbances, one growing season at the most, during construction and excavation and would be limited to within the project area. Potential direct impacts to soils include compaction, disturbance of soil horizons, and chemical contamination. Compaction may occur from the use of heavy equipment during construction and reclamation. The area of possible surface disturbance would total approximately 55 acres for the preferred pipeline route and 57 acres for the alternate pipeline route (Figure 2-1). Disturbance of soil horizons would occur during excavation, which would include the area of the pilot plant building, sludge lagoon, and Mission Loop road crossing, for a total of eight acres. This acreage would not differ between pipeline route options. In the event of a spill associated with equipment refueling, localized chemical contamination of soils could occur.

Soils exposed during construction activity would be indirectly affected due to increased susceptibility to erosion until vegetation is established. Temporary sediment releases would potentially occur during construction anytime water is available to transport excavated or unstable soils. By the next growing season, sediment release and transport would return to pre-construction levels due to re-vegetation efforts following the decommissioning of the pilot plant.

Past and present impacts to soils in the project area are primarily related to farming and ranching, which have cumulatively contributed to compaction and cultivation of soils in the area. This project would result in compaction and surface disturbance to areas that currently experience these impacts from ranching and other uses. Soil excavation would occur in areas of previous disturbance or cultivation. With the implementation of the conservation measures described below to minimize sedimentation, erosion, and contamination, the project would not measurably contribute to additional cumulative effects to soils.

3.2.3 Conservation Measures

Several measures would be in place to minimize impacts to soils. Both temporary and long term impacts would be minimized by limiting the construction area and the extent of excavation. The majority of the length of the supply and discharge pipeline would rest on the top of the ground surface rather than being trenched, preventing sub-surface disturbance and limiting potential for erosion and sedimentation to approximately eight acres of soils.

A site-specific Storm Water Pollution Prevention Plan (SWPPP) would be prepared and implemented for the project, which would outline measures and best management practices (BMPs) to minimize and mitigate construction stormwater runoff, sediment discharge, and erosion and spill prevention, as well as notification and corrective procedures. Temporary and long-term erosion and sediment control structures would be installed and dewatering measures would be implemented as necessary during and after construction and reclamation. Topsoil would be segregated from subsoils during excavations and stored on-site to be used for reclamation and seedbed preparation. Seeding and mulching would occur promptly after construction is complete in order to minimize the time soils are exposed to erosion. The seeding mixture would be determined through consultation with the BIA Natural Resource Group. Equipment re-fueling would occur in designated areas away from sensitive features. With the use of these measures, impacts or losses to soils as a result of the project would be minor and short term.

Several aspects of the project would also be in place to limit the potential effects of soils on construction materials. Supply and discharge pipelines would be made of PVC material to mitigate the corrosive nature of the Alluvial land, Haverson and Glenberg soils, and Haverson and Lohmiller wet soils. To further mitigate impacts both to and from the Alluvial land soil strata, the pipeline would be suspended across these areas rather than trenching or boring. This would be done for either of the pipeline route options. The pilot plant would be constructed aboveground, thus eliminating impacts on the building structure due to the corrosive nature of the Kyle silty clay.

3.3 Water Resources

The Clean Water Act (CWA) of 1977 (as Amended, 33 U.S.C. Section 1251) sets the basic structure for regulating discharges of pollutants to waters of the United States. The CWA gives the EPA authority to establish water quality standards, control discharges into surface and ground waters, develop waste treatment management plans and practices, and issue permits for discharges (Section 402) and for dredged or fill material (Section 404). The CWA makes it unlawful to discharge any pollutant from a point source into any navigable water of the U.S. without a permit obtained from the National Pollutant Discharge Elimination System (NPDES) program. The U.S. Army Corps of Engineers was consulted regarding Section 404 of the CWA and determined it was not applicable (Cathy Juhas, Regulatory Project Manager, Joint Application Review, pers. comm. 2014).

The CWA provides for the delegation by EPA of many permitting, administrative, and enforcement aspects of the law to state and tribal governments. The Tribe is in the process of establishing water quality standards and developing a ground water and surface water monitoring plan. Until the EPA adopts such standards, federal water quality regulations are applicable to tribal waters.

For the purposes of this EA, reference to state water quality standards were used, as they are equal to or more stringent than federal standards. The Water Quality Act is the basis for water quality protection in the state of Montana (Title 75, Ch. 5). The Administrative Rules of Montana define water quality standards and require the classification of waters in the state as “B-1”, “B-2”, or “B-3” according to beneficial uses each body of water should support, according to Section 303(d) of the CWA (Admin. Rules of Montana 2014, Rules 17.30.623, 17.30.624, and 17.30.625). Variations in water use classifications reflect the potential to support cold-water or warm-water fisheries.

The Tribe has quantified water rights to 500,000 acre-feet per year (AFY) of the natural flow of the Bighorn River, for currently developed uses and new development within the Reservation. In addition to the natural flow, the Tribe is entitled to an allocation of 300,000 AFY of water stored in Bighorn Lake, as measured at the outlet works of Yellowtail Dam. Up to an additional 150,000 AFY of stored water may be used by the Tribe, in the event of a shortage to the Tribe’s natural flow right of 500,000 AFY in the Bighorn River. (Settlement Act, Section 408)

3.3.1 Existing Surface and Ground Water Sources and Water Quality

Water supply for the pilot plant would be via an intake well located at 45°28’23.12”N and 107°44’28.52”W from groundwater under the influence of surface water from the adjacent Bighorn River (Figure 2-1). The

Bighorn River flows north through the reservation from the Montana-Wyoming state line and empties into the Yellowstone River. The Bighorn River is part of the Yellowstone River sub-basin and the Missouri River basin (MTDEQ 2014a). Other surface water resources within the project area include Rottengrass Creek, which is a perennial stream, and an unnamed wetland/intermittent stream. Both pipeline route alternatives cross both of these features in the north half of Section 23 (Figure 2-1).

The Bighorn River above Williams Creek is designated B-1 (supports cold-water fishery) and the Bighorn River mainstem from Williams Coulee to the Yellowstone River is designated B-2 (marginal support of cold-water fishery) (Admin. Rules of Montana, 2014, Rule 17.30.611). The Bighorn River from the north boundary of the Reservation to its mouth (Yellowstone River) is listed by the state as impaired as a result of not meeting water quality standards for lead and mercury (MTDEQ 2014 303(d) list; MTDEQ 2014b). The pilot plant intake/discharge is located north of St. Xavier and south of Williams Coulee. Therefore, the project is in a portion of the Bighorn River designated as B-1 and not listed as impaired.

Groundwater along the bank of the Bighorn River is considered under the influence of surface water. In the fall of 2014, an observation well was installed approximately 100 feet north of the proposed pilot well location. The well is approximately 20 feet in depth and constructed of two-inch PVC/PVC screen. This sample site reflects the anticipated water quality of the raw water proposed for use during the pilot plant study. Sample data that has been collected to date is included in Table 3-2.

Table 3-2: Summary of 2014 Grab Sample Data at Observation Well

	pH	Temp °C	Turbidity (NTU)	ORP (mv)	T. Hardness (mg/L)	Alkalinity (mg/L)	Iron (mg/L)	Manganese (mg/L)
Count	7	8	8	7	9	9	9	9
Max	7.83	15	1.33	-37	285	240	0.73	0.77
Average	7.57	11.7	0.61	-42	258	213	0.49	0.75
Min	7.47	9.6	0.27	-54	239	185	0.37	0.72

3.3.2 Direct, Indirect and Cumulative Effects to Water Resources from the Pilot Plant Alternative

Potential effects to water resources as a result of the project include removal and discharge of groundwater during development of the intake well and observations wells and associated aquifer testing; extraction of groundwater for operation of the pilot plant; and discharge of treated water from the pilot plant into the Bighorn River. These effects would all be temporary and minor and would not differ between pipeline route alternatives.

During development of wells, continual dewatering of the boreholes would be necessary. During aquifer testing, water would be pumped at a rate of 500-1000 gallons per minute (GPM) from the intake well until the water ran clear and consistent. The development of the wells would take about one day each and thus would only be a temporary disturbance to the local groundwater aquifer. Once each well is complete, the water table would realign to original levels. Withdrawals of water from the observation wells for sampling would be insignificant.

During operation of the pilot plant, the intake well would extract groundwater at a rate of 60 GPM. This rate is miniscule compared to the Bighorn River flow, of which the well would be influenced, with flows conservatively estimated at 753,086 GPM during the course of the pilot plant study. This estimate was determined using the minimum monthly flow from May to November 2012 to 2014 (the lowest flow month was October 2012) (USGS 2015). No long-term impacts to the groundwater aquifer are anticipated, due to the relatively minor amount of water which would be withdrawn. The aquifer level is under the influence of surface water flows and would be expected to continuously readjust to near-original levels during the period of withdrawal and to original levels after withdrawal ceases at the end of the study.

The discharge structure for the pilot plant would occur in sufficiently deep water to prevent erosion and sedimentation along the river bank or river bed to protect water quality. During pilot plant operation, clean, treated water would be discharged into the Bighorn at a rate of 26 GPM. The treated water would be of equal or higher quality than the river, therefore, no negative impacts to water quality would occur. The U.S. Army Corps of Engineers was consulted regarding Section 404 of the CWA and determined it was not applicable (Cathy Juhas, Regulatory Project Manager, Joint Application Review, pers. comm. 2014).

No impacts are anticipated to the other surface water features within the project area, since the intake and discharge pipelines would be suspended above Rottengrass Creek and the unnamed wetland/intermittent stream to avoid impacts. There are no federally designated Wild and Scenic Rivers within or downstream of the project area (National Wild and Scenic Rivers System 2015).

Past and present impacts to the water resources of the project area include diversion for irrigation and factors contributing to poor water quality, including natural geology, runoff and irrigation returns, and sedimentation. The Proposed Action is not anticipated to measurably contribute to cumulative effects to water resources because of its temporary nature, the small volume and rate of water required for operation, the avoidance of direct impacts to surface water features, and the implementation of conservation measures as described below to minimize impacts to water quality.

3.3.3 Conservation Measures

Appropriate BMPs, as described here, would be implemented during installation and operation of the intake well and associated aquifer testing facilities to mitigate impacts to water resources. The boreholes for all wells would be done via conventional air-rotary methods with circulation provided by air, unless ground conditions are determined to require injection of water or drilling fluid. If water must be used, this drilling water and the pumped water from aquifer testing would be discharged in a vegetated upland area and allowed to infiltrate into the soil to prevent any impacts to water quality. Following completion of the project, the intake and observation wells would be capped and would no longer impact water resources.

A site-specific SWPPP would be prepared and implemented for the project, which would outline measures and BMPs to minimize and mitigate construction stormwater runoff, sediment discharge, erosion, and spill prevention, as well as notification and corrective procedures. Temporary and long-term erosion and sediment control structures such as silt fence, earth berms, fiber rolls, and straw wattles would be installed and dewatering would be implemented as necessary during and after construction and during reclamation in accordance with the SWPPP. Specific measures would be determined in the preparation of the SWPPP.

Only treated water would be returned to the Bighorn River. Concentrate, backwash, and sediment from flocculation/sedimentation basins would be collected and attenuated in the sludge lagoon rather than discharged to the river. The sludge lagoon would allow for infiltration of the liquid, resulting in groundwater recharge.

3.4 Wetlands

Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (Federal Register 1980).

3.4.1 Existing Wetlands

The intake well and discharge would be located west of an unnamed wetland area and the pilot plant would be located to the east of this area, which extends to the north and south beyond the project area (refer to Figure 2-1). National Wetland Inventory maps developed by the United States Fish and Wildlife Service (USFWS) identify this wetland as a Freshwater Emergent Wetland (USFWS 2014).

3.4.2 Direct, Indirect, and Cumulative Effects to Wetlands from the Pilot Plant Alternative

The unnamed wetland area would be crossed under either pipeline route alternative. To avoid disturbance to vegetation, soils, or hydrology of the wetland, the intake and discharge pipelines would be suspended across the wetland with a cable suspension system and support posts on either side installed outside of the wetland boundary. There is no evidence that the wetland is hydrologically connected to the groundwater of the intake well. Therefore, the project would result in no impacts to wetlands.

The project would have no impacts to wetland acreages with implementation of avoidance and mitigation measures; therefore, the project would not measurably contribute to cumulative effects on wetlands.

3.4.3 Conservation Measures

Open trench and pipe boring construction methods were considered for crossing the wetland area, but the impact to the wetland was determined to be too great. Since the pipelines for this project would be on the ground surface rather than underground, environmental impacts to the wetland would be mitigated by suspending the pipelines across the features rather than using the other methods.

3.5 Vegetation and Land Use

The Tribe does not have any laws that specifically apply to vegetation or plants. However the Crow Tribal Culture Department has a policy that certain plants important for cultural practices be protected from destruction, contamination, and eradication. The policy includes medicinal plants and roots, ceremonial foods, trees (particularly those identified as potential final resting places), and willows along waterways; however, no species lists are provided in the policy (Reed 2002). Many native plants are culturally important to the Tribe and are used for food, medicinal, and religious or spiritual purposes.

3.5.1 Existing Vegetation and Land Use

The project is within the Northwestern Great Plains ecoregion (Montana Central Grasslands), generally characterized as unglaciated semiarid rolling plains and typically used for rangeland (Woods et al. 2002). Agricultural production is restricted to areas near irrigation water sources. The site of the pilot plant/sludge lagoon is intermittently agricultural land supporting cultivated crops. The intake and discharge pipelines cross undeveloped land near the Bighorn River that is used for cattle grazing. The vegetation is a canopy of scattered cottonwood trees with an understory of shrubs and grasses (S. Simmers, Botanist, Wenck, pers. obs., Nov. 2014).

No plants are listed as threatened or endangered under the Endangered Species Act (ESA) within the project area. Culturally significant plants that may be present within the project area in grassland or wetland habitats include: arrowleaf balsamroot (*Balsamorrhiza sagittata*); Buffaloberry (*Shepherdia argentea*); cattail (*Typha* sp.); chokecherry (*Prunus virginiana*); purple coneflower (*Echinacea angustifolia*); dandelion (*Taraxacum officinalis*); flax (*Linum* sp.); sage (*Artemisia* sp.); sweetgrass (*Hierochloe odorata*); wild onion (*Allium* sp.); common yarrow (*Achillea millefolium*); yucca (*Yucca glauca*); and willow (*Salix* sp.) (Snell 2006).

Table 3-3 lists noxious weeds that could occur in Big Horn County (MTDA 2013, BONAP 2014). No lists specific to the Reservation were available. Of these, the noxious weeds observed in the project area during a preliminary survey of the pipeline routes include Canada thistle and cheatgrass. Though not listed as noxious, several other non-native, invasive species are present in the project area, including Russian olive (*Elaeagnus commutata*), Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), Canada bluegrass (*Poa compressa*), crested wheatgrass (*Agropyron cristatum*), and reed canarygrass (*Phalaris arundinacea*) (S. Simmers, Botanist, Wenck, pers. obs., Nov. 2014). No acreage estimates or exact locations are available for these species in or surrounding the project area.

Table 3-3: Noxious Weed Species Listed in Big Horn County, Montana

Priority	Description of Priority Status	Listed Plant Species*
2A	Common in isolated areas of Montana	Perennial pepperweed (*Lepidium latifolium*)
2B	Abundant in Montana and widespread in many counties	**Canada thistle (*Cirsium arvense*)**
		Field bindweed (*Convolvulus arvensis*)
		Leafy spurge (*Euphorbia esula*)
		Whitetop (*Cardaria draba*)
		Russian knapweed (*Rhaponticum repens*)
		Spotted knapweed (*Centaurea stoebe*)
		Diffuse knapweed (*Centaurea diffusa*)
		Dalmation toadflax (*Linaria dalmatica*)
		St. Johnswort (*Hypericum perforatum*)
		Sulfur cinquefoil *(Potentilla recta*)
		Common tansy (*Tanacetum vulgare*)
		Houndstongue (*Cynoglossum officinale*)
		Yellow toadflax (*Linaria vulgaris*)
		Saltcedar (*Tamarix spp.*)
3	Regulated, but not listed as noxious in Montana. May not be intentionally spread or sold other than as a contaminant in agricultural products.	**Cheatgrass (*Bromus tectorum*)**

*Species in bold are known within project area. Source: BONAP 2014, MTDA 2013

3.5.2 Direct, Indirect and Cumulative Effects to Vegetation and Land Use from the Pilot Plant Alternative

During operation of the pilot plant, the agricultural production of the land would be temporarily reduced by 8 acres due to the placement of the pilot plant and sludge lagoon site. This would be a short term impact during the pilot plant study timeframe. In the recent growing seasons, the agricultural area that would be impacted has not been seeded. The date of last agricultural use is unknown. However, the potential for agricultural production would resume in the 2016 growing season. The land use of the undeveloped land would not be impacted as part of this project.

Construction activities associated with pipeline installation and removal would include placement of the pipe on the ground surface and potentially driving a skid steer to bring pipe materials to necessary locations for installation. These activities would lead to vegetation surface disturbance due to compaction and leveling, but not direct removal. The maximum area of possible surface disturbance would total 55 acres for the preferred pipeline route and 57 acres for the alternate pipeline route (Figure 2-1).

Soil stripping and vegetation removal activities are expected to be limited to the pilot plant/sludge lagoon site and the Mission Loop road crossing, an area encompassing a maximum of eight acres. These areas consist of either cultivated agricultural land or previously disturbed vegetation in road ditches. Removal of limited number of trees may be required to lay the pipeline of either route. If removal is necessary, the BIA, Tribal Forestry Department, and Crow Tribal Historic Preservation Office (THPO) would be consulted for guidance on required pre-construction surveys and restrictions.

The project would not impact potential areas of culturally significant wetland or grassland plants since the pipelines would be suspended above the wetland areas and the pipeline would be laid on the surface through native understory grassland communities. No ESA-listed plants would be affected since none occur in the project area.

Construction equipment could spread seeds or root fragments of noxious weeds or invasive plants in the project area. Soil-disturbing activities would potentially disturb and expose buried seed banks of noxious weeds. Bare soils provide an environment where noxious weeds typically establish and thrive, whether seeds of the species were already present or are newly dispersed into the area.

Past and present cumulative impacts to vegetation in the project area are primarily related to farming and ranching, having contributed to conversion of native plant communities and introduction of noxious or invasive plants. This project would result in surface disturbance to areas that currently experience disturbance from livestock grazing. Vegetation removal has been limited to previously disturbed areas. With the implementation of conservation measures described below to restore temporary impacts to land use and to avoid or minimize the spread of noxious/invasive species, the project would not measurably contribute to cumulative effects to vegetation and land uses.

3.5.3 Conservation Measures

Following completion of the pilot project, the disturbed land used for the pilot site would be returned to its original state, thus avoiding long term impacts to land use. Solids in the sludge lagoon would be analyzed to determine the appropriate disposal method, either incorporation into the soil or removed to an approved landfill. The lagoon would be filled and seeded with a cover crop to prevent erosion unless near-term agricultural use is planned. Other site disturbance, such as gravel staging and parking areas, would be reclaimed by removing any fill, subgrade or gravel surfacing material placed during construction. For further details see the *Decommissioning and Reclamation Plan* in Appendix C.

Prior to construction, a survey would be completed detailing location and areas of noxious weeds, as allowed by surface conditions. The BIA would be notified of any noxious weeds found. If noxious weeds are found on site, disturbance to those areas would be avoided and the populations would be treated according to BIA guidelines.

During construction, contractors would follow the Reclamation's *Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species* (DiVittorio et al. 2012). In addition, revegetation following construction and reclamation activities would mitigate the introduction or spread of noxious weeds by minimizing the time disturbed soils are exposed. When construction is complete, seeding and mulching would be done in non-cultivated areas where soil has been disturbed. Seedbed preparation would include removal or treatment of noxious weeds or infested topsoil. Seeding mixtures would be determined through consultation with the BIA Natural Resource Group and would include native species.

3.6 Fish and Wildlife

Section 2 of the Fish and Wildlife Coordination Act (FWCA) of 1958 (P.L. 85-624, as amended, and 40 CFR 1502.25) states that fish and wildlife conservation shall receive equal consideration with other project purposes and will be coordinated with other features of water resources development projects.

The ESA mandates protection of species federally listed as threatened or endangered and their associated habitats. All federal agencies must use their authorities to conserve listed species and ensure that their actions do not jeopardize the continued existence of listed species and/or adversely modify their habitat. Candidate species receive no statutory protection until they are listed as threatened or endangered under ESA.

The Reservation does not have an endangered species law different from the federal government, though it does grant protection to those species designated by the Crow Tribal Fish and Game Commission (CLOC 12-5-108). Additionally, the Crow Tribal Culture Department has a policy which requires that animals used in religious rights and ceremonies or used as ceremonial food be protected from injury and extinction (Reed 2002). In 2002, the Crow Tribal Legislature designated Yellowstone cutthroat trout a "species of special concern" on the Crow Reservation under Joint Action Resolution number JAR0231 (Crow Tribal Legislature 2002). Other than this species, lists of Crow Tribal Fish and Game Commission designated species were not available.

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-711), Executive Order (E.O.) 13186, and Crow tribal law (CLOC 12-7-110 and 111). The MBTA prohibits the taking, killing, possession, and transportation (among other actions) of migratory birds, their eggs, parts, and nests, except when permitted. E.O. 13186 requires all federal agencies support the conservation intent of migratory bird conventions and integrate bird conservation principles into their activities.

Bald and golden eagles are federally protected under the MBTA, the Bald and Golden Eagle Protection Act (BGEPA) and Crow tribal law (CLOC 12-7-110). The BGEPA prohibits anyone without a permit from taking bald or golden eagles, including their parts, nests, or eggs.

3.6.1 Existing Fisheries and Wildlife

The Bighorn River area supports aquatic communities comprised of native species and popular, introduced sport fisheries. Due to the construction of Yellowtail Dam and the release of cold, clear, nutrient rich water, the Bighorn River supports a world class tailwater fishery for rainbow and brown trout from Fort Smith to Hardin. Some headwaters of the Bighorn River support native Yellowstone cutthroat trout, however the tailwaters of the project area do not provide habitat for this species. Management of the Bighorn River fishery is accomplished through adjustment of outflow and retention of water at the Yellowtail Dam.

Many animal species important to the Tribe are common in Big Horn County and potentially exist in or near the undeveloped riparian woodland of the project area along the Bighorn River, including deer, badger, coyote, eagles, hawks, and other birds.

Migratory birds and bald and golden eagles migrate or reside in southeastern Montana, potentially including the project area. Migratory birds pass through or breed and nest in Montana beginning as early as February 1st, but primarily from April 15th to July 15th. The bald eagle is a year-round resident but also migrates regionally in Montana, preferring to nest in large trees or on cliffs in proximity to large, perennial water bodies (MFWP 2014a). Golden eagles are found year round throughout Montana. They prefer to nest on cliffs or in large trees, typically hunting in open prairie or sagebrush steppe (MFWP 2014b). Due to the habitat preference of bald and golden eagles, it is unlikely they would nest within the project boundary. No bald or golden eagle nests were present along the proposed pipeline routes during a preliminary survey of the project area (D. Ackerman, Wildlife Biologist, Wenck, pers. obs., Nov. 2014).

There is the potential for one federally-listed endangered species and two candidate species to be present within Big Horn County (Table 3-4) (USFWS 2014). The project area consists of agricultural land and riparian woodland and would thus not provide necessary habitat for any of these three species.

Table 3-4: Threatened, Endangered and Candidate Species in Big Horn County

Species	Scientific Name	Status	Range in Montana
Black-footed ferret	*Mustela nigripes*	Endangered	Prairie dog complexes; Eastern Montana
Greater sage grouse	*Centrocercus urophasianus*	Candidate	Eastern, central and southwestern Montana in sagebrush, sagebrush-grasslands, and associated agricultural lands.
Sprague's pipit	*Anthus spragueii*	Candidate	Grassland habitats with little or no shrub cover east of the Continental Divide.

Source: USFWS 2014

3.6.2 Direct, Indirect and Cumulative Effects to Fisheries and Wildlife from the Pilot Plant Alternative

Operation of the pilot plant would remove a small net volume of water from the groundwater aquifer and associated Bighorn River; the majority of the intake water removed would be replaced by discharge of clean, treated water into the river. This minor amount of water would not measurably reduce instream flow and thus would have no effect on the existing fisheries in the Bighorn River.

During construction and reclamation activities, there is potential for sediment-laden runoff from excavated areas of the site to eventually reach drainages within or adjacent to the project area, which could temporarily impact water quality and affect fisheries and aquatic life. For several reasons, this likelihood is very low. No excavation areas are within or immediately adjacent to drainages. Excavation would occur in a relatively small area of eight total acres and erosion control would be in place to minimize sediment migration off-site. The discharge and discharge structure would have no impact to fisheries in the Bighorn River due to the nature of the discharge water (treated water of higher quality than Bighorn River water) and due to the design of the discharge structure above the water surface with insignificant flow (Mike Ruggles, Montana Fish, Wildlife, and Parks Fisheries Specialist, pers. comm. 2014).

Though wildlife species of concern, including migratory birds, eagles, and culturally significant wildlife, have the potential to occur in the project area, no population-level effects are expected to result from project actions. No direct mortality and minimal, if any, removal or disturbance to potential wildlife habitat in the project area would occur from project construction. No large numbers of wildlife are expected to be affected; and no significant adverse impacts are anticipated for any one species or species group. Indirect impacts could be result from displacement from habitat due to construction activity, noise, visual interference, or human presence. Displacement would be temporary, limited to the duration of the pilot project with an expected maximum of five months.

The nearest federally designated wilderness area is the Cloud Peak Wilderness, over 60 miles southeast of the project within the Bighorn National Forest (Wilderness.net 2015). No project actions would affect the wilderness area at such a distance.

The project would not measurably reduce instream flow of the river and would have temporary and localized impacts to wildlife and terrestrial habitat with no direct, long-term, or population-level effects. With the implementation of conservation and reclamation measures described below to further minimize temporary indirect effects to water quality and habitat, the project would not measurably contribute to cumulative effects on wildlife from other actions.

3.6.3 Conservation Measures

Water discharged to the Bighorn River would meet the requirements set forth in the NPDES permit from the EPA. As such, the discharged water would meet necessary requirements to not be detrimental to existing fisheries. Implementation of construction BMPs such as silt fences or other measures identified within the project SWPPP would ensure sedimentation impacts are minimized and localized to the immediate project work area.

A pre-construction survey would be completed to ensure no nests or habitat necessary for any of the protected or culturally significant animals would be affected by the project. After construction, disturbed areas would be reclaimed; vegetation would re-establish and provide habitat within one to three growing seasons.

3.7 Historic Properties and Culturally Sensitive Areas

Cultural resources encompass sites, objects, or practices of archaeological, historical, cultural and religious significance that are protected under various laws and regulations. The proposed project area is located entirely on the Crow Reservation and, as such, the project should proceed with particular sensitivity to Crow culture and heritage.

Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (16 U.S.C. 470a, et seq.), and its implementing regulations (36 CFR Part 800) requires that federal actions take into account the effect of a proposed action on cultural resources included in or potentially eligible to the National Register of Historic Places (NRHP). Federal agencies must consult with Historic Preservation Officers who are responsible for administering programs at the state or tribal level. The Crow THPO maintains Tribal register of cultural places, properties composed of religious sites, traditional cultural properties, burial sites, archeological sites, districts, buildings, and structures significant to the history, life ways, and customs of the Apsáalooke (Crow THPO 2013). The THPO also issues permits for excavation and construction projects within the boundary of the Crow Reservation (Crow THPO 2013). The Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 allows tribes to protect American Indian graves and to repatriate human remains; it applies to all developments regardless of the funding source.

3.7.1 Existing Cultural Resources

Three Class III Cultural Resource Inventories have been completed for the project to identify any cultural, historical, or sacred sites within proposed areas of disturbance (SWCA 2014; SWCA 2015a and 2015b). The inventories identified eleven irrigation features associated with the Bighorn Unit of the Crow Irrigation Project (CIP), three isolated finds, and one previously recorded archaeological site within the project area.

3.7.2 Direct, Indirect and Cumulative Effects to Cultural Resources from the Pilot Plant Alternative

The eleven features associated with the CIP include a culvert and associated ditch, an inlet/drain, seven irrigation ditches, and two road crossings on the upper terrace east of Rottengrass Creek. The culvert and inlet drain features are near the pilot plant site. One of the irrigation ditches would be crossed by both the preferred and alternate pipeline routes. Another irrigation ditch is to the north of the preferred pipeline route; whereas the remaining five ditches are crossed or run near the alternate pipeline route. The road crossings are also near the alternate pipeline route. These features would not be impacted by the project (SWCA 2014; SWCA 2015a and 2015b).

The three isolated finds were considered insignificant and ineligible for the NRHP and would not be impacted by the project (SWCA 2015b).

The previously recorded site is a collection of historic outbuildings located about 0.1 mile southwest of the pilot plant site. Because the site was associated with the construction of the original CIP, it has likely contributed to the eligibility of the CIP for the NRHP. The alternate pipeline route would cross the northern edge of the site boundary. However, because the pipeline route would avoid outbuildings and features on the site and would be above ground with no construction disturbance, the site would not be impacted by the project. (SWCA 2015b, and George Shannon, Reclamation Regional Archeologist, pers. comm. 2014).

With the stipulation described below (Section 3.7.3) being met, the construction would not impact any known significant cultural resources, and a finding of *No Historic Properties Adversely Affected was* recommended for the project. The three Class III reports for the project (SWCA 2014, 2015a, 2015b) were submitted to THPO for concurrence and to obtain further guidance for mitigation and necessary permits. THPO concurred with Reclamation’s determinations in early 2015.

The project would have no direct or indirect effects to cultural resources and therefore would not contribute to cumulative effects.

3.7.3 Conservation Measures

If cultural resources or burial sites are discovered during construction activities, work would be stopped immediately, the site secured, and the THPO notified. Work would not resume until there is authorization to proceed. The Apsáalooke consider human remains and burial sites sacred (Reed 2002); disturbing or removing any remains would be avoided. Project workers would be prohibited from collecting artifacts or disturbing cultural resources in any area, under any circumstances.

3.8 Paleontological Resources

The 2010 Paleontological Resources Preservation Act does not apply on Reservation lands; however, paleontological resources on the reservation are treated as a Trust asset because of their potential commercial value.

3.8.1 Existing Paleontological Resources

The project area is in alluvial sediments that are not fossiliferous, categorized as having "low fossil potential" (BLM 2011).

3.8.2 Direct, Indirect and Cumulative Effects to Paleontological Resources from the Pilot Plant Alternative

Since the project involves soil-disturbing activities, there is potential for encountering paleontological materials during construction or reclamation. However, the likelihood of disturbing fossils is low because of the low fossil potential of alluvial soil materials and because of the limited area of soil excavation, a maximum of eight acres. No direct, indirect, or cumulative impacts are expected and no conservation measures are necessary.

3.9 Environmental Justice

E.O. 12898 (1994) requires that measures must be taken to avoid disproportionately high adverse impacts on minority or low-income communities by pursuing fair treatment and meaningful involvement of minority and low-income populations. Environmental Justice also relates to existing hazards that may affect the health of individuals or communities, especially those with low incomes.

3.9.1 Existing Hazards to Minority and Low Income Populations

The reservation population is both a minority and low income population, consisting of an American Indian population at an economic disadvantage compared to surrounding communities. In comparison to surrounding counties and census populations, the Reservation has a higher percentage of individuals living below the poverty level, a lower median household income, and a higher unemployment rate (US Census Bureau 2009-2013).

Existing hazards within or near the reservation include hazardous waste generators regulated by Resources Conservation and Recovery Act and potentially contaminated Brownfield sites. Brownfield sites are properties which may be contaminated with a hazardous substance or pollutant. The EPA has a program to assess, clean up, and rehabilitate these sites (USEPA 2012). The city of Hardin, approximately 20 miles from the project area, has twelve hazardous waste generators, two Brownfield sites, and the City of Hardin Class II landfill (i.e. non-hazardous waste) (USEPA 2014a and 2014b). One Brownfield site is located in Lodge Grass, about 20 miles from the project area (USEPA 2014a). The nearest Superfund site is in the city of Billings, over 40 miles northwest from the project area (USEPA 2014a). Superfund sites are abandoned hazardous waste sites with cleanup funded under an EPA program (USEPA 2013).

3.9.2 Direct, Indirect and Cumulative Effects to Minority and Low Income Populations from the Pilot Plant Alternative

No adverse or disproportionately negative impacts are anticipated to the minority and low income population of the reservation. Existing hazardous sites or facilities on or near the Reservation are not in proximity to the project area and would not be affected by the pilot plant study, nor would any of those sites have an effect on the proposed project. The project would generate sludge waste consisting of concentrate, backwash, and sediment from flocculation/sedimentation basins. This waste would be attenuated in the sludge pond and disposed of properly, either through incorporation into the soil or at an approved landfill. Therefore, no negative health or environmental effects to minority or low income populations are anticipated and the project would not contribute to cumulative effects to the communities.

3.10 Indian Trust Assets

Indian Trust Assets (ITAs) are "legal interests in property or resources held in trust by the United States for Indian tribes or individual Indians" (Indian Trust Policy issued July 2, 1993). The Secretary of the Interior is the trustee for the United States on behalf of Indian tribes. ITAs include land, minerals, timber, culturally important resources (fish and wildlife, vegetation, etc.), hunting and fishing rights, water rights, and in-stream flows. ITAs may be located on or off-reservation lands. This policy reaffirms the legal trust relationship and the government-to-government relationship between the Secretary of the Interior and Indian tribes. This project is being initiated and completed by the Tribe with the broad purpose of benefitting the Tribe and tribal members.

3.10.1 Direct, Indirect and Cumulative Effects to Trust Assets from the Pilot Plant Alternative

No adverse or disproportionately negative impacts are anticipated to Trust resources. While the pilot plant alone would not have a large positive impact on the Tribe and their assets, it would aid in the construction of a drinking water treatment plant and associated distribution system with a large positive and cumulative impact. Using a pilot plant study prior to construction of a full scale treatment facility contributes to more informed decision making and planning, which often results in cost savings and reduced impacts to resources. Short-term employment for construction workers, of Indian preference, would be generated due to construction of the pilot plant. Monitoring and testing associated with the pilot plant would also generate short term employment. Therefore, overall positive effects to property and resources of the Tribe are anticipated under the Pilot Plant Alternative.

4.0 Compliance with Environmental Statutes

The proposed project would comply with the following federal and tribal statutes and orders, as well as state statutes pertaining to the Bighorn River. The relevance of these laws to the project is explained under individual resource discussions and analysis. All required permits and necessary authorizations would be obtained prior to construction.

Federal

- American Indian Religious Freedom Act (P.L. 95-341)
- Archaeological Resources Protection Act of 1979 (P.L. 96-95)
- Archaeological and Historic Preservation Act of 1974 (P.L. 93-291)

- Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines (Federal Register, Vol. 48, No.190, 1983, pp. 44716 to 44740)
- Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d, 54 Stat. 250)
- Clean Air Act (42 U.S.C. §§ 7401-7671q) and Amendments of 1970
- Clean Water Act (33 U.S.C. 1251 et seq.)
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (P.L. 96-510)
- Endangered Species Act of 1973 (P.L. 93-205), 16 U.S.C. Sections 1531-1544
- Executive Order 11593, 1971 (Protection and Enhancement of the Cultural Environment) (16 USC 470)
- Executive Order 11988 (Floodplain Management, 1977)
- Executive Order 11990 (Protection of Wetlands, 1977)
- Executive Order 12898 (Environmental Justice, 1994)
- Executive Order 13112 (Invasive Species Control, 1999)
- Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds, 2001)
- Farmland Protection Policy Act of 1981
- Federal Water Protection Recreation Act of 1965 (P.L. 89-72)
- Fish and Wildlife Coordination Act of 1958 (P.L. 85-624, as amended, and 40 CFR 1502.25)
- Indian Trust Policy (July 2, 1993)
- Migratory Bird Treaty Act (16 U.S.C. 703-711),
- National Historic Preservation Act of 1966, as amended through 1992 (P.L. 89-665 and P.L. 96-515)
- National Invasive Species Act of 1996
- Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 et seq.) and 43 CFR Part 10 – Native American Graves Protection and Repatriation Act Regulations
- Paleontological Resources Preservation Act of 2010
- Rivers and Harbors Act of 1890, Section 10 Permit
- 36 CFR 60.4 – National Register Criteria
- 36 CFR 79 – Curation of Federally Owned and Administered Archeological Collections
- National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd-668ee (Refuge Administration Act)

Tribal

- Crow Law and Order Code (CLOC) 12-5-108 Protection of Species Designated by Crow Tribal Fish and Game Commission
- CLOC 12-7-110 and 111 Protection of Migratory Birds
- CLOC 12-7-110 Protection of Bald and Golden Eagles
- Crow Tribal Legislature Joint Action Resolution JAR0231 Designation of Yellowstone Cutthroat Trout "Species of Special Concern"
- Crow Tribal Culture Department Policy protecting culturally important plants
- Crow Tribal Culture Department policy protecting ceremonially important animals

State

These state laws would potentially apply to resources within the banks of the Bighorn River pursuant to the ruling from Montana v. United States, 450 U.S. 544 (1981).

- Montana Water Quality Act (Title 75, Ch. 5)
- Montana Stream Protection Act (SPA 124 Permit)
- Montana Natural Streambed and Land Preservation Act (310 Permit)
- Short-term Water Quality Standard for Turbidity (318 Authorization)
- Montana Floodplain and Floodway Management Act
- Montana Land-Use License or Easement on Navigable Waters

5.0 Consultation and Coordination

Public involvement and agency coordination are required as part of the NEPA process, to the extent practicable (40 C.F.R. §§ 1501.4(b), 1506.6(b)).

Scoping of the overall MR&I System began in September 2014. Public scoping activities included mailings, website development, community notices, and several public open houses. The scoping period ran through October 2014. Specific actions taken to facilitate public involvement on this EA included:

- A 19-day (14 business days) public comment period of the Draft EA.
- Mailing (dated June 24th, 2015) to interested parties, providing notification of the availability of the Draft EA for review and comment.
- Legal notification of the public comment period was published in the Billings Gazette on June 22nd and July 6th, 2015.
- Legal notification of the public comment period was published in the Big Horn County News in Hardin on June 25th and July 2nd, 2015.
- Regular updates to the MR&I System project website, hosted on Reclamation's website. The Draft EA and Appendices were made available on the project website. Public comments were also accepted through the website portal.
- Official Reclamation press release, issued on June 22nd, 2015, was posted online and distributed to local news outlets.
- Hard-copy versions of the Draft EA were made available at the following locations:
    - Bureau of Reclamation – Great Plains Regional Office in Billings, MT
    - Bureau of Indian Affairs – Crow Agency, MT
    - Crow Tribe, Water Resource Department – Crow Agency, MT

There were no public comments on the Draft EA and the comment period closed on Friday, July 10th, 2015. Public notification documents can be found in Appendix D.

The following persons and agencies were consulted as part of permitting, developing this EA, or aspects of conservation or reclamation measures for the proposed pilot plant.

- BIA Crow Agency Office, Crow Agency, MT
- Bureau of Reclamation Regional Office, Billings, MT
- Crow Tribe Tribal Historic Preservation Office, Emerson Bull Chief, Crow Agency, MT
- Crow Tribe Water Resource Department, Crow Agency, MT
- EPA, Denver, CO
- Montana Fish, Wildlife, and Parks, Mike Ruggles, Fisheries Specialist, Billings, MT

- NRCS Crow Agency Field Office, Crow Agency, MT
- NRCS Hardin Field Office, Hardin, MT
- US Army Corps of Engineers, Cathy Juhas, Billings Regulatory Office, Billings, MT

6.0 List of Preparers

The following individuals contributed to preparation of this EA (Table 6-1).

Table 6-1: List of Preparers

Affiliation	Name	Title	Project Role	Years of Experience
Reclamation	Christina Gomer	Environmental Specialist	Coordination of ESA informal consultation, Content review	7.5
	George Shannon	Regional Archeologist	Cultural review	41
BIA	Robin Stewart	Regional Environmental Specialist	Environmental review	unavailable
	John Hill	Natural Resource Officer	Environmental review	unavailable
CTWRD	Titus Takes Gun	Director	Coordination	7
Crow THPO	Emerson Bull Chief	Crow Tribal Historic Preservation Officer	Historical Review	unavailable
Bartlett & West	Colin Nygaard, P.E.	Project Manager	Project Management and Coordination	9
	Jodie Binger, P.E.	Project Engineer	Primary Author	4
	Chris Maus	Project Engineer	Scoping Coordination	2
	Xuejiao Rich	GIS Specialist	Map Production	2
Wenck Associates, Inc.	Sara Simmers	Natural Resource Specialist, Botanist	QA/QC, Contributing author, Preliminary Vegetation Survey	8
	Daniel Ackerman	Wildlife Biologist	Preliminary Wildlife/Nest Survey	15

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 WYNKOOP STREET
DENVER, COLORADO 80202-1129

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended, (33 U.S.C. §1251 et seq; the "Act"),

Crow Indian Tribe

is authorized to discharge from the Crow Municipal Rural & Industrial (MR&I) Pilot Water Treatment Plant located in the northeast ¼ of Section 23, Township 4S, Range 32E, latitude 45.472222° N, longitude 107.739447° W, Bighorn County, Montana

to the Bighorn River,

in accordance with discharge point(s), effluent limitations, monitoring requirements and other conditions set forth herein. Authorization for discharge is limited to those outfalls specifically listed in the permit.

This permit shall become effective **March 1, 2015**.

This permit and the authorization to discharge shall expire at midnight, **February 29, 2020.**

Signed this 18th day of February , 2015

Authorized Permitting Official

Callie A. Videtich, Acting Assistant Regional Administrator
Office of Partnerships and Regulatory Assistance

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1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1.1. Definitions.

The *30-day (and monthly) average*, other than for fecal coliform bacteria and total coliform bacteria, is the arithmetic average of all samples collected during a consecutive 30-day period or calendar month, whichever is applicable. Geometric means shall be calculated for fecal coliform bacteria and total coliform bacteria. The calendar month shall be used for purposes of reporting self-monitoring data on discharge monitoring report forms.

The *7-day (and weekly) average*, other than for fecal coliform bacteria and total coliform bacteria, is the arithmetic mean of all samples collected during a consecutive 7-day period or calendar week, whichever is applicable. Geometric means shall be calculated for fecal coliform bacteria and total coliform bacteria. The 7-day and weekly averages are applicable only to those effluent characteristics for which there are 7-day average effluent limitations. The calendar week, which begins on Sunday and ends on Saturday, shall be used for purposes of reporting self-monitoring data on discharge monitoring report forms. Weekly averages shall be calculated for all calendar weeks with Saturdays in the month. If a calendar week overlaps two months (i.e., the Sunday is in one month and the Saturday in the following month), the weekly average calculated for that calendar week shall be included in the data for the month that contains the Saturday.

Daily Maximum (*Daily Max.*) is the maximum measured value for a pollutant discharged during a calendar day or any 24-hour period that reasonably represents a calendar day for purposes of sampling. For pollutants with daily maximum limitations expressed in units of mass (e.g., kilograms, pounds), the daily maximum is calculated as the total mass of pollutant discharged over the calendar day or representative 24-hour period. For pollutants with limitations expressed in other units of measurement (e.g., milligrams/liter, parts per billion), the daily maximum is calculated as the average of all measurements of the pollutant over the calendar day or representative 24-hour period. If only one measurement or sample is taken during a calendar day or representative 24-hour period, the single measured value for a pollutant will be considered the daily maximum measurement for that calendar day or representative 24-hour period.

Daily Minimum (*Daily Min.*) is the minimum value allowable in any single sample or instantaneous measurement collected during the course of a day.

Grab sample, for monitoring requirements, is defined as a single "dip and take" sample collected at a representative point in the discharge stream.

Instantaneous measurement, for monitoring requirements, is defined as a single reading, observation, or measurement.

Composite samples shall be flow proportioned. The composite sample shall, at a minimum, contain at least four (4) samples collected over the compositing period. Unless otherwise specified, the time between the collection of the first sample and the last sample shall not be less than six (6) hours, nor more than twenty-four (24) hours. Acceptable methods for the preparation of composite samples are as follows:

a. Constant time interval between samples, sample volume proportional to flow rate at the time of sampling;

b. Constant time interval between samples, sample volume proportional to total flow (volume) since last sample. For the first sample, the flow rate at the time of the first sample was collected may be used;

c. Constant sample volume, time interval between samples proportional to flow (i.e., sample taken every "X" gallons of flow); and,

d. Continuous collection of sample with sample collection rate proportional to flow rate.

Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

Director means the Regional Administrator of EPA Region 8 or an authorized representative.

EPA means the United States Environmental Protection Agency.

Storm Water means storm water runoff, snow melt runoff, and surface runoff and drainage.

CWA means the Clean Water Act (formerly referred to as either the Federal Water Pollution Act or the Federal Water Pollution Control Act Amendments of 1972), Pub. L. 92-500, as amended by Pub. L. 95-217, Pub. L. 95-576, Pub. L. 96-483, Pub. L. 97-117, and Pub. L. 100-4. In this permit the CWA may be referred to as "the Act."

Sewage Sludge is any solid, semi-solid or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary or advanced wastewater treatment processes; and a material derived from sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

Whole Effluent Toxicity, Acute occurs when 50 percent or more mortality is observed for either species (see Part 1.3) at any effluent concentration. Mortality in the control must simultaneously be 10 percent or less for the effluent results to be considered valid.

1.2. Description of Discharge Point(s). The authorization to discharge provided under this permit is limited to those outfalls specifically designated below as discharge locations. Discharges at any location not authorized under an NPDES permit is a violation of the Clean Water Act and could subject the person(s) responsible for such discharge to penalties under Section 309 of the Act.

Outfall Serial Number(s)	Description of Discharge Point(s)
001	Any discharge of finished water from the Crow Municipal Rural & Industrial (MR&I) Pilot Water Treatment Plant to the Bighorn River. The outfall shall be located, at or near, 45.473172° N, 107.741347° W.

1.3. Specific Limitations and Self-Monitoring Requirements

1.3.1. Effluent Limitations - Outfall 001. Effective immediately and lasting through the life of this permit, the quality of effluent discharged by the facilities shall, as a minimum, meet the limitations as set forth below:

Effluent Characteristic	30-Day Average a/	Daily Maximum a/	Basis
Total Suspended Solids, mg/L	30	45	40 CFR § 133.102(b)
Total Residual Chlorine, mg/L, b/	N/A	0.019	BPJ
The pH of the discharge shall not be less than 6.0 or greater than 9.0 at any time.			40 CFR § 133.102(c)
There shall be no discharge of floating solids or visible foam in other than trace amounts. There shall be no discharge which causes a visible oil sheen in the receiving water.			BPJ, 40 CFR § 110.3
There shall be no discharge of any wastewater from the water treatment process. This includes, but is not limited to, jar testing wastewater, side stream testing wastewater, sediment/sludge, filter backwash wastewater, reverse osmosis concentrate/brine, disinfectant testing wastewater, and sanitary wastewater.			BPJ

a/ See Definitions, Part 1.1, for definition of terms.

b/ For the purposes of the permit, the minimum limit of analytical reliability in the analysis for total residual chlorine is considered to be 0.05 mg/L. For purposes of calculating averages and reporting on the Discharge Monitoring Report form, analytical values less than 0.05 mg/L shall be considered zero.

1.3.2. Self-Monitoring Requirements - Outfall 001. As a minimum, upon the effective date of this permit, the following constituents shall be monitored at the frequency and with the type of measurement indicated; samples or measurements shall be representative of the volume and nature of the monitored discharge. If no discharge occurs during the entire monitoring period, it shall be stated on the Discharge Monitoring Report Form (EPA No. 3320-1) that no discharge or overflow occurred. The following samples shall be taken from the outlet pipe from the Crow Municipal Rural & Industrial (MR&I) Pilot Water Treatment Plant to the Bighorn River.

Effluent Characteristic	Frequency	Sample Type a/
Total flow, gpm b/	Monthly	Instantaneous
Total Suspended Solids, mg/L	Weekly	Grab
Total Residual Chlorine, mg/L	Weekly	Grab
Aluminum, Total Recoverable, mg/L	Weekly	Grab
Iron, Dissolved, mg/L	Weekly	Grab
pH, s.u.	Weekly	Grab or Instantaneous

a/ See Definitions, Part 1.1, for definition of terms.

b/ Flow measurements of effluent volume shall be made in such a manner that the permittee can affirmatively demonstrate that representative values are being obtained. The average flow rate (in gallons per minute) during the reporting period and the maximum flow rate observed (in gpm) shall be reported.

1.3.3. Inspection Requirements

1.3.3.1. On at least a weekly basis, unless otherwise approved by the permit issuing authority, the permittee shall inspect the sludge ponds at a minimum, for the following:

1.3.3.1.1. Determine if a discharge is occurring;

1.3.3.1.2. Check to see if there is any leakage through the dikes;

1.3.3.1.3. Check to see if there are any animal burrows in the dike;

1.3.3.1.4. Check to see if there has been any excessive erosion of the dikes; and

1.3.3.1.5. Check to see if there are any rooted plants, including weeds growing in the water.

1.3.3.2. Each calendar year during early spring (March - April), summer (June - August), and fall (October - November), unless otherwise approved by the permit issuing authority, the permittee shall determine the following for each sludge pond: (Note: This is not required for a sludge pond if the sludge has been removed from the pond within the previous 45 days.)

1.3.3.2.1. The vertical distance from the water surface to the rim of the overflow structure, if one is present. Measurements shall be given in feet and inches.

1.3.3.2.2. The average depth of the top of the sludge blanket below the water surface of the sludge pond. At least five (5) measurements shall be made at approximately equal intervals along the long axis of the pond at approximately equal distances from the sides of the pond.

1.3.3.2.3. Based on the information on the amount of sludge accumulated in the pond and expected accumulation of sludge before the next measurements are made, the permittee shall make a determination as to whether or not the sludge needs to be removed from the pond before the next measurements are taken.

1.3.3.3. The permittee shall maintain a bound notebook recording information obtained during the inspection. At a minimum, the notebook shall include the following:

1.3.3.3.1. Date and time of the inspection;

1.3.3.3.2. Name of the inspector(s);

1.3.3.3.3. The facility's discharge status;

1.3.3.3.4. The flow rate of the discharge if occurring;

1.3.3.3.5. The findings of the observations and/or measurements required under Parts 1.3.3.1 and 1.3.3.2 above.

1.3.3.3.5. Identification of operational problems and/or maintenance problems;

1.3.3.3.6. Recommendations, as appropriate, to remedy identified problems;

1.3.3.3.7. A brief description of any actions taken with regard to problems identified; and,

1.3.3.3.8. Other information, as appropriate.

The permittee shall maintain the notebook in accordance with proper record-keeping procedures and shall make the log available for inspection, upon request, by authorized representatives of the U.S. Environmental Protection Agency or the Environmental Protection Office of the Crow Tribe.

1.3.3.3. Problems identified during the inspection shall be addressed through proper operation and maintenance. (See Part 3.5 of this permit.)

2. MONITORING, RECORDING AND REPORTING REQUIREMENTS

2.1. Representative Sampling. Samples taken in compliance with the monitoring requirements established under Part 1 shall be collected from the effluent stream prior to discharge into the receiving waters. Samples and measurements shall be representative of the volume and nature of the monitored discharge. Sludge samples shall be collected at a location representative of the quality of sludge immediately prior to use-disposal practice.

2.2. Monitoring Procedures. Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit. Sludge monitoring procedures shall be those specified in 40 CFR 503, or as specified in the permit.

2.3. Penalties for Tampering. The Act provides that any person who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than two years, or by both. Second conviction is punishable by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four years, or both.

2.4. Reporting of Monitoring Results. Effluent monitoring results obtained during the previous month shall be summarized and reported on **one** Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. If no discharge occurs during the reporting period, "no discharge" shall be reported. Until further notice, sludge monitoring results may be reported in the testing laboratory's normal format (there is no EPA standard form at this time), but should be on letter size pages. Whole effluent toxicity (biomonitoring) results must be reported on the most recent version of EPA Region 8's Guidance For Whole Effluent Reporting. Legible copies of these, and all other reports required herein, shall be signed and certified in accordance with the Signatory Requirements (see Part 4), and submitted to the NPDES Program, EPA Region 8 Montana Operations Office, and the Crow Tribe at the following addresses:

original to: US EPA
NPDES Program
10 West 15th Street, Suite 3200
Helena, MT 59626

copy to: Crow Environmental Protection Office
P.O. Box 159
Crow Agency, MT 59022

2.5. Additional Monitoring by the Permittee. If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR Part 136, 40 CFR Part 503, or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

2.6. Records Contents. Records of monitoring information shall include:

2.6.1. The date, exact place, and time of sampling or measurements;

2.6.2. The initials or name(s) of the individual(s) who performed the sampling or measurements;

2.6.3. The date(s) analyses were performed;

2.6.4. The time(s) analyses were initiated;

2.6.5. The initials or name(s) of individual(s) who performed the analyses;

2.6.6. References and written procedures, when available, for the analytical techniques or methods used; and,

2.6.7. The results of such analyses, including the bench sheets, instrument readouts, computer disks or tapes, etc., used to determine these results.

2.7. Retention of Records. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least three years from the date of the sample, measurement, report or application. Records of monitoring required by this permit related to sludge use and disposal activities must be kept at least five years (or longer as required by 40 CFR Part 503). This period may be extended by request of the Director at any time. Data collected on site, data used to prepare the DMR, copies of Discharge Monitoring Reports, and a copy of this NPDES permit must be maintained on site.

2.8. Twenty-four Hour Notice of Noncompliance Reporting.

2.8.1. The permittee shall report any noncompliance which may endanger health or the environment as soon as possible, but no later than twenty-four (24) hours from the time the permittee first became aware of the circumstances. The report shall be made to the EPA, Region 8, Preparedness, Assessment and Response Program at (303)293-1788, the Tribe at (406)638 -3905.

2.8.2. The following occurrences of noncompliance shall be reported by telephone to the NPDES Program, EPA Region 8 Montana Operations Office, at (406) 457-5000 (toll-free (866)457-2690) (8:00 a.m. - 4:30 p.m. Mountain Time) and the Tribe at (406)638-3905 (8:00 a.m. - 4:30 p.m. Mountain Time) by the first workday following the day the permittee became aware of the circumstances:

2.8.2.1. Any unanticipated bypass which exceeds any effluent limitation in the permit (See Part 3.7, Bypass of Treatment Facilities.);

2.8.2.2. Any upset which exceeds any effluent limitation in the permit (See Part 3.8, Upset Conditions.); or,

2.8.2.3. Violation of a maximum daily discharge limitation for any of the pollutants listed in the permit to be reported within 24 hours.

2.8.3. A written submission shall also be provided to the NPDES Program, EPA Region 8 Montana Operations Office, and to the Tribe within five days of the time that the permittee becomes aware of the circumstances. The written submission shall contain:

2.8.3.1. A description of the noncompliance and its cause;

2.8.3.2. The period of noncompliance, including exact dates and times;

2.8.3.3. The estimated time noncompliance is expected to continue if it has not been corrected; and,

2.8.3.4. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

2.8.4. The Director may waive the written report on a case-by-case basis for an occurrence of noncompliance listed under Part 2.8.2 above if the incident has been orally reported in accordance with the requirements of Part 2.8.2.

2.8.5. Reports shall be submitted to the addresses in Part 2.4, Reporting of Monitoring Results.

2.9. Other Noncompliance Reporting. Instances of noncompliance not required to be reported within 24 hours shall be reported at the time that monitoring reports for Part 2.4 are submitted. The reports shall contain the information listed in Part 2.8.3.

2.10. Inspection and Entry. The permittee shall allow the Regional Administrator, or authorized representative (including an authorized contractor acting as a representative of the Administrator) upon presentation of credentials and other documents as may be required by law, to:

2.10.1. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

2.10.2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

2.10.3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and,

2.10.4. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Act, any substances or parameters at any location.

3. COMPLIANCE RESPONSIBILITIES

3.1. Duty to Comply. The permittee must comply with all conditions of this permit. Any failure to comply with the permit may constitute a violation of the Clean Water Act and may be grounds for enforcement action, including, but not limited to permit termination, revocation and reissuance, modification, or denial of a permit renewal application. The permittee shall give the director advance notice of any planned changes at the permitted facility that will change any discharge from the facility, or of any activity that may result in failure to comply with permit conditions.

3.2. Penalties for Violations of Permit Conditions. The Clean Water Act provides for specified civil and criminal monetary penalties for violations of its provisions. However, the Federal Civil Penalties Inflation Adjustment Act of 1990, as amended by the Debt Collection Improvement Act of 1996, requires EPA to adjust the civil monetary penalties for inflation on a periodic basis. EPA previously adjusted its civil monetary penalties on December 31, 1996 (61 Fed. Reg. 69359-69365), with technical corrections and additions published on March 20, 1997 (62 Fed. Reg. 13514-13517) and June 27, 1997 (62 Fed. Reg. 35037-35041). On February 13, 2004 (69 Fed. Reg. 7121-7127) EPA once again adjusted its civil monetary penalties. The civil and criminal penalties, as of March 15, 2004, for violations of the Act (including permit conditions) are given below:

3.2.1. Any person who violates section 301, 302, 306, 307, 308, 318 or 405 of the Act, or any permit condition or limitation implementing any such sections in a permit issued under section 402, or any requirement imposed in a pretreatment program approved under sections 402(a)(3) or 402(b)(8) of the Act, is subject to a civil penalty not to exceed $32,500 per day for each violation.

3.2.2. Any person who *negligently* violates sections 301, 302, 306, 307, 308, 318, or 405 of the Act, or any condition or limitation implementing any of such sections in a permit issued under section 402 of the Act, or any requirement imposed in a pretreatment program approved under section 402(a)(3) or 402(b)(8) of the Act, is subject to criminal penalties of $2,500 to $25,000 per day of violation, or imprisonment for not more than 1 year, or both. In the case of a second or subsequent conviction for a negligent violation, a person shall be subject to criminal penalties of not more than $50,000 per day of violation, or by imprisonment for not more than 2 years, or both.

3.2.3. Any person who *knowingly* violates sections 301, 302, 306, 307, 308, 318, or 405 of the Act, or any condition or limitation implementing any of such sections in a permit issued under section 402 of the Act, or any requirement imposed in a pretreatment program approved under section 402(a)(3) or 402(b)(8) of the Act, is subject to criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment for not more than 3 years, or both. In the case of a second or subsequent conviction for a knowing violation, a person shall be subject to criminal penalties of not more than $100,000 per day of violation, or imprisonment for not more than 6 years, or both.

3.2.4. Any person who *knowingly* violates section 301, 302, 303, 306, 307, 308, 318 or 405 of the Act, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of the Act, and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine of not more than $250,000 or imprisonment for not more than 15 years, or both. In the case of a second or subsequent conviction for a knowing endangerment violation, a person shall be subject to a fine of not more than $500,000 or by imprisonment for not more than 30 years, or both. An organization, as defined in section 309(c)(3)(B)(iii) of the CWA, shall, upon conviction of violating the imminent danger provision, be subject to a fine of not more than $1,000,000 and can be fined up to $2,000,000 for second or subsequent convictions.

3.2.5. Any person may be assessed an administrative penalty by the Administrator for violating section 301, 302, 306, 307, 308, 318 or 405 of this Act, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of this Act. Where an administrative enforcement action is brought for a Class I civil penalty, the assessed penalty may not exceed $11,000 per violation, with a maximum amount not to exceed $32,500. Where an administrative enforcement action is brought for a Class II civil penalty, the assessed penalty may not exceed $11,000 per day for each day during which the violation continues, with the maximum amount not to exceed $157,500.

3.3. Need to Halt or Reduce Activity not a Defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

3.4. Duty to Mitigate. The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

3.5. Proper Operation and Maintenance. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit. However, the permittee shall operate, as a minimum, one complete set of each main line unit treatment process whether or not this process is needed to achieve permit effluent compliance.

3.5.1 The permittee shall, as soon as reasonable and practicable, but no later than six (6) months after the effective date of this permit, do the following as part of the operation and maintenance program for the wastewater treatment facility:

3.5.1.1. Have a current O & M Manual(s) that describes the proper operational procedures and maintenance requirements of the wastewater treatment facility;

3.5.1.2. Have the O & M Manual(s) readily available to the operator of the wastewater treatment facility and require that the operator become familiar with the manual(s) and any updates;

3.5.1.3. Have a schedule(s) for routine operation and maintenance activities at the wastewater treatment facility; and,

3.5.1.4. Require the operators to perform the routine operation and maintenance requirements in accordance with the schedule(s).

3.5.2. The permittee shall maintain a daily log in a **bound notebook(s)** containing a summary record of all operation and maintenance activities at the wastewater treatment facility. At a minimum, the notebook shall include the following information:

3.5.2.1. Date and time;

3.5.2.2 Name and title of person(s) making the log entry;

3.5.2.3. Name of the persons(s) performing the activity;

3.5.2.4. A brief description of the activity; and,

3.5.2.5. Other information, as appropriate.

The permittee shall maintain the notebook in accordance with proper record-keeping procedures and shall make the log available for inspection, upon request, by authorized representatives of the U.S. Environmental Protection Agency or the Crow Tribe.

3.6. Removed Substances. Collected screenings, grit, solids, sludge, or other pollutants removed in the course of treatment shall be buried or disposed in a manner consistent with all applicable federal and tribal regulations (i.e., 40 CFR Part 257, 40 CFR Part 258, 40 CFR Part 503) and in a manner so as to prevent any pollutant from entering any waters of the United States or creating a health hazard. **In addition, the use and/or disposal of sewage sludge shall be done under the authorization of an NPDES permit issued for the use and/or disposal of sewage sludge by the appropriate NPDES permitting authority for sewage sludge.** Sludge/digester supernatant and filter backwash shall not be directly blended with or enter either the final plant discharge and/or waters of the United States.

3.7. Bypass of Treatment Facilities.

3.7.1. Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of Parts 3.7.2 and 3.7.3.

3.7.2. Notice:

3.7.2.1. Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least 10 days before the date of the bypass to the NPDES Program, EPA Region 8 Montana Operations Office, and the Tribe.

3.7.2.2. Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required under Part 2.8, Twenty-four Hour Noncompliance Reporting, to the NPDES Program, EPA Region 8 Montana Operations Office, and the Tribe.

3.7.3. Prohibition of bypass.

3.7.3.1. Bypass is prohibited and the Director may take enforcement action against a permittee for a bypass, unless:

3.7.3.1.1. The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

3.7.3.1.2. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and,

3.7.3.1.3. The permittee submitted notices as required under Part 3.7.2.

3.7.3.2. The Director may approve an anticipated bypass, after considering its adverse effects, if the Director determines that it will meet the three conditions listed above in Part 3.7.3.1.

3.8. Upset Conditions

3.8.1. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with technology based permit effluent limitations if the requirements of Part 3.8.2 are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review (i.e., Permittees will have the opportunity for a judicial determination on any claim of upset only in an enforcement action brought for noncompliance with technology-based permit effluent limitations).

3.8.2. Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

3.8.2.1. An upset occurred and that the permittee can identify the cause(s) of the upset;

3.8.2.2. The permitted facility was at the time being properly operated;

3.8.2.3. The permittee submitted notice of the upset as required under Part 2.8, Twenty-four Hour Notice of Noncompliance Reporting; and,

3.8.2.4. The permittee complied with any remedial measures required under Part 3.4, Duty to Mitigate.

3.8.3. Burden of proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

3.9. Toxic Pollutants. The permittee shall comply with effluent standards or prohibitions established under Section 307 (a) of the Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

3.10. Changes in Discharge of Toxic Substances. Notification shall be provided to the Director as soon as the permittee knows of, or has reason to believe:

3.10.1. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels."

3.10.1.1. One hundred micrograms per liter (100 ug/L);

3.10.1.2. Two hundred micrograms per liter (200 ug/L) for acrolein and acrylonitrile; five hundred micrograms per liter 500 ug/L) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;

3.10.1.3. Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR § 122.21(g)(7); or,

3.10.1.4. The level established by the Director in accordance with 40 CFR § 122.44(f).

3.10.2. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following notification levels:

3.10.2.1. Five hundred micrograms per liter (500 ug/L);

3.10.2.2. One milligram per liter (1 mg/L) for antimony;

3.10.2.3. Ten (10) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR § 122.21(g)(7); or,

3.10.2.4. The level established by the Director in accordance with 40 CFR § 122.44(f).

4. GENERAL REQUIREMENTS

4.1. Planned Changes. The permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

4.1.1. The alteration or addition could significantly change the nature or increase the quantity of pollutant discharged. This notification applies to pollutants which are not subject to effluent limitations in the permit; or, 4.1.2. There are any planned substantial changes to the existing sewage sludge facilities, the manner of its operation, or to current sewage sludge management practices of storage and disposal. The permittee shall give the Director notice of any planned changes at least 30 days prior to their implementation.

4.1.3. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source.

4.2. Anticipated Noncompliance. The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

4.3. Permit Actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

4.4. Duty to Reapply. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application should be submitted at least 180 days before the expiration date of this permit.

4.5. Duty to Provide Information. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

4.6. Other Information. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Director, it shall promptly submit such facts or information.

4.7. Signatory Requirements. All applications, reports or information submitted to the Director shall be signed and certified.

4.7.1. All permit applications shall be signed by either a principal executive officer or ranking elected official.

4.7.2. All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

4.7.2.1. The authorization is made in writing by a person described above and submitted to the Director; and,

4.7.2.2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

4.7.3. Changes to authorization. If an authorization under Part 4.7.2 is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Part 4.7.2 must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

4.7.4. Certification. Any person signing a document under this section shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

4.8. Penalties for Falsification of Reports. The Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six months per violation, or by both.

4.9. Availability of Reports. Except for data determined to be confidential under 40 CFR Part 2, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Director. As required by the Act, permit applications, permits and effluent data shall not be considered confidential.

4.10. Oil and Hazardous Substance Liability. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

4.11. Property Rights. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state, tribal or local laws or regulations.

4.12. Severability. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

4.13. Transfers. This permit may be automatically transferred to a new permittee if:

4.13.1. The current permittee notifies the Director at least 30 days in advance of the proposed transfer date;

4.13.2. The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage, and liability between them; and,

4.13.3. The Director does not notify the existing permittee and the proposed new permittee of his or her intent to modify, or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in Part 4.13.2.

4.14. Permittees in Indian Country. EPA is issuing this permit pursuant to the Agency's authority to implement the Clean Water Act NPDES program in Indian country, as defined at 18 U.S.C. 1151.

4.15. Reopener Provision. This permit may be reopened and modified (following proper administrative procedures) to include the appropriate effluent limitations (and compliance schedule, if necessary), or other appropriate requirements if one or more of the following events occurs:

4.15.1. Water Quality Standards: The water quality standards of the receiving water(s) to which the permittee discharges are modified in such a manner as to require different effluent limits than contained in this permit.

4.15.2. Wasteload Allocation: A wasteload allocation is developed and approved by the CrowTribe and/or EPA for incorporation in this permit.

4.15.3. Water Quality Management Plan: A revision to the current water quality management plan is approved and adopted which calls for different effluent limitations than contained in this permit.

4.16. Toxicity Limitation-Reopener Provision. This permit may be reopened and modified (following proper administrative procedures) to include whole effluent toxicity limitations if whole effluent toxicity is detected in the discharge.

Appendix B. Water Treatment Plant Alternative Process Design Report

CROW MR&I SYSTEM

WATER TREATMENT PLANT ALTERNATIVE ANALYSIS REPORT

JUNE 2015-REVISED JULY 2015

BARTLETT & WEST

CROW TRIBE

CROW MR&I SYSTEM -

WATER TREATMENT PLANT ALTERNATIVE ANALYSIS REPORT -

CROW TRIBE

CROW TRIBE WATER RESOURCE DEPARTMENT

JUNE 15, 2015-REVISED JULY 1, 2015

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1 Introduction and Background

1.1 Description of the Crow MR&I Water System

The MR&I System is a water supply and delivery system that will be constructed to meet the domestic, commercial, and industrial water needs of residents and communities on the Crow Indian Reservation. The authorization of the MR&I System is a result of the Claims Resolution Act of 2010 (Public Law 111-291). Title IV of this Act is the Crow Tribe Water Rights Settlement which, in part, authorized $246,381,000 for the design and construction of the MR&I System.

The Act defines the MR&I System as generally described in the document entitled "Crow Indian Reservation Municipal, Rural and Industrial Water System Engineering Report" prepared by DOWL HKM (Authorizing Report), and dated July 2008 and updated in a status report prepared by DOWL HKM dated December 2009.

The Authorizing Report briefly discusses the use of Mechanical Pre-filters, Microfiltration Membranes, Ultraviolet Disinfections, Chlorine and Ammonia in the water treatment process. The Authorizing Report does not elaborate on why these components were selected since this was a feasibility level document. It is critical to note that the Authorizing Report had utilized a different intake location and type than what is currently being proposed. Processes may vary from earlier based on different water quality parameters.

This Water Treatment Plant Preliminary Process Design Report (Report) is a preliminary/feasibility design document in which technically feasible treatment processes will be considered and evaluated. Options may be eliminated from future consideration for cost, residuals-environmental, water quality goals, or implementation/operational reasons. This report will also identify the processes to be carried into the bench scales and pilot scale testing level.

1.2 Populations, Water Demands, and Master Plan Information

The Crow Indian Reservation, the largest of the seven Indian reservations in Montana, is located in south-central Montana, bordered by Wyoming to the south and the Northern Cheyenne Indian Reservation to the east. The Crow Indian Reservation encompasses approximately 2,300,000 acres, which includes the northern end of the Bighorn Mountains, Wolf Mountains, and Pryor Mountains. Approximately 404,172 acres of land within the reservation are owned by the Crow Tribe and the Bighorn River is the largest hydrologic feature on the reservation. Flowing north from the Montana-Wyoming state line through the center of the reservation to the Little Bighorn River just outside Hardin, Montana, the Bighorn River continues north to its confluence with the Yellowstone River. Incidentally, part of the western reservation boundary runs along the ridgeline separating Pryor Creek and the Yellowstone River, and the city of Billings is approximately 10 miles northwest of this reservation boundary.

There are 6 cities, towns, or communities located on the Crow Reservation. The largest cities, according to the 2010 population census, are Crow Agency (1616), Fort Smith (161), Lodge Grass (428), Pryor (618), Saint Xavier (83), and Wyola (215). The only incorporated community on the Reservation is the town of Lodge Grass. The City of Hardin(3505), which is located on the Northeastern corner just outside of the reservation boundary was also analyzed in previously completed Engineering Reports as a possible bulk service connection to the Crow Indian Reservation MR&I System. The population of the entire Reservation (2010 census) was 6,863 of which approximately 78% was Indian and 22% was non-Indian. The projected 2060 population based on Census information is 9,050 while the projected population based on Tribal Enrollment figures is closer to 12,000.

Water needs for the entire Reservation were analyzed within the 2014 Crow MR&I Master Plan Report [1]. The combined water demand for the entire Reservation, including Municipal, Rural (including livestock), and Industrial users is 3,154 gallons per minute peak, approximately 4.5 MGD. Of this livestock water usage across the system is estimated at 0.79 MGD or 550 gallons per minute peak transmission flow. Included within this 4.5 MGD is approximately 0.65 MGD or 450 gallons per minute peak for Industrial use. The remaining 3.06 MGD is municipal and rural household/residential usage. If the community of Hardin connects to the system the demand is 4,660 gallons per minute peak, approximately 6.7 MGD. Should the population growth experienced more closely match the Tribal Enrollment forecast than the US Census information the demand may be as high as approximately 8.0-8.5 MGD.

Complete population projections, water demand criteria, water treatment regulations, raw water quality & quantity parameters, water treatment process technology, system cost estimates, and preliminary project schedule are all included in the 2014 Crow MR&I Master Plan Report [1].

2 Water Quality Data, Treatment Goals, Water Costs & Socioeconomic Effects

2.1 Raw Water Information

Surface water sampling of the Big Horn River has been conducted to obtain low and high, along with average water quality of the river. The construction of the pilot well was affected due to delays with obtaining a BIA Surface Use Agreement for the well construction. It was determined that surface water sampling would be conducted until a pilot well could be constructed. Initial surface water quality data was collected via grab samples from the Bighorn River over the summer months of June, July and August 2013. Grab samples were analyzed for pH, temperature, conductivity, total hardness, alkalinity, total iron, total manganese, and tubidity. During this period, one grab sample was collected and provided to a testing laboratory to test for a variety of biological and physical properties, inorganics, nutrients, metals and radionuclides. A list of the parameter results for the field and lab analysis can be found in Appendix A. This initial data set from 2013 along with information gathered from the USGS gauging station and the city of Hardin water treatment plant provided a baseline of information.

In spring of 2014, sampling began on a broad range of parameters not initially tested in 2013, including those note above in the grab sampling; as well as TSS, TDS, TOC/DOC, microbiological, UV 254, odor, additional total and dissolved metals, non-metals and organics, inorganics, nutrients, TTHM potential, HAA5 potential, radiological parameters, recent weather conditions, and river flow rate. Repeating field and laboratory analysis provided a more thorough characterization of the source water. Source water sampling has continued through 2014 with a focus on the parameters that were detected in this sample set. The sample set was used to establish a scheduled sampling program for the present and expected parameters necessary to inform the designers of the treatment process and EPA permitting of the pilot plant and ultimate water treatment plant. The results of the 2014 testing are displayed in Appendix A.

In the fall of 2014, an additional sample site was added; an observation well located approximately 300' north of the planned pilot well. The well was installed during geotechnical investigation of the site and is approximately 20' in depth and constructed of 2" PVC/PVC screen. This sample location provides an approximate characterization of the ground water under the influence of Big Horn River surface water. The results of the fall 2014 lab and grab sample testing are displayed in Appendix A.

The ongoing surface water and GWUISW sampling is focused on the parameters that will be either most impacting to the treatment design and or complex to treat. These parameters include TOC, DOC, hardness, alkalinity, iron and manganese and others. The list of parameters, frequency and approximate scheduled end date of the ongoing sampling is included in Appendix A.

Table 2.1(a): Source Water (Observation Well) Sampling Results-September 2014 through June 2015

Summary of Pilot Observation Well Water								
	pH	Temp °C	Turbidity (NTU)	ORP (mv)	T. Hardness (mg/L)	Alkalinity (mg/L)	Iron (mg/L)	Manganese (mg/L)
Count	10	12	10	10	14	14	14	14
Max	7.83	15	1.49	-12	285	240	0.73	0.77
Average	7.48	11.0	0.67	-34	263	214	0.49	0.75
Min	7.22	7.7	0.27	-54	239	185	0.29	0.64
	DOC (mg/L)	TOC (mg/L)	UVA 254 (cm^{-1})	TSS (mg/L)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Bromide (mg/L)
Count	11	11	9	8	8	8	8	8
Max	3	3.3	0.383	425	522	10	176	0
Average	2.7	2.9	0.1153333	57	417	8.75	158.375	0
Min	2.2	2.3	0.062	0	0	8	145	0
	Ammonia (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Orthopho-sphate (mg/L)	Total Phosphorous (mg/L)	Dissolved Aluminum (mg/L)	Dissolved Boron (mg/L)	Dissolved Calcium (mg/L)
Count	8	8	8	8	8	8	8	8
Max	0.57	0	0	0.124	0.253	0.41	0.19	70
Average	0.38	0	0	0.0625	0.129375	0.065	0.1185714	56.6
Min	0.33	0	0	0.04	0.1	0	0.1	0.54
	Dissolved Magnesium (mg/L)	Dissolved Silicon (mg/L)	Dissolved Sodium (mg/L)	Dissolved Strontium (mg/L)	Total Aluminum (mg/L)	Total Arsenic (mg/L)	Total Calcium (mg/L)	Total Iron (mg/L)
Count	8	8	8	8	8	8	8	8
Max	24	11.7	114	0.70	9.69	0.006	72	5.71
Average	20.5	9.9375	75.625	0.66	1.28625	0.003875	64.375	1.22
Min	17	9	63	0.59	0	0.003	58	0.46
	Total Manganese (mg/L)	Total Selenium (mg/L)	Total Silicon (mg/L)	Total Silica (mg/L)	Total Uranium (mg/L)	Gross Alpha (pCi/L)	Radium 226 (pCi/L)	Radium 228 (pCi/L)
Count	8	8	8	12	8	3	3	3
Max	0.743	0	32	23.9	0.003	6	0.5	0.4
Average	0.68775	0	12.575	10.3	0.0014125	5.2	0.3333333	0.13333333
Min	0.601	0	8.8	4.9	0.001	4	0.2	-0.1
	Total Zinc (mg/L)	*Non-Detect Parameters						
Count	8	Antimony	Copper	Silver				
Max	0.04	Beryllium	Lead	Thallium				
Average	0.005	Cadmium	Mercury	Chlorophyll-a				
Min	0	Chromium	Nickel	Cyanide				

2.2 Treated Water Quality Requirements & Goals

The Crow Tribe has made it a priority to construct a new Water Treatment Plant that produces high quality drinking water, addresses ease of operation concerns, and provides the Crow Tribe a potential economic impact and jobs creation source. Goals for the water treatment plant processes include compliance with current and future regulations (specifically future Disinfection Byproducts), operation performance and reliability, affordability of water to system users, and expandability. Although these goals will increase the cost to produce high quality drinking water, the Crow Tribal Chairman and CTWRD Director have approved these secondary goals above the required primary standards to treat the water. The cost for production of this high quality drinking water will be the responsibility of the Crow Tribal members and any other users connected to the system.

High quality water determined by the Crow Tribe will be defined by four parameters:

1. - Requirement-Water produced will meet the Safe Drinking Water Act (SDWA), including:
   a. - National Primary Drinking Water Regulations [Appendix B]
   b. - Stage 1 and Stage 2 Disinfection / Disinfection By Product Rule (D/DBPR)
   c. - Lead and Copper Rules
   d. - Total Coliform Rule
   e. - LT2ESWTR
   f. - Filter Backwash Recycling (FBRR) Rule

2. - Goal- Water produced shall be softened from the raw water hardness level of "Very Hard" (approximately 180-300+ mg/l as $CaCO_3$) to "Moderately Hard" (125-150 mg/l as $CaCO_3$) or less.

3. - Goal- Effluent Water quality will meet National Secondary Drinking Water Standards [Appendix B] for - contaminants of concern, such as iron, manganese and aluminum. -

4. - Goal -Effluent Water quality will achieve sufficient total organic carbon (TOC) reduction to minimize disinfection by-product (DBP) formation to 10% lower than regulatory mandates, with a goal being 33% lower than the regulatory limit. DBP formation potential and simulated distribution system testing will utilize free chlorine and chloramines as distribution system residual disinfectants, will be performed during the bench and pilot study to determine the required TOC removal through the treatment process to achieve DBP compliance with the respective disinfectants.

5. - Goal- Flexibility of the selected process to adapt and have the ability to achieve the potential treatment goals presented by future regulations. Water will be compliant with potential future regulations specifically Nitrosodimethylamine (NDMA) and the formation of other nitrogenous disinfection by products associated with Chloramines.

Table 2.2(a): Crow MR&I Treatment Quality Goals - May 2014 through June 2015

Contaminant	Crow MR&I Goal	MCL-Required Limit	Source-Surface Water Sample Range	Source- RBF Well Sample Range
Primary Standards-Requirements [4]				
Secondary Standards-Goals				
Sulfate	< 200 mg/L	250 mg/L[2]	255-273 mg/L	145-176 mg/L
Iron	<0.05 mg/L	0.3 mg/L[2]	0.01-0.4 mg/L	0.29-0.73 mg/L
Manganese	<0.03 mg/L	0.05 mg/L[2]	0.01-0.02 mg/L	0.64-0.77 mg/L
Aluminum	<0.1 mg/L	0.2 mg/L[2]	0.03-2.74 mg/L	ND-0.4 mg/L
Chloride	<250 mg/L	250 mg/L[2]	5-13 mg/L	8-10 mg/L
TDS	<500 mg/L	500 mg/L[2]	292-572 mg/L	472-522 mg/L
Non –Standards-Goals				
Hardness[2]	125 mg/l as CaCO3	NA	176-322 mg/L Approximately	239-285 mg/L Approximately
TOC[1]	1.25 mg/L*	NA-DBP Precursor	2.7-4.8 mg/L	2.3-3.3 mg/L
Disinfectant Byproducts				
TTHMs	Below MCL	80 ug/L	97-236 ug/L[3]	97-236 ug/L[3]
HAA5	Below MCL	60 ug/L	100-161 ug/L[3]	100-161 ug/L[3]
Bromate[1]	Below MCL	10 ug/L	NA	ND - < 1ug/L

[1]Bromide & TOC are Disinfection Byproduct precursors.

[2]Not a regulated standard but typical desired range is 100-200 mg/L

[3]Maximum TTHM and HAA5 Potential of the sample taken. TTHM contained an initial free chlorine reading of 0.01 mg/L and HAA5 contain 0.04 mg/L. Samples were spiked with a 5% sodium hypochlorite solution the lab and incubated for 7 days at 25˚ C before analysis. Final free chlorine after incubation was 0.41 mg/L in the TTHM sample and 0.71 mg/L in the HAA5 sample.

[4]See Appendix B for All Primary standard as well as source water sample ranges

** EPA's recommended TOC goal of 1.25 mg/L will be further evaluated following Bench & Pilot testing. TOC Reduction Requirements are applicable. A Hardness reduction goal of 125 mg/L will also be considered further following the Bench & Pilot testing.*

Table 2.2 (b): Design Considerations

Treatment Considerations	Technical Considerations	Financial Considerations
TOC Reduction necessary to-minimize Disinfection Byproduct precursors	MR&I Water Treatment Plant must have the flexibility of treatment processes to meet current & future regulations as well as the challenges of a large distribution system	Capital Costs
Iron & Manganese Removal is needed	Minimize Labor Intensity	OM&R Costs
Hardness reduction is desired by the Crow Tribe	Decrease Technical Difficulty	Labor Costs (part of OM&R costs)
Treatment of Secondary Goals desired by the Crow Tribe (Secondary Goals include Aluminum, Chloride, TDS, Sulfate	Water Treatment Plant must be able to successfully permit the residuals removal	Residuals Handling Costs (part of OM&R costs)
Treatment to meet all required Primary Standards		MR&I system and Water Treatment Plant provides the Crow Tribe the potential for economic impact and jobs source
Compliance Future Regulations – Specifically minimize NDMA formation (with the use of Chloramines)		

2.3 Socioeconomic Effects & Considerations

Items noted below are many of the socioeconomic effects and considerations of a new regional water treatment plant providing high quality water to the people of the Crow Reservation.

- Improved health
    - Reduced sulfate = reduced gastrointestinal illnesses & dehydration
    - Reduced nitrate = reduced infant illness & mortality
    - Reduced uranium = reduced kidney toxicity
    - Reduced Manganese = reduced respiratory problems & neurological damage

    - Reduced healthcare costs
- Improved safety
    - Larger flows are available along transmission pipelines which allow for potential for firefighting in rural areas; (Note-fire flows are not available in all pipelines, design criteria will allow water to be taken from transmission pipelines but design does not include fire flow and is not available in any capacity in the smaller distribution lines, community tanks contain additional storage for fire flow within communities)
- Expansion and upgrade abilities
- Tribal Operation for all water delivered on the Reservation is from one single entity, the Crow Tribe
    - One organization operating, maintaining, and managing the water system
- Jobs creation during construction and operations & maintenance
- Increased property valves
- Decrease in water deposit on pipes and appliances
    - Increase longevity of:
        - Water heaters – up to 50% longer
        - Washers – up to 30%
        - Toilets – up to 70%
        - Water faucets – up to 40%
        - Dishwashers – up to 30%
    - Increase efficiency of water heaters – up to 25%
    - Decreased repair and replacement costs
- Cleaning
    - Fabrics last longer when laundered in soft water
    - Decreased time to clean
    - Removal of manganese staining of laundry
- Potential for increased economic development
- Increased tax revenue due to increased economic activity and property values
    - Benefit for school districts
- Increased water availability could lead to new industries and job development on the reservation
- Decrease scaling of pipes due to softened water
    - Extend distribution system life
- Centralized softening rather than home softeners; an outreach program with the Crow Tribe Water Resource Department is continuing to work to reach out to the public within the system and educate them further

3 Treatment Process Alternatives

3.1 Potential Treatment Technologies

Many water treatment process technologies can be utilized to the meet the treatment goals and requirements identified. The complete water treatment process train must provide the following:

1. - Filtration process to remove contaminants, pathogens, other impurities in the source water.
2. - Soften source water
3. - TOC reduction process to reduce chlorinated DBP precursors and possible future regulated micro-pollutants.
4. - Pretreatment process to remove Iron and Manganese
5. - Treatment process to enhance Radionuclide removal. Uranium is of particular concern in the Crow Nation. Approximately 2/3's of the individual wells tested indicate uranium levels at or near the MCL of 30 ug/L. Source water sampling indicates levels at 1-6.4 ug/L, there for under the current treatment requirements.

See 2014 Crow MR&I Master Plan Section 6.5 for description of technologies. The Bureau of Reclamation also provides a summary of contaminant and treatment technologies located in Appendix C.

Filtration Process	Advantages	Disadvantages
Media Filtration	Tried and true history of use Normally lower Capital and O&M Costs than Membrane Filtration Does not require Chemical cleans like Membranes	Allows for passage of larger colloidal / particulate matter than Membrane filters More sensitive to source water changes, less repeatable with varying source water Less Log removal of Viruses, Giardia, Cryptosporidium than membranes Less Log removal by filtration requires more disinfection Log credits Larger footprint requirement Increased operator expertise required for operation
Microfiltration/Ultrafiltration	Established technology Small filtration size than media filters provides greater barrier to pathogens, containments Filtration is very reliable and repeatable; integrity testing provides a consistent method of maintaining this reliability Smaller filtration size allows for a greater possibility of meeting future more stringent regulations	Normally higher capital and O&M costs than media filtration Chemical cleans are required Membrane replacement costs

	Ability to start and stop operations and maintain performance Higher Log removal of Viruses, Giardia, Cryptosporidium than media filtration	
BAC Filtration	Provides some level of Organics removal Normally lower Capital and O&M Costs than Membrane Filtration	Starting and stopping of process may disrupt biological activity and changes in effluent quality produced Less Log removal of Viruses, Giardia, Cryptosporidium than membranes

Table 3.1 (a): Filtration Processes Considered

Description of the technologies (Microfiltration & Ultrafiltration, Media Filtration, and Biological Activated Carbon Filtration) are located in Appendix C:

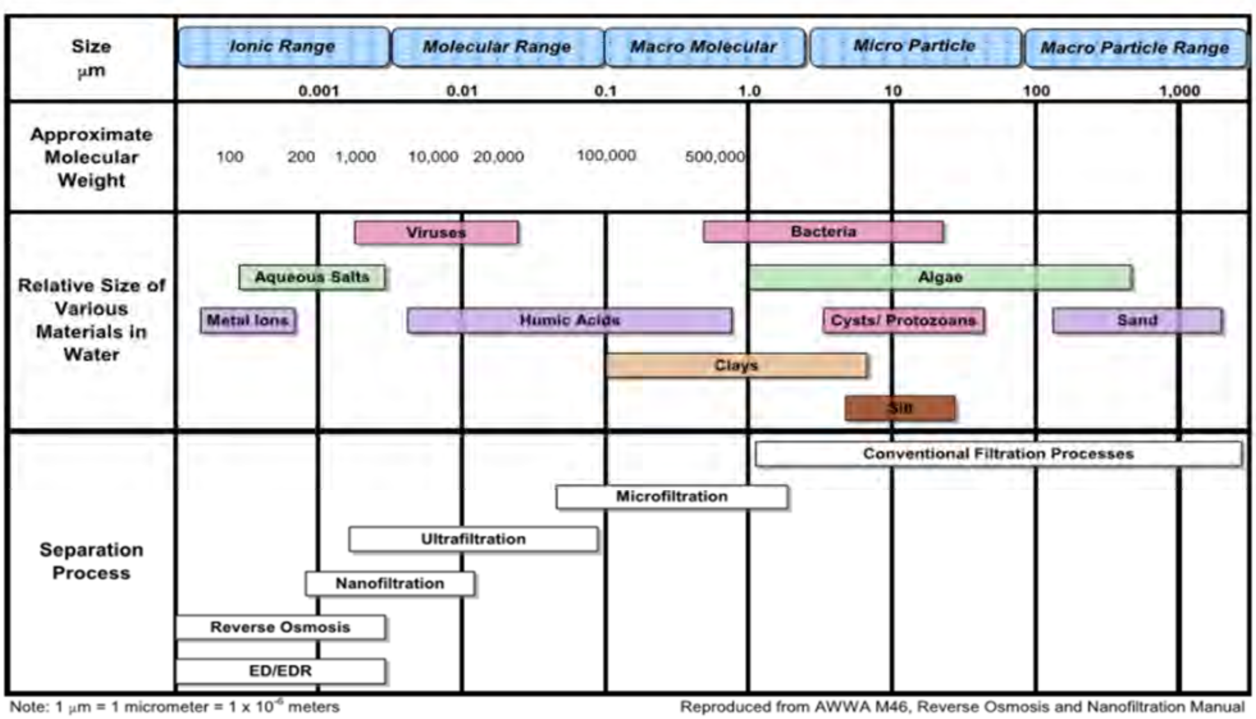


Table 3.1 (b): Filtration Sizes

Table 3.1 (c): Softening Processes Considered

Filtration Process	Advantages	Disadvantages
Reverse Osmosis (RO)/Nanofiltration (NF)	Tried and true history of use in water treatment Additional Pathogen barrier beyond filtration Highest removal of TOC, taste & odor, uranium, other pollutants Provides removal of DBP Precursors, Nitrate, hardness, TDS, Sulfates, Uranium, radionuclides all in one process Ability to start and stop operations and maintain performance Easy capacity increase for future expansion Low labor operation	Higher capital cost and O&M than other softening options Large chemical demands with cleaning and anti-scalants Large quantity of concentrated waste stream; residuals discharge difficulties Membranes are not oxidant tolerant High Feed Pressures Membrane fouling and scaling can occur if the pretreatment and/or RO system is not operated correctly for a given water quality Water stabilization may be required following treatment, which requires chemistry knowledge and effects of bypassing / blending.
Lime Softening	Established technology Normally lower Capital and O&M Costs than RO/NF Provides softened water to desired level	Handling of lime-both storing, feeding, and cleaning Starting and stopping of process may disrupt lime sludge and change effluent quality produced Lower Organics-TOC-DBP precursor reduction than other softening options Large lime sludge & solids residuals to dispose of Labor requirements High level chemistry knowledge needed for operation
Ion Exchange-Miex®/MICo®	Provides good level of Organics removal Provides hardness reduction Capital costs are typically equal to or slightly lower than other softening options Pretreatment Option	Established technology but less utilized than other softening technology considered Large quantity of concentrated waste brine; residual discharge difficulties Ion exchange resin must be regenerated periodically Labor requirements
Electrodialysis (EDR) Softening (EDR)	Softening and removal ability is similar to NF/RO	Very limited suppliers –one Significant capital and Operating costs

	Oxidant tolerant membranes Automated Process Low chemical addition for pretreatment Low feed pressure	Large quantity of concentrated waste stream; residuals discharge difficulties

Description of the softening technologies (Reverse Osmosis (RO)/Nanofiltration (NO), Lime Softening, Ion Exchange Miex®, EDR) are located in Appendix C:

Table 3.1 (d): Pretreatment & Post-treatment Process Options Considered

Filtration Process	Advantages	Disadvantages
PAC Pretreatment Feed	Can be fed in basin as powder or slurry Organic removal as well has taste and odor	Cannot be fed with chlorine or potassium permanganate PAC sludge disposal, not able to be regenerated
GAC Post-treatment Contactor	Well Established Organic removal as well has taste and odor	Expensive O&M cost for regeneration Requires close monitoring
Ion Exchange-Miex® Pretreatment	Provides good level of Organics removal Pretreatment Option	Large quantity of concentrated waste brine; residuals discharge difficulties Ion exchange resin must be regenerated periodically Labor requirements Can be used with PAC dosing
Pretreatment Coagulation/Flocculation/Sedimentation-Clarifier, Plate Settler	Plate Settler-High loading rate, small footprint Clarifier-Can incorporate lime softening, long history of use in water treatment	Plate Settler-Maintenance of mixer, flocculators, sludge collection system Clarifier-high equipment costs, high level operation skill & labor, optimal performance with polymer
Oxidation for Iron-MN Removal	Options for oxidant-Ozone, Permanganate, etc.	Potential byproduct formation; pre-oxidation can lead to increased levels of TTHMs, HAA5s, Bromate
Greensand Filtration	Relatively low cost	Oxidation required

	Proven & Reliable	Backwash disposal along with regeneration

Description of the pretreatment-post treatment technologies (Greensand Filtration, Oxidation, Ozone, and GAC-PAC) are located in Appendix C:

Table 3.1 (e): Water Treatment Processes Barrier Table

Treatment Process	Iron-Manganese	Biological (Filtration)	TOC-DBP Precursors	Hardness	TDS	Sulfate	Aluminum	Radionuclides (Uranium)
Media Filtration		X						
MF/UF		X						
BAC Filtration		X	X					
NF/RO			X-High	X	X	X	X	X
Lime Softening	X		X-Low	X				X
Ion Exchange-MIEX®			X	X		X		X
EDR		X	X	X	X	X	X	
PAC Pretreatment			X					
GAC Post-Treatment			X					

Ion-Exchange Pretreatment			X					
Pretreatment- Coag/Floc/Sed Clarifier or Plate Settlers	X							
Oxidation- FE/MN Removal	X							
Greensand Filtration	X							

As discussed in previous sections of this report, the Crow Tribe has strongly indicated their desire to provide high quality drinking water meeting Primary Drinking Water requirements as well as treating for Secondary Drinking Water Standards noted to provide benefits to the residence of the Crow Reservation. The expense to treat the water to the secondary goals identified is greater than treating to primary standards, but the Crow Tribal Chairman and CTWRD Director have approved this process on behalf of the residency of the Crow Reservation.

3.2 Residuals Considerations

A large part of any treatment process selection is the consideration of the residuals. Management and permitting of water treatment plant residuals can be a difficult and take a long period of time. The following table summarizes the residuals streams produced by each treatment process identified in previous sections.

Table 3.2 (a): Residuals of Processes Considered

Residuals	Liquid Residuals				Solid Residuals	
Treatment Process	Brine /Concentrate	Back wash	Rinse Water	Neutralized Water	Spent Resin /Media	Sludge
Media Filtration		X				X
MF/UF		X	X	X		
BAC Filtration		X				X
NF/RO	X		X			

Lime Softening		X			X	X
Ion Exchange-MIEX®	X	X	X			
EDR	X		X			
PAC Pretreatment						X
GAC Post-Treatment					X	
Ion-Exchange Pretreatment	X	X	X		X	
Pretreatment-Coag/Floc/Sed Clarifier or Plate Settlers		X			X	X
Oxidation-FE/MN Removal						
Greensand Filtration		X				

Since the Radionuclides (Uranium, Radium, Beta & Alpha Particles) source water levels are all below the MCL it is not likely that the residuals concentration will significantly concentrated. The waste streams for the ion exchange, lime softening-drying beds, and NF/RO are specifically the processes of concern and are described further in the Mass Balance Diagrams.

Table 3.2 (b): Residuals Disposal Options

Residuals	Disposal Options			
	Surface Water Discharge	Discharge to onsite ponds	Underground Injection	Surface Application-Landfill
Liquids	X	X	X	
Sludge		X		X
Spent Resin/Media/Membranes				X

Additional residuals disposal investigation and agency discussions will take place upon receiving the pilot residuals information. Preliminary discussions with the EPA, MT Fish, Wildlife, & Parks, US Army Corps of Engineers, MT DEQ, and local NRCS have provided no indication that any of the options noted above are not feasible. Following the piloting project, coordination meeting(s) will be conducted to review the residuals options with Federal, Tribal, and Local agencies with interest. Reclamation has authored a report regarding the treatment of concentrate [2] which provides additional information of the treatment and disposal requirement of concentrate streams.

3.3 Treatment Process Train Alternative Preliminary Development

Below is the preliminary list of all alternatives developed to meet the Crow Tribe's water treatment goals for preliminary review.

1. - **Alternative Process No. 1 –** PAC Feed with Lime Softening Clarification, MF/UF Filtration, Chlorine Disinfection
2. - **Alternative Process No. 2 –** MIEX Pretreatment, Lime Softening Clarification, MF/UF Filtration, Chlorine Disinfection
3. - **Alternative Process No. 3 –**Lime Softening Clarification, MF/UF Filtration, GAC Contactor, Chlorine Disinfection
4. - **Alternative Process No. 4 –**Pretreatment Oxidation, Lime Softening Clarification, MF/UF Filtration, Chlorine Disinfection
5. - **Alternative Process No. 5 –**Lime Softening Clarification, MF/UF Filtration, Chloramine Disinfection
6. - **Alternative Process No. 6 –** PAC Feed with Lime Softening Clarification, Media Filtration, Chlorine Disinfection
7. - **Alternative Process No. 7 –** Ion Exchange Pretreatment, Lime Softening Clarification, Media Filtration, Chlorine Disinfection
8. - **Alternative Process No. 8 –**Lime Softening Clarification, Media Filtration, GAC Contactor, Chlorine Disinfection
9. - **Alternative Process No. 9 –**Pretreatment Oxidation, Lime Softening Clarification, Media Filtration, Chlorine Disinfection
10. - **Alternative Process No. 10 –**Lime Softening Clarification, Media Filtration, Chloramine Disinfection
11. - **Alternative Process No. 11-** Pretreatment Oxidation-Coagulation-Sedimentation, Lime Softening Clarification, Biologically Active Media Filtration, Chlorine Disinfection
12. - **Alternative Process No. 12-** Pretreatment Oxidation-Coagulation-Sedimentation, Media Filtration, NF/RO Softening, Chlorine Disinfection
13. - **Alternative Process No. 13-** Pretreatment Coagulation-Sedimentation, Greensand Media Filtration, NF/RO Softening, Chlorine Disinfection
14. - **Alternative Process No. 14-** Pretreatment Oxidation-Coagulation-Sedimentation, MF/UF Filtration, NF/RO Softening, Chlorine Disinfection
15. - **Alternative Process No. 15 –** Pretreatment Oxidation-Coagulation-Sedimentation, Biologically Active Filtration, NF/RO Softening, Chlorine Disinfection
16. - **Alternative Process No. 16 –** PAC Feed with Pretreatment Coagulation-Sedimentation, MF/UF Filtration, ED/EDR Softening, Chlorine Disinfection
17. - **Alternative Process No. 17 –**Pretreatment Coagulation-Sedimentation, MF/UF Filtration, ED/EDR Softening, GAC Contactor, Chlorine Disinfection
18. - **Alternative Process No. 18 –** MIEX Pretreatment with Oxidation Pretreatment Coagulation-Sedimentation, MF/UF Filtration, ED/EDR Softening Chlorine Disinfection -
19. - **Alternative Process No. 19 –** Pretreatment Oxidation-Coagulation-Sedimentation, MIEX Softening, MF/UF Filtration, Chlorine Disinfection
20. - **Alternative Process No. 20 -** Pretreatment Oxidation-Coagulation-Sedimentation, MIEX Softening, Media Filtration, Chlorine Disinfection

Table 3.3(a): Complete Process Train Alternative

Crow MR&I Water Treatment Process Alternatives								Treatment Goals									Decision to Move Investigation Forward		
								Organic Matter Removal											
Process Option No.	Treatment Group	Process Train Components						Primary	Secondary	Hardness Removal	Iron & Manganese	Aluminum	TDS	Uranium/ Arsenic/ Sulfates	Filtration	Disinfection	Accepted for Further Investigation	Why not carried forward	Notes
1	Lime Softening & MF/UF	PAC Pretreatment	Lime Softening	MF/UF	Chlorine	pH, Recarbonation		PAC-10%	Lime Softening (10% - 30%)	Lime Softening	PAC/Lime			Lime	MF/UF	Chlorine	No	DOC Reduction less than Goal; PAC dosages will be high, PAC contact would be long, FE-MN Removal inadequate to meet goal	
2	Lime Softening & MF/UF	MIEX Pretreatment	Lime Softening	MF/UF	Chlorine	pH, Recarbonation		MIEX-35%	Lime Softening (10% - 30%)	Lime Softening	MIEX/Lime	MIEX	MIEX	Lime, MIEX	MF/UF	Chlorine	Yes		Oxidation removed from analysis but still an option-dependent on lime softening bench FE-MN removal; MIEX not softening-TOC removal
3	Lime Softening & MF/UF	Lime Softening	MF/UF	GAC Post Filtration	Chlorine	pH, recarbonation		GAC-50% +	Lime Softening (10% - 30%)	Lime Softening	Lime			Lime	MF/UF	Chlorine	Yes		Oxidation removed from analysis but still an option; depend on lime softening bench FE-MN removal
4	Lime Softening & MF/UF		Lime Softening	MF/UF	Chlorine	pH, Recarbonation		Lime Softening (10% - 30%)		Lime Softening	Lime			Lime	MF/UF	Chlorine	No	Insufficient DOC removal	
5	Lime Softening & MF/UF	Lime Softening	MF/UF	Chloramines	pH, Recarbonation			Lime Softening (10% - 30%)		Lime Softening	Lime			Lime	MF/UF	Chloramines	No	Concerns over future regulations with NDMA and Chloramines, Nitrification concerns in distribution system	Chloramines still an option with other TOC reduction processes considered
6	Lime Softening & Media Filtration	PAC	Lime Softening	Media	Chlorine	pH, Recarbonation		PAC-10%	Lime Softening (10% - 30%)	Lime Softening	PAC/Lime			Lime	Media Filtration	Chlorine	No	DOC Reduction less than Goal; PAC dosages will be high, PAC contact would be long, FE-MN Removal inadequate to meet goal	
7	Lime Softening & Media Filtration	MIEX	Lime Softening	Media	Chlorine	pH, Recarbonation		MIEX-35%	Lime Softening (10% - 30%)	Lime Softening	MIEX/Lime	MIEX	MIEX	Lime, MIEX	Media Filtration	Chlorine	Yes		Oxidation removed from analysis but still an option dependent on lime softening bench FE-MN removal; MIEX not softening-TOC removal
8	Lime Softening & Media Filtration	Lime Softening	Media	GAC	Chlorine	pH, recarbonation		GAC-50% +	Lime Softening (10% - 30%)	Lime Softening	Lime			Lime	Media Filtration	Chlorine	Yes		Oxidation removed from analysis but still an option; depend on lime softening bench FE-MN removal
9	Lime Softening & Media Filtration	Oxidation	Lime Softening	Media	Chlorine	pH, Recarbonation		Lime Softening (10% - 30%)		Lime Softening	Oxidation			Lime	Media Filtration	Chlorine	No	Insufficient DOC removal	
10	Lime Softening & Media Filtration	Lime Softening	Media	Chloramines	pH, Recarbonation			Lime Softening (10% - 30%)		Lime Softening	Lime			Lime	Media Filtration	Chloramines	No	Concerns over future regulations with NDMA and Chloramines, Nitrification concerns, in dist. System	chloramines still an option with other TOC reduction processes considered
11	Bio Filter	Ozone	Lime Softening	Bio Filter	Chlorine	pH, Recarbonation		Bio Filter 20%-40%	Lime Softening (10% - 30%)	Lime Softening	Pre Oxidation			Lime	Bio Filter	Chlorine	Yes		Operational Concerns, temperatures, weekend shut downs, Bio Filters are difficult to develop in a lab-bench testing environment, Consider anthracite or GAC for biofilter media, If biofilter is
12	NF/RO	Pre Oxidation Coag/Sed	Media	NF/RO	Chlorine			NF/RO-95% + RO Permeate, 60-70% Blended		RO/NF	Pre Oxidation	NF/RO	NF/RO	NF/RO	Media Filtration	Chlorine	No	If media filtration, greensand provide s additional MN removal	
13	NF/RO	Potassium Permanganate	Coag/Sed	Greensand Media	NF/RO	Chlorine		NF/RO-95% + RO Permeate, 60-70% Blended		RO/NF	Potassium Permanganate (Ox) & Greensand Media	NF/RO	NF/RO	NF/RO	Greensand Media	Chlorine	Yes		Possible pre-oxidation of Mn required if NF/RO blend is insufficient, Coag/Sed could be eliminated if NF/RO blend is sufficient to remove DOC
14	NF/RO	Oxidation	Coag/Sed	MF/UF	NF/RO	Chlorine		NF/RO-95% + RO Permeate, 60-70% Blended		RO/NF	Pre Oxidation	NF/RO	NF/RO	NF/RO	MF/UF	Chlorine	Yes		Oxidation kinetics of Mn are slow, ozone could biofoul membranes
15	Bio Filter	Ozone	Coag/Sed	Bio Filter	NF/RO	Chlorine		NF/RO-95% + RO Permeate, 60-70% Blended	Bio Filter 20%-40%	NF/RO	Ozone (Ox) & Coag/Sed	NF/RO	NF/RO	NF/RO	Bio Filter	Chlorine	No	Operational Concerns, Biofouling on RO from BAC, TOC reduction to the level not necessary,	Biofouling concerns with Bio filter in front on RO
16	ED/EDR	PAC	Coag/Sed	MF/UF	ED/EDR	Chlorine		EDR 60-70%	PAC 10%	ED/EDR		EDR	EDR	EDR	MF/UF	Chlorine	No	One manufacturer, Costs, future Replacement, EDR Complexity of operation and O&M, PAC dosage will be high to achieve DOC removal	
17	ED/EDR	Coag/Sed	MF/UF	ED/EDR	GAC	Chlorine		EDR 60 70%	GAC 50%	ED/EDR	Pre Oxidation	EDR	EDR	EDR	MF/UF	Chlorine	No	One manufacturer, Costs, or Future Replacement, EDR complexity	
18	ED/EDR	MIEX	Coag/Sed	MF/UF	ED/EDR	Chlorine		MIEX 35%	Coag/Sed	ED/EDR		EDR, MIEX	EDR	MIEX, EDR	MF/UF	Chlorine	No	One manufacturer, Costs, or Future Replacement, Potential scaling of IX resin dependent on WQ.	
19	MIEX	MIEX	Oxidation	Coag/Sed	MF/UF	Chlorine		MIEX 35%	Coag/Sed	MIEX	Pre Oxidation	MIEX		MIEX	MF/UF	Chlorine	No	DOC Reduction less than Goal, Potential scaling of IX resin dependent on WQ. ~15% increase in TDS with IX softening.	
20	MIEX	MIEX	Oxidation	Coag/Sed	Media	Chlorine		MIEX 35%	Coag/Sed	MIEX	Pre Oxidation	MIEX		MIEX	Media Filtration	Chlorine	No	DOC Reduction less than Goal, Potential scaling of IX resin dependent on WQ. ~15% Increase in TDS with IX softening	

Notes
Lime Softening DOC Removal - Standard (10%), Sludge Recycle (up to 30%), https://etd.ohiolink.edu/!etd.send_file?accession=osu1047486107&disposition=inline
MIEX DOC Removal - 35%, March 2015 Orica-MIEX Report
PAC DOC Removal - 10%, http://pubs.usgs.gov/sir/2013/5001/section11.html
BAC DOC Removal - 20-40%, file:///C:/Users/jjh01103/Downloads/hozalski-jawwa-1995.pdf
EDR - http://cdn.intechweb.org/pdfs/13751.pdf

Notes
Lime Softening DOC Removal - Standard (10%), Sludge Recycle (up to 30%), https://etd.ohiolink.edu/!etd.send_file?accession=osu1047486107&disposition=inline
MIEX DOC Removal - 35%, March 2015 Orica-MIEX Report
PAC DOC Removal - 10%, http://pubs.usgs.gov/sir/2013/5001/section11.html
BAC DOC Removal - 20-40%, file:///C:/Users/jjh01103/Downloads/hozalski-jawwa-1995.pdf
EDR - http://cdn.intechweb.org/pdfs/13751.pdf

A number of process technologies were initially noted as alternatives to be considered. During the initial water treatment process alternative analysis process it was determined that there are 7 options to be evaluated further. The options that were not moved forward contained the technologies discussed in the next paragraphs based on the concerns and potentially issues identified.

Powder Activated Carbon was withheld from further investigation as a pretreatment organic removal process based on the relatively high dosages that would be required along with the organic reduction being less than that of other pretreatment options. A PAC feed system is still a possibility during final analysis.

Based on concerns over future regulation compliance with EPA standards for NDMA (Nitrosodimethylamine) as well as Nitrification with the distribution system Chloramine disinfection was not carried forward for further evaluation within this report. Correspondence received from the EPA was a factor in these concerns. A chloramination disinfection system is still a possibility during final analysis and design.

Electro-dialysis Reversal (EDR) membranes were not carried into the further analysis portion of the report due to several issues identified. These issues include: limited manufacturers, future replacement issues, complexity of O&M, and costs-both capital and operating. These items were the main reasons for not considering the EDR system as one of the most beneficial process technology options.

The MIEX Ion Exchange technology was initially considered as a softening option. After initial manufacturer's bench scale information was reviewed it was determined that the organic reduction level did not meet the project DOC reduction goal. This along with potential issues with ion exchange resin scaling and increase in TDS due utilizing the technology for softening led to the determination to not carry the technology forward. MIEX is still a pretreatment organic removal option when paired with lime softening for enhanced organics removal.

3.4 Treatment Process Train Alternatives Considered for Further Evaluation

Following the alternate review process the number of processes that were determined to be most beneficial for Further Evaluation were identified. The seven alternatives are discussed in detail below. All seven are seen as robust treatment scenarios based on desktop information available. Schematics of these alternatives are provided in section 3.5.1.1.

1. *Alternative Train No. 1* - Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels, Micro/Ultra Filtration; Chlorine

   In this treatment process the initial step will be Lime Softening clarification. This process includes clarification, coagulation, and flocculation. A coagulant or polymer along with lime is fed during this process. This step will oxidize iron and manganese and will remove hardness, iron & manganese, along with other flocculated materials. Accommodations in design may be made to be able to provide a pretreatment oxidation step prior to either the MIEX or Lime Softening steps. Several oxidation options are possible to oxidize the iron and manganese present in the source water. These options are ozone, chlorine, and permanganate. The ozone oxidation would provide treatment for iron & manganese as well as the option to treat for taste and odor compounds. Taste and odor events are unlikely given intake facility being considered and the source water information collected. The MIEX Pressure filters would follow the lime softening process and would provide additional organics removal, iron/manganese removal, and softening. Consideration will be given for the location of MIEX system to placed either prior to or follow the Lime Softening process. The water is then filtered through MF/UF to remove pathogens, turbidity, and other particulates in the water. The final step is to then disinfect the filtered water with chlorine prior to distribution. Space can be left for future ammonia system which along with the chlorine system could be used to disinfect by chloramination.

2. *Alternative Train No. 2* – Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation) Micro/Ultra Filtration; GAC Vessels, Chlorine

In this treatment process the initial step will be Lime Softening clarification. This process includes clarification, coagulation, and flocculation. A coagulant or polymer along with lime is fed during this process. This step will oxidize iron and manganese and will remove hardness, iron & manganese, along with other flocculated materials. Accommodations in design may be made to be able to provide a pretreatment oxidation step prior to the Lime Softening steps. Several oxidation options are possible to further oxidize the iron and manganese present in the source water should the lime softening not provide enough removal. These options are ozone, chlorine, and permanganate. The water is then filtered through MF/UF to remove pathogens, turbidity, and other particulates in the water. After the filtration step the water flows to the GAC Pressure filters for post treatment organics removal. The GAC also would provide treatment for taste and odor compounds. The final step is to then disinfect the filtered water with chlorine prior to distribution. Space can be left for future ammonia system which along with the chlorine system could be used to disinfect by chloramination.

3. *Alternative Train No. 3* - Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels; Media Filtration; Chlorine

In this treatment process the initial step will be Lime Softening clarification. This process includes clarification, coagulation, and flocculation. A coagulant or polymer along with lime is fed during this process. This step will oxidize iron and manganese and will remove hardness, iron & manganese, along with other flocculated materials. Accommodations in design may be made to be able to provide a pretreatment oxidation step prior to either the MIEX or Lime Softening steps. Several oxidation options are possible to oxidize the iron and manganese present in the source water. These options are ozone, chlorine, and permanganate. The ozone oxidation would provide treatment for iron & manganese as well as the option to treat for taste and odor compounds. Taste and odor events are unlikely given intake facility being considered and the source water information collected. The MIEX Pressure filters would follow the lime softening process and would provide additional organics removal, iron/manganese removal, and softening. Consideration will be given for the location of MIEX system to placed either prior to or follow the Lime Softening process. The water is then filtered through media filters (GAC, anthracite, sand, and/or combination) to remove pathogens, turbidity, and other particulates in the water. The final step is to then disinfect the filtered water with chlorine prior to distribution. Space can be left for future ammonia system which along with the chlorine system could be used to disinfect by chloramination.

4. *Alternative Train No. 4* – Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Media Filtration; GAC Vessels, Chlorine

In this treatment process the initial step will be Lime Softening clarification. This process includes clarification, coagulation, and flocculation. A coagulant or polymer along with lime is fed during this process. This step will oxidize iron and manganese and will remove hardness, iron & manganese, along with other flocculated materials. Accommodations in design may be made to be able to provide a pretreatment oxidation step prior to the Lime Softening steps. Several oxidation options are possible to further oxidize the iron and manganese present in the source water should the lime softening not provide enough removal. These options are ozone, chlorine, and permanganate. The water is then filtered through media filters (GAC, anthracite, sand, and/or combination) to remove pathogens, turbidity, and other particulates in the water. After the filtration step the water flows to the GAC Pressure filters for post treatment organics removal. The GAC also would provide treatment for taste and odor compounds. The final step is to then disinfect the filtered water with chlorine prior to distribution. Space can be left for future ammonia system which along with the chlorine system could be used to disinfect by chloramination.

5. *Alternative Train No. 5* – Pretreatment Oxidation (Ozone), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Bio GAC Media Filtration, Chlorine

In this treatment process the initial treatment step is the pretreatment oxidation. Several oxidation options are possible to oxidize the iron and manganese present in the source water. With bio filtration being utilized ozone would be required to break up the organic material present. Ozone oxidation converts some of the total organic carbon (TOC) to biodegradable dissolved organic carbon (BDOC). To promote biological activity ozone is added upstream to the filter beds. Ozone may be applied prior to rapid mix or the biofilter. The ozone oxidation would also provide the flexibility for treatment of taste and odor compounds. Following this step the water is sent to the Lime Softening process. This process includes clarification, coagulation, and flocculation. A coagulant or polymer along with lime is fed during this process. This step will remove hardness, iron & manganese, along with other flocculated materials. The water is then filtered through biologically active GAC media filters to remove pathogens, turbidity, and other particulates in the water. The biological active component of the filter also will provide some organics removal. The final step is to then disinfect the filtered water with chlorine prior to distribution. Space can be left for future ammonia system which along with the chlorine system could be used to disinfect by chloramination.

6. *Alternative Train No. 6* - (Pretreatment Oxidation, Coagulation, Sedimentation) Greensand Media Filtration; NF/RO Softening, Chlorine

   In this treatment process the initial treatment step is the pretreatment oxidation, coagulation, and sedimentation. Several oxidation options are possible for the removal of the iron and manganese present in the source water. These options are ozone, chlorine, and permanganate. Several coagulants are options as well; Aluminum Sulfate, Ferric Chloride, Polyaluminum Chloride, along with proprietary chemical designer options. Following the oxidation; coagulation and sedimentation steps will settle a portion of the iron & manganese and potentially other contaminants that have formed into floc. The water is then filtered through greensand media filters to remove pathogens, turbidity, and other particulates in the water. The greensand media following the oxidation step provides iron and manganese removal. If it is determined during bench testing that the greensand filter is sufficient for iron and manganese removal the coagulation and sedimentation step can possibly be removed. Following the filtration step the water would flow through the NF/RO membranes. This step will remove hardness, organics, micro-pollutants, TDS, and others. A portion of the NF/RO permeate water is blended with the filtrate effluent in order to achieve the desired water stability. The final step is to then disinfect the filtered water with chlorine prior to distribution. Space can be left for future ammonia system which along with the chlorine system could be used to disinfect by chloramination.

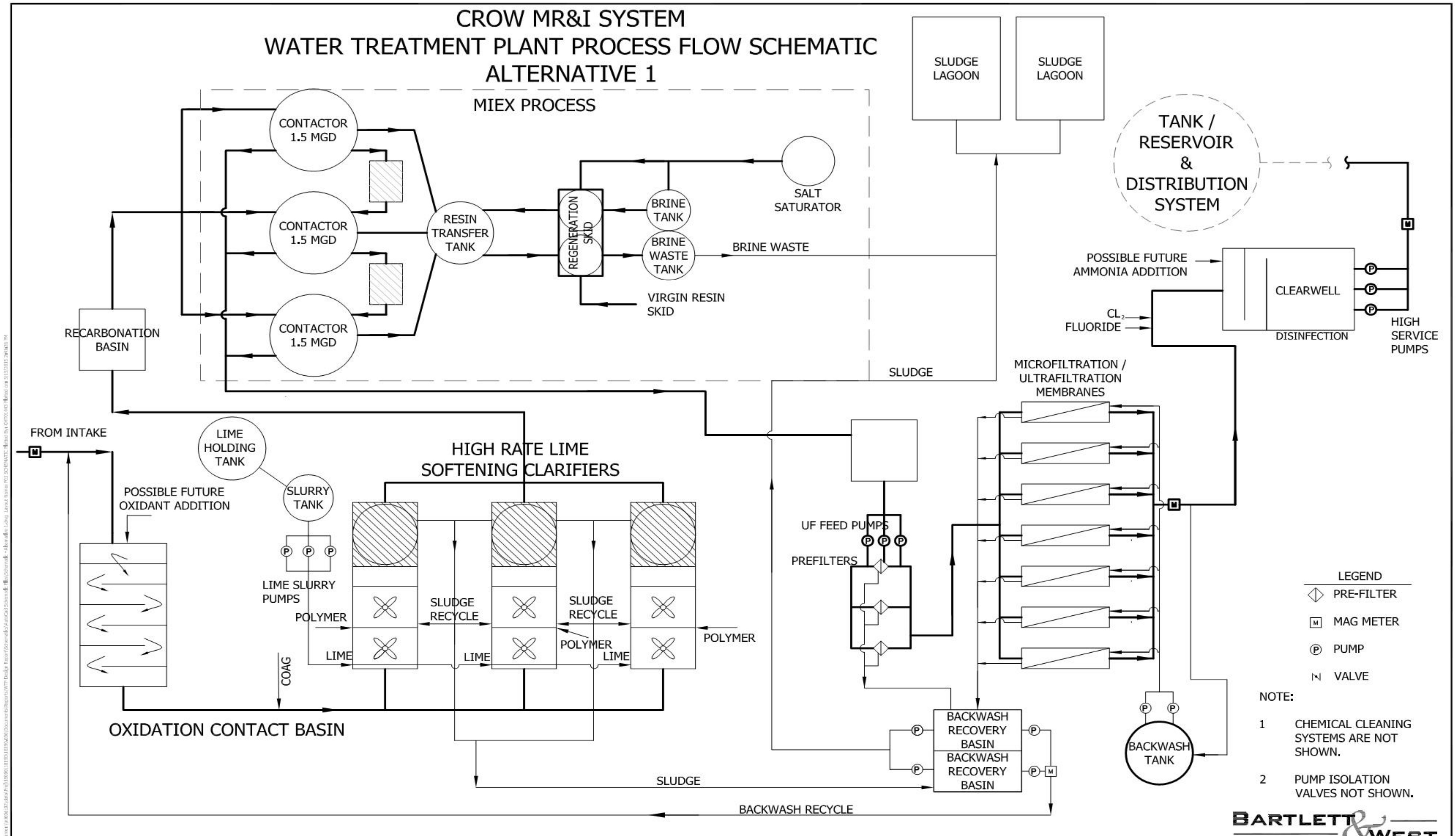
7. *Alternative Train No. 7* - Pretreatment Oxidation, Coagulation, Sedimentation, Micro/Ultra Filtration; NF/RO Softening, Chlorine

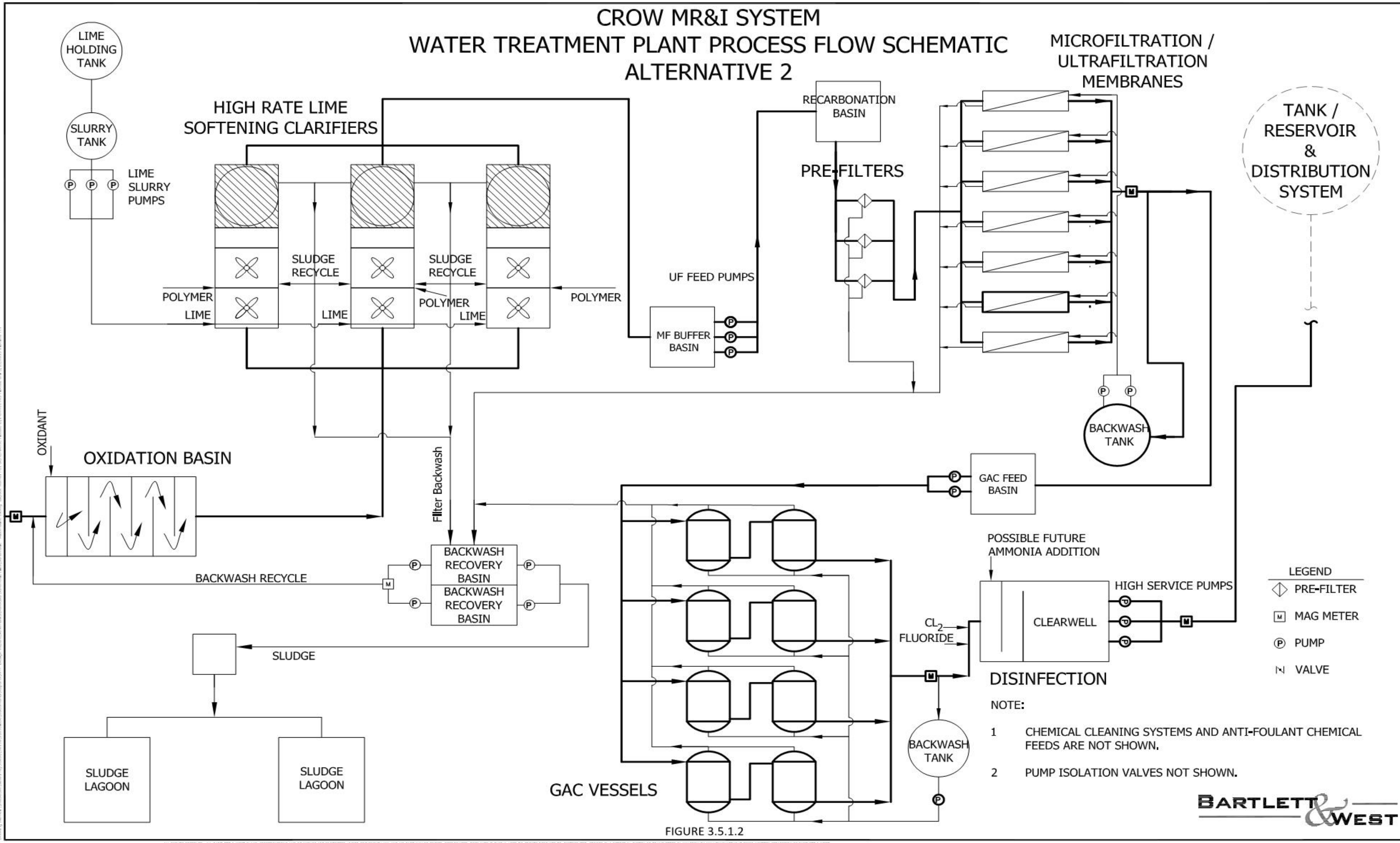
   In this treatment process the initial treatment step is the pretreatment oxidation, coagulation, and sedimentation. Several oxidation options are possible for the removal of the iron and manganese present in the source water. These options are ozone, chlorine, and permanganate. Several coagulants are options as well; Aluminum Sulfate, Ferric Chloride, Polyaluminum Chloride, along with proprietary chemical designer options. Following the oxidation; coagulation and sedimentation steps will remove the iron & manganese and potentially other contaminants. The water is then filtered through MF/UF membranes to remove pathogens, turbidity, and other particulates in the water. Following the filtration step the water would flow through the NF/RO membranes. A portion of the NF/RO permeate water is blended with the filtrate effluent in order to achieve the desired water stability. The NF/RO step will remove hardness, organics, micro-pollutants, TDS, and others. The final step is to then disinfect the filtered water with chlorine prior to distribution. Space can be left for future ammonia system which along with the chlorine system could be used to disinfect by chloramination

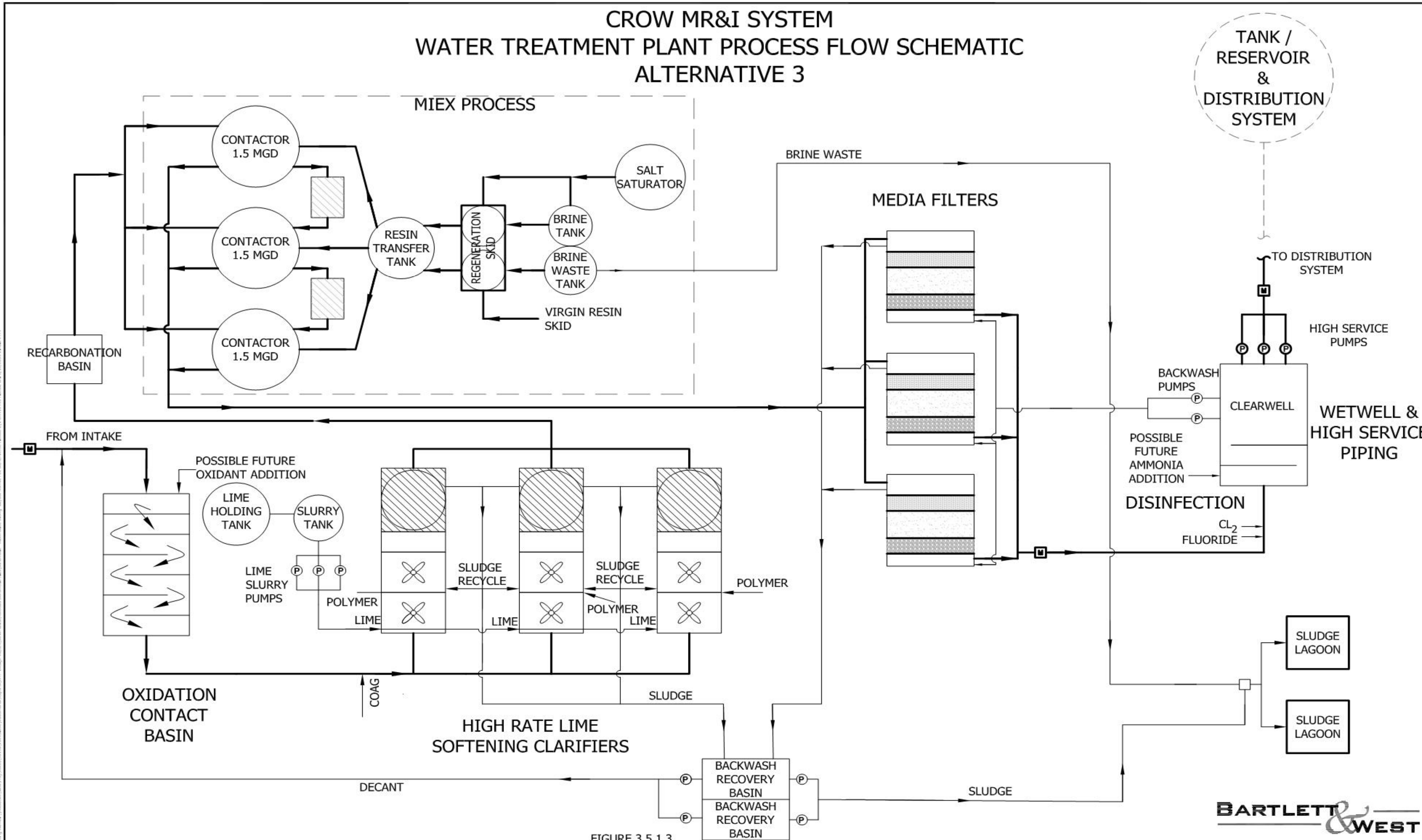
3.5 Evaluation of Treatment Process Train Alternatives

3.5.1 Treatment Train Schematics

In the following pages schematics for each of the 7 options are shown. These schematics are meant to be general in nature, with flow and removal characteristics included within the mass balance diagrams.


CROW MR&I SYSTEM
WATER TREATMENT PLANT PROCESS FLOW SCHEMATIC
ALTERNATIVE 1
MIEX PROCESS
CONTACTOR 1.5 MGD
CONTACTOR 1.5 MGD
CONTACTOR 1.5 MGD
RESIN TRANSFER TANK
REGENERATION SKID
BRINE TANK
BRINE WASTE TANK
SALT SATURATOR
BRINE WASTE
VIRGIN RESIN SKID
SLUDGE LAGOON
SLUDGE LAGOON
TANK / RESERVOIR & DISTRIBUTION SYSTEM
POSSIBLE FUTURE AMMONIA ADDITION
CLEARWELL
DISINFECTION
CL2
FLUORIDE
HIGH SERVICE PUMPS
RECARBONATION BASIN
SLUDGE
MICROFILTRATION / ULTRAFILTRATION MEMBRANES
FROM INTAKE
LIME HOLDING TANK
SLURRY TANK
HIGH RATE LIME SOFTENING CLARIFIERS
POSSIBLE FUTURE OXIDANT ADDITION
LIME SLURRY PUMPS
POLYMER
SLUDGE RECYCLE
SLUDGE RECYCLE
POLYMER
POLYMER
LIME
LIME
LIME
COAG
OXIDATION CONTACT BASIN
UF FEED PUMPS
PREFILTERS
BACKWASH RECOVERY BASIN
BACKWASH RECOVERY BASIN
BACKWASH TANK
SLUDGE
BACKWASH RECYCLE
LEGEND
PRE-FILTER
MAG METER
PUMP
VALVE
NOTE:
1 CHEMICAL CLEANING SYSTEMS ARE NOT SHOWN.
2 PUMP ISOLATION VALVES NOT SHOWN.
BARTLETT & WEST
FIGURE 3.5.1.1


CROW MR&I SYSTEM
WATER TREATMENT PLANT PROCESS FLOW SCHEMATIC
ALTERNATIVE 2
LIME HOLDING TANK
SLURRY TANK
LIME SLURRY PUMPS
HIGH RATE LIME SOFTENING CLARIFIERS
SLUDGE RECYCLE
SLUDGE RECYCLE
POLYMER
LIME
LIME
POLYMER
LIME
POLYMER
UF FEED PUMPS
MF BUFFER BASIN
RECARBONATION BASIN
PRE-FILTERS
MICROFILTRATION / ULTRAFILTRATION MEMBRANES
TANK / RESERVOIR & DISTRIBUTION SYSTEM
BACKWASH TANK
OXIDANT
OXIDATION BASIN
Filter Backwash
BACKWASH RECOVERY BASIN
BACKWASH RECOVERY BASIN
BACKWASH RECYCLE
SLUDGE
SLUDGE LAGOON
SLUDGE LAGOON
GAC FEED BASIN
GAC VESSELS
POSSIBLE FUTURE AMMONIA ADDITION
HIGH SERVICE PUMPS
CL2
FLUORIDE
CLEARWELL
DISINFECTION
BACKWASH TANK
LEGEND
PRE-FILTER
MAG METER
PUMP
VALVE
NOTE:
1 CHEMICAL CLEANING SYSTEMS AND ANTI-FOULANT CHEMICAL FEEDS ARE NOT SHOWN.
2 PUMP ISOLATION VALVES NOT SHOWN.
BARTLETT & WEST
FIGURE 3.5.1.2


CROW MR&I SYSTEM
WATER TREATMENT PLANT PROCESS FLOW SCHEMATIC
ALTERNATIVE 3
TANK / RESERVOIR & DISTRIBUTION SYSTEM
MIEX PROCESS
CONTACTOR 1.5 MGD
CONTACTOR 1.5 MGD
CONTACTOR 1.5 MGD
RESIN TRANSFER TANK
REGENERATION SKID
SALT SATURATOR
BRINE TANK
BRINE WASTE TANK
VIRGIN RESIN SKID
BRINE WASTE
MEDIA FILTERS
TO DISTRIBUTION SYSTEM
HIGH SERVICE PUMPS
BACKWASH PUMPS
CLEARWELL
WETWELL & HIGH SERVICE PIPING
POSSIBLE FUTURE AMMONIA ADDITION
DISINFECTION
CL2
FLUORIDE
RECARBONATION BASIN
FROM INTAKE
POSSIBLE FUTURE OXIDANT ADDITION
LIME HOLDING TANK
SLURRY TANK
LIME SLURRY PUMPS
POLYMER
LIME
SLUDGE RECYCLE
LIME
SLUDGE RECYCLE
POLYMER
LIME
POLYMER
COAG
SLUDGE
OXIDATION CONTACT BASIN
HIGH RATE LIME SOFTENING CLARIFIERS
BACKWASH RECOVERY BASIN
BACKWASH RECOVERY BASIN
DECANT
SLUDGE
SLUDGE LAGOON
SLUDGE LAGOON
BARTLETT & WEST
FIGURE 3.5.1.3

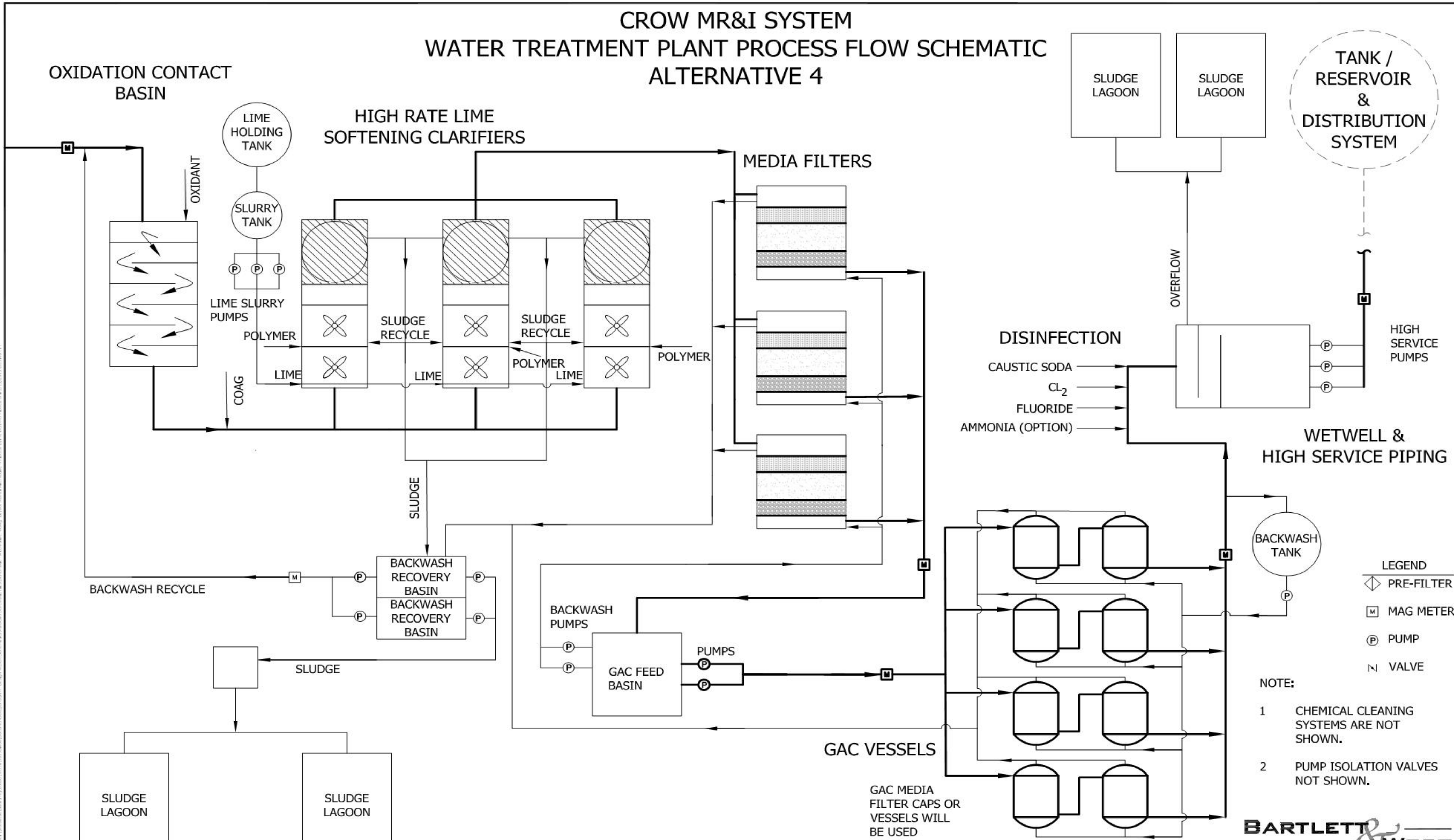

CROW MR&I SYSTEM
WATER TREATMENT PLANT PROCESS FLOW SCHEMATIC
ALTERNATIVE 4
OXIDATION CONTACT BASIN
LIME HOLDING TANK
HIGH RATE LIME SOFTENING CLARIFIERS
MEDIA FILTERS
SLUDGE LAGOON
SLUDGE LAGOON
TANK / RESERVOIR & DISTRIBUTION SYSTEM
OXIDANT
SLURRY TANK
LIME SLURRY PUMPS
POLYMER
SLUDGE RECYCLE
SLUDGE RECYCLE
POLYMER
POLYMER
LIME
LIME
LIME
COAG
OVERFLOW
DISINFECTION
CAUSTIC SODA
CL_2
FLUORIDE
AMMONIA (OPTION)
HIGH SERVICE PUMPS
WETWELL & HIGH SERVICE PIPING
SLUDGE
BACKWASH RECOVERY BASIN
BACKWASH RECOVERY BASIN
BACKWASH RECYCLE
BACKWASH PUMPS
GAC FEED BASIN
PUMPS
SLUDGE
BACKWASH TANK
LEGEND
PRE-FILTER
MAG METER
PUMP
VALVE
NOTE:
1 CHEMICAL CLEANING SYSTEMS ARE NOT SHOWN.
2 PUMP ISOLATION VALVES NOT SHOWN.
GAC VESSELS
GAC MEDIA FILTER CAPS OR VESSELS WILL BE USED
SLUDGE LAGOON
SLUDGE LAGOON
BARTLETT & WEST

FIGURE 3.5.1.4

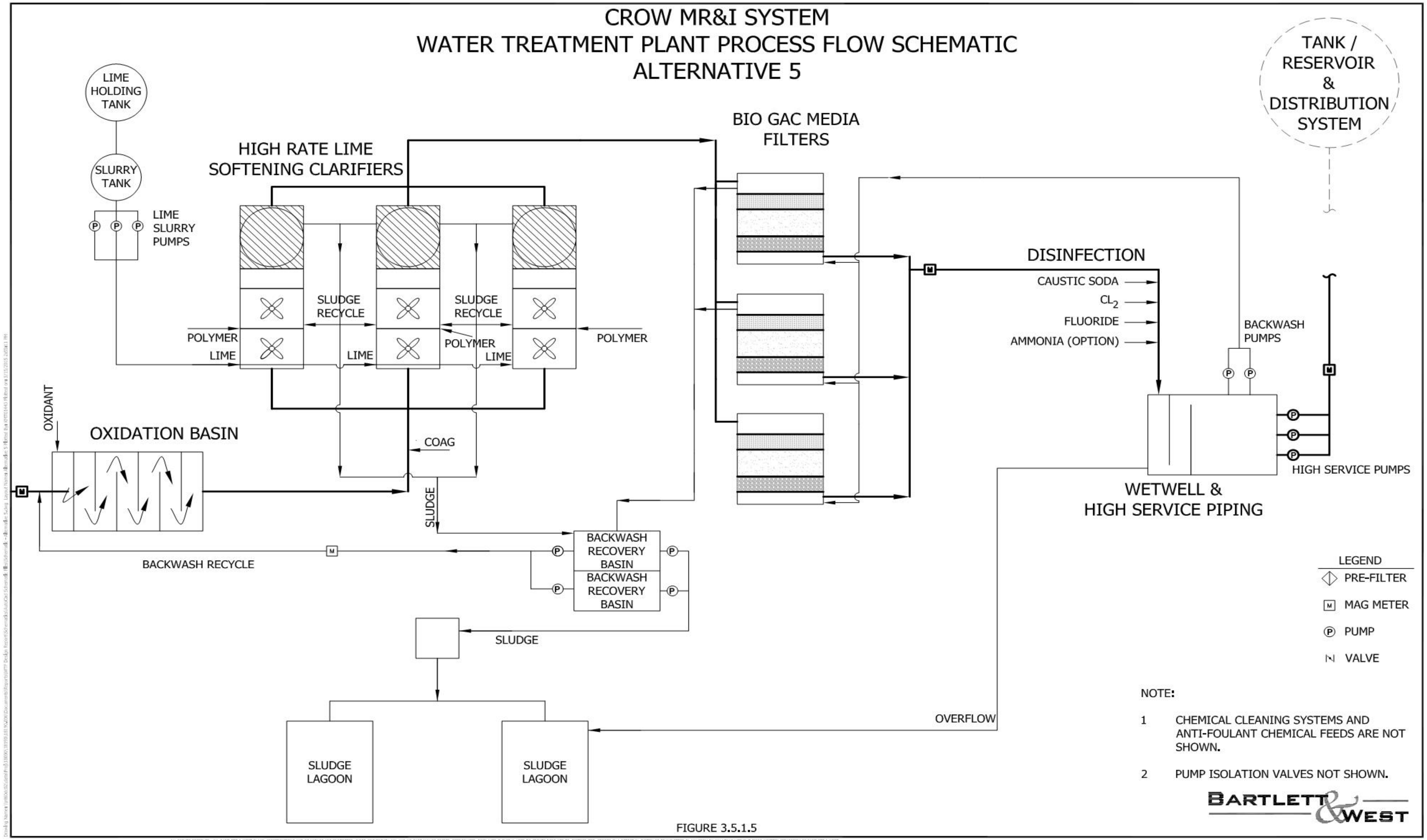

CROW MR&I SYSTEM
WATER TREATMENT PLANT PROCESS FLOW SCHEMATIC
ALTERNATIVE 5
LIME HOLDING TANK
SLURRY TANK
LIME SLURRY PUMPS
HIGH RATE LIME SOFTENING CLARIFIERS
BIO GAC MEDIA FILTERS
TANK / RESERVOIR & DISTRIBUTION SYSTEM
SLUDGE RECYCLE
SLUDGE RECYCLE
POLYMER
LIME
LIME
POLYMER
LIME
POLYMER
DISINFECTION
CAUSTIC SODA
CL2
FLUORIDE
AMMONIA (OPTION)
BACKWASH PUMPS
OXIDANT
OXIDATION BASIN
COAG
SLUDGE
HIGH SERVICE PUMPS
WETWELL & HIGH SERVICE PIPING
BACKWASH RECOVERY BASIN
BACKWASH RECOVERY BASIN
BACKWASH RECYCLE
SLUDGE
LEGEND
PRE-FILTER
MAG METER
PUMP
VALVE
NOTE:
1 CHEMICAL CLEANING SYSTEMS AND ANTI-FOULANT CHEMICAL FEEDS ARE NOT SHOWN.
2 PUMP ISOLATION VALVES NOT SHOWN.
OVERFLOW
SLUDGE LAGOON
SLUDGE LAGOON
BARTLETT & WEST

FIGURE 3.5.1.5

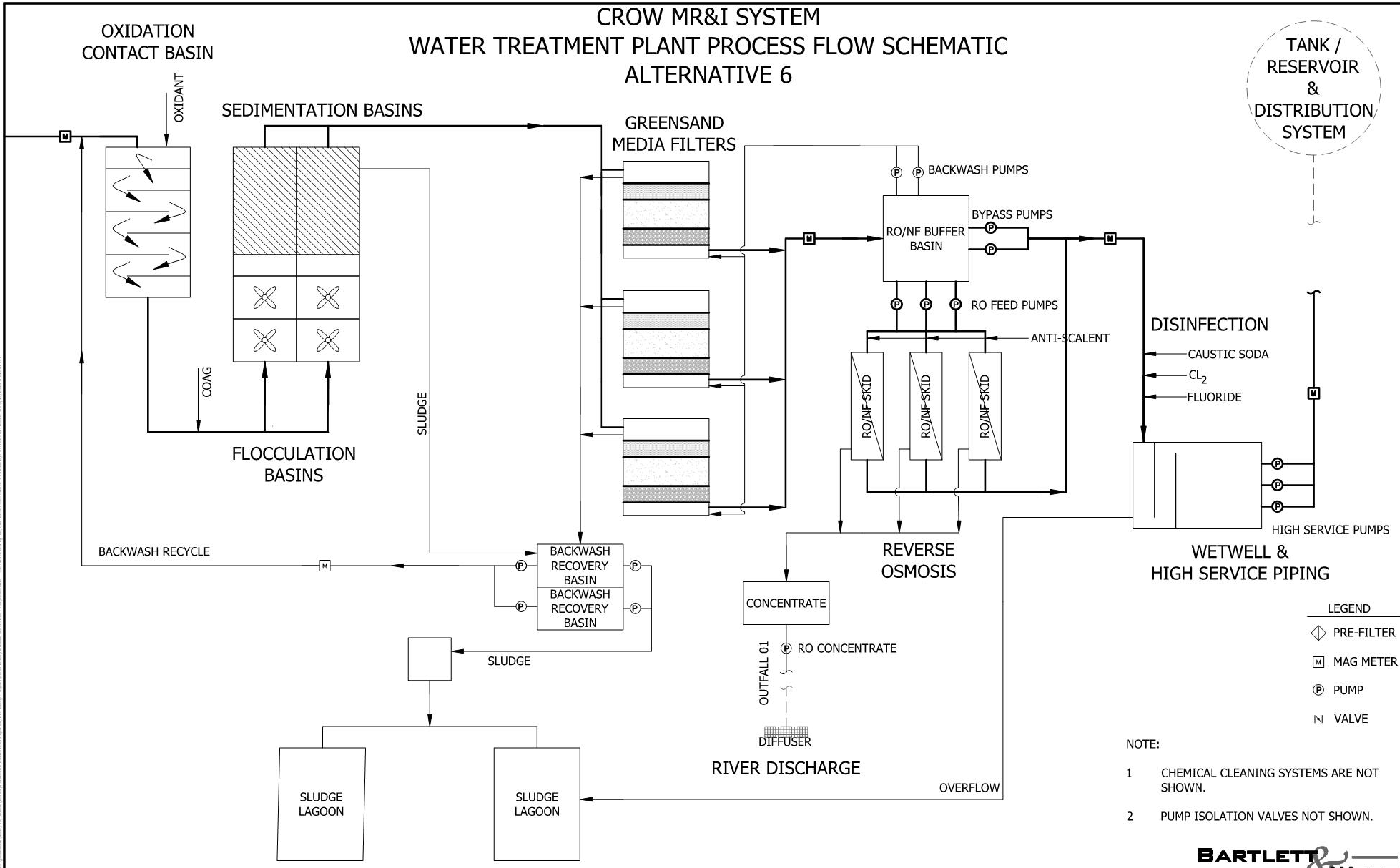

CROW MR&I SYSTEM
WATER TREATMENT PLANT PROCESS FLOW SCHEMATIC
ALTERNATIVE 6
OXIDATION CONTACT BASIN
OXIDANT
SEDIMENTATION BASINS
GREENSAND MEDIA FILTERS
BACKWASH PUMPS
RO/NF BUFFER BASIN
BYPASS PUMPS
TANK / RESERVOIR & DISTRIBUTION SYSTEM
RO FEED PUMPS
ANTI-SCALENT
DISINFECTION
CAUSTIC SODA
CL2
FLUORIDE
RO/NF SKID
RO/NF SKID
RO/NF SKID
COAG
SLUDGE
FLOCCULATION BASINS
BACKWASH RECYCLE
BACKWASH RECOVERY BASIN
BACKWASH RECOVERY BASIN
REVERSE OSMOSIS
WETWELL & HIGH SERVICE PIPING
HIGH SERVICE PUMPS
CONCENTRATE
RO CONCENTRATE
OUTFALL 01
DIFFUSER
RIVER DISCHARGE
SLUDGE
SLUDGE LAGOON
SLUDGE LAGOON
OVERFLOW
LEGEND
PRE-FILTER
MAG METER
PUMP
VALVE
NOTE:
1 CHEMICAL CLEANING SYSTEMS ARE NOT SHOWN.
2 PUMP ISOLATION VALVES NOT SHOWN.
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FIGURE 3.5.1.6

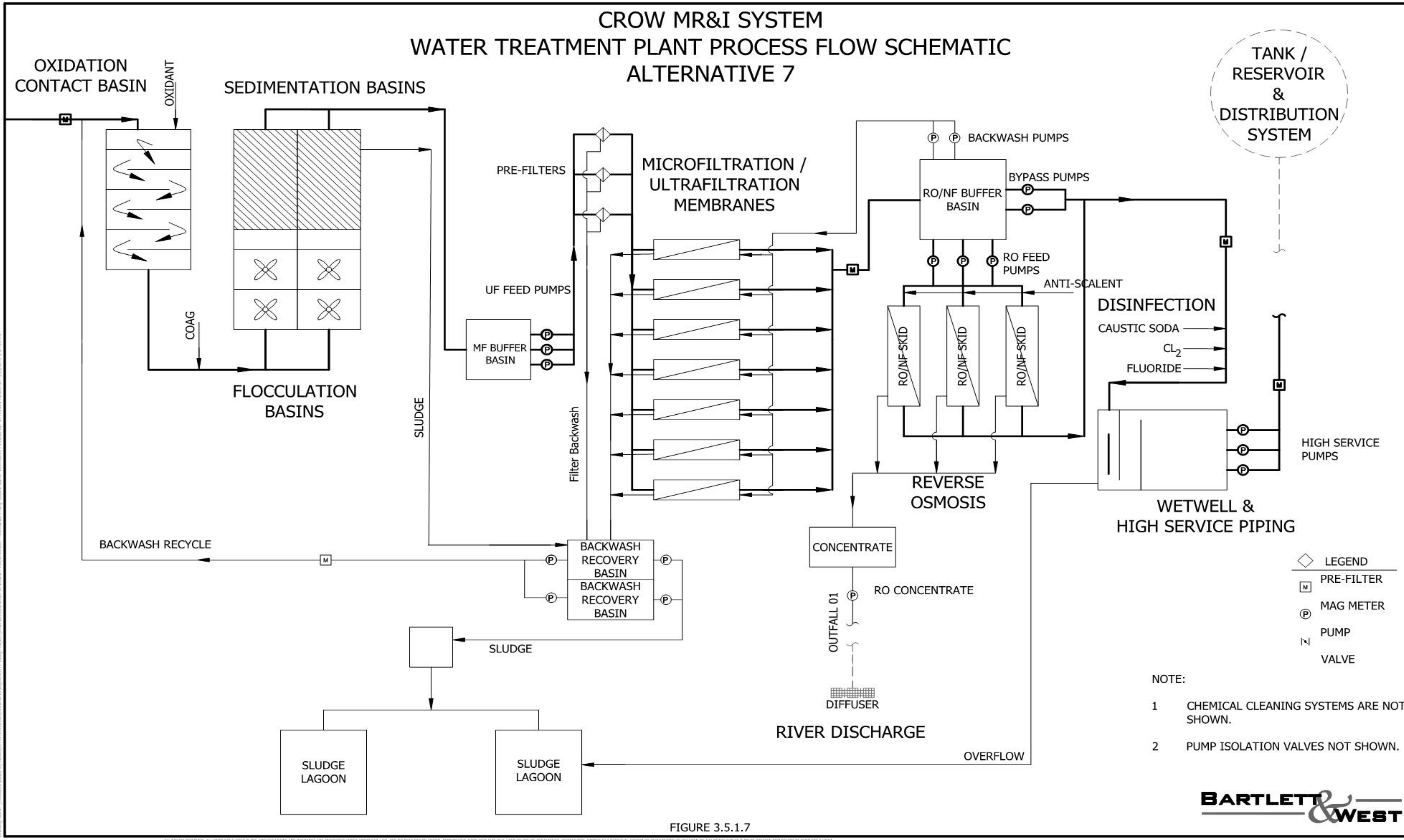
CROW MR&I SYSTEM
WATER TREATMENT PLANT PROCESS FLOW SCHEMATIC
ALTERNATIVE 7
OXIDATION CONTACT BASIN
OXIDANT
SEDIMENTATION BASINS
COAG
FLOCCULATION BASINS
SLUDGE
PRE-FILTERS
UF FEED PUMPS
MF BUFFER BASIN
Filter Backwash
MICROFILTRATION / ULTRAFILTRATION MEMBRANES
BACKWASH PUMPS
RO/NF BUFFER BASIN
BYPASS PUMPS
RO FEED PUMPS
ANTI-SCALENT
RO/NF SKID
RO/NF SKID
RO/NF SKID
REVERSE OSMOSIS
TANK / RESERVOIR & DISTRIBUTION SYSTEM
DISINFECTION
CAUSTIC SODA
CL2
FLUORIDE
HIGH SERVICE PUMPS
WETWELL & HIGH SERVICE PIPING
BACKWASH RECYCLE
BACKWASH RECOVERY BASIN
BACKWASH RECOVERY BASIN
SLUDGE
SLUDGE LAGOON
SLUDGE LAGOON
CONCENTRATE
RO CONCENTRATE
OUTFALL 01
DIFFUSER
RIVER DISCHARGE
OVERFLOW
LEGEND
PRE-FILTER
MAG METER
PUMP
VALVE
NOTE:
1 CHEMICAL CLEANING SYSTEMS ARE NOT SHOWN.
2 PUMP ISOLATION VALVES NOT SHOWN.
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FIGURE 3.5.1.7

3.5.2 Treatment Train Mass Balance Diagrams -

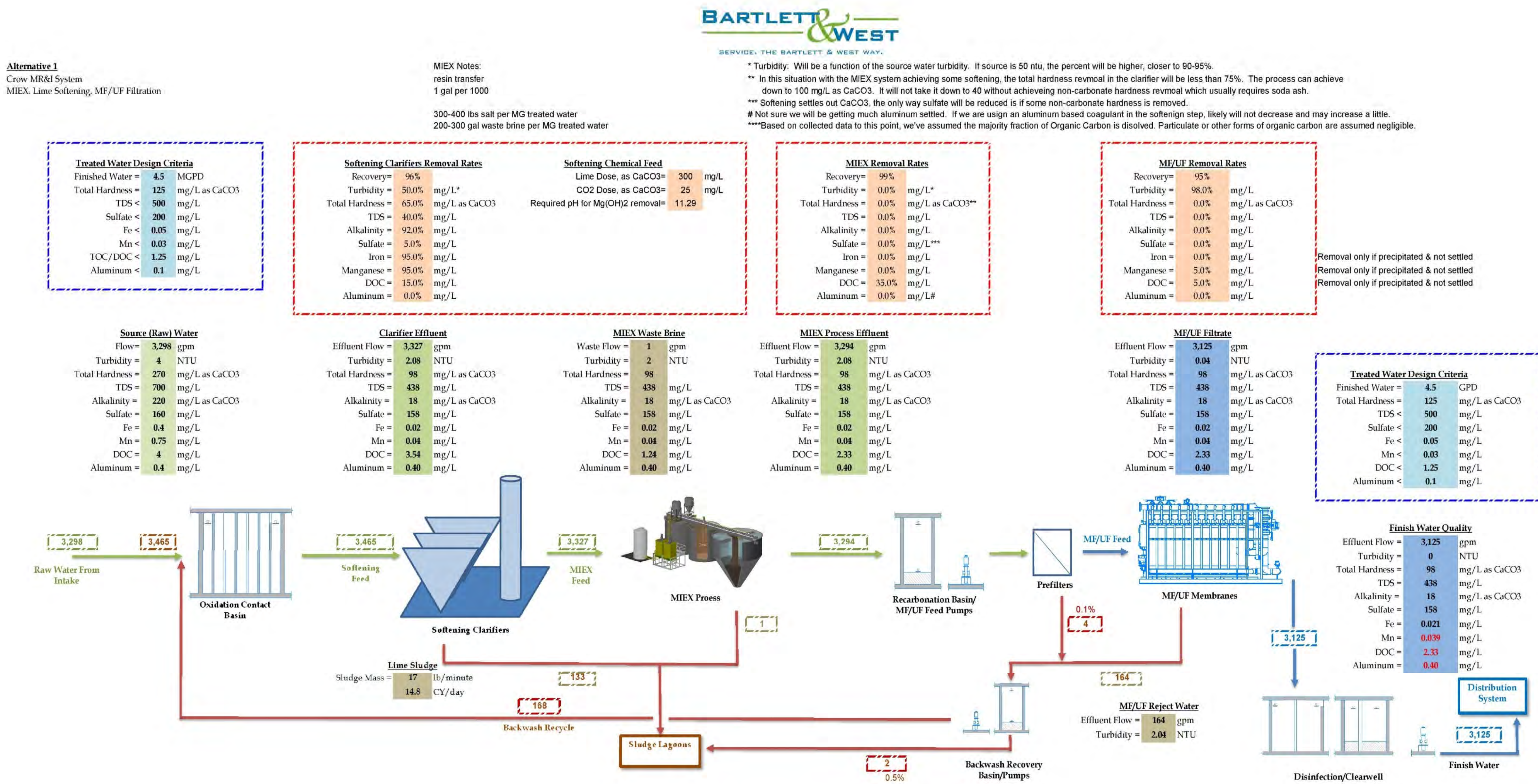

Figure 3.5.2.1 - Alternative Train No. 1 - Pretreatment Oxidation, MIEX Pretreatment, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Micro/Ultra Filtration; Chlorine

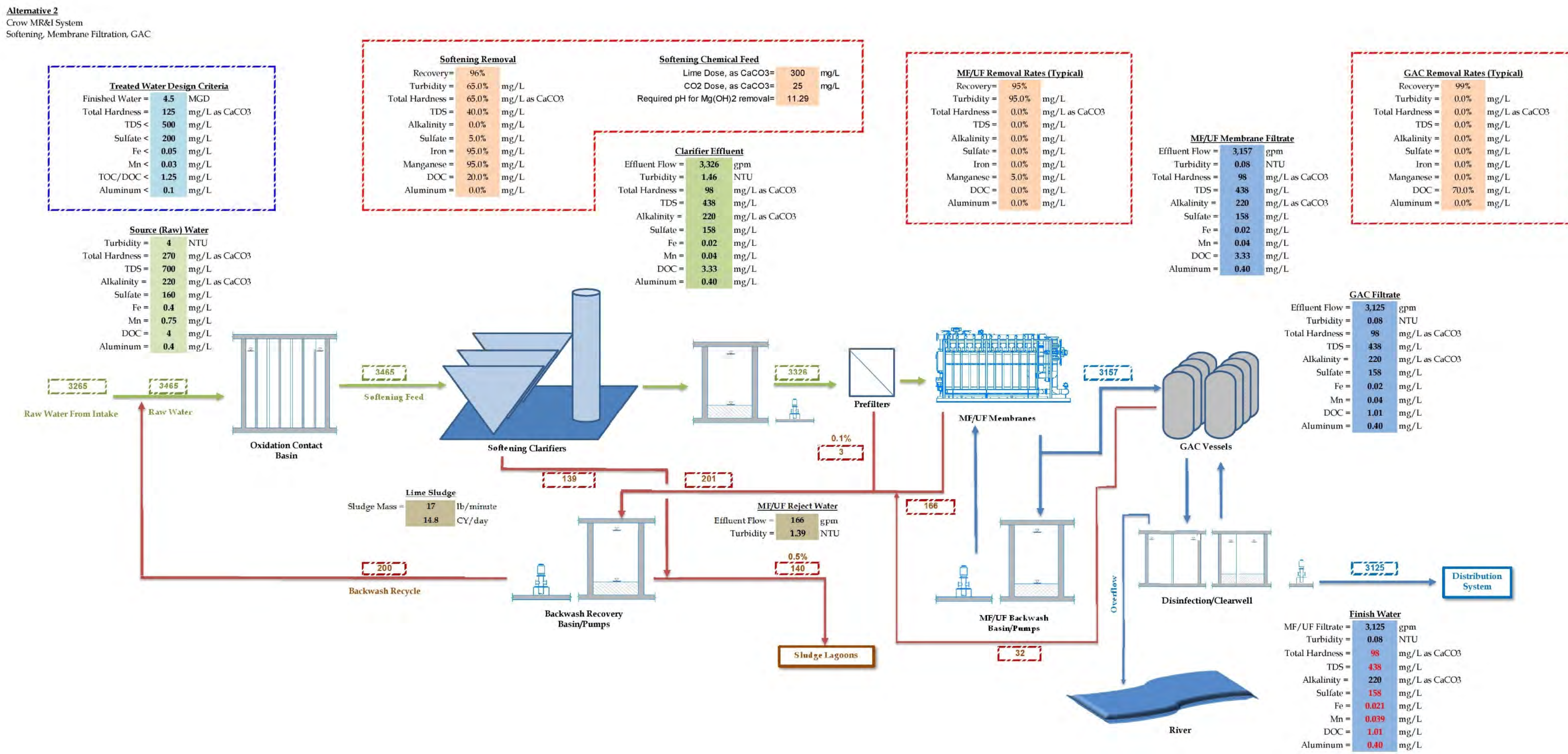

Figure 3.5.2.2 - Alternative Train No. 2 - Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation)Micro/Ultra Filtration; GAC Vessels, Chlorine

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Alternative 3

Crow MR&I System

MIEX, Lime Softening, MF/UF Filtration

Treated Water Design Criteria

Finished Water =	4.5	MGD
Total Hardness =	125	mg/L as CaCO3
TDS <	500	mg/L
Sulfate <	200	mg/L
Fe <	0.05	mg/L
Mn <	0.03	mg/L
TOC <	1.25	mg/L
Aluminum <	0.1	mg/L

Sofening Clarifier Removal Rates

Recovery=	96%	
Turbidity =	50.0%	mg/L
Total Hardness =	65.0%	mg/L as CaCO3
TDS =	40.0%	mg/L
Alkalinity =	92.0%	mg/L
Sulfate =	5.0%	mg/L
Iron =	95.0%	mg/L
Manganese =	95.0%	mg/L
DOC =	15.0%	mg/L
Aluminum =	0.0%	mg/L

Softening Chemical Feed

Lime Dose, as CaCO3=	300	mg/L
CO2 Dose, as CaCO3=	25	mg/L
Required pH for Mg(OH)2 removal=	11.29	

MIEX Removal Rates

Recovery=	99%	
Turbidity =	0.0%	mg/L
Total Hardness =	0.0%	mg/L as CaCO3
TDS =	0.0%	mg/L
Alkalinity =	0.0%	mg/L
Sulfate =	0.0%	mg/L
Iron =	0.0%	mg/L
Manganese =	0.0%	mg/L
DOC =	35.0%	mg/L
Aluminum =	0.0%	mg/L

Media Filter Removal Rates

Recovery=	95%	
Turbidity =	90.0%	mg/L
Total Hardness =	0.0%	mg/L as CaCO3
TDS =	0.0%	mg/L
Alkalinity =	0.0%	mg/L
Sulfate =	0.0%	mg/L
Iron =	0.0%	mg/L
Manganese =	5.0%	mg/L
DOC =	0.0%	mg/L
Aluminum =	0.0%	mg/L

Source (Raw) Water

Flow=	3,297	gpm
Turbidity =	4	NTU
Total Hardness =	270	mg/L as CaCO3
TDS =	700	mg/L
Alkalinity =	220	mg/L as CaCO3
Sulfate =	160	mg/L
Fe =	0.4	mg/L
Mn =	0.75	mg/L
DOC =	4.00	mg/L
Aluminum =	0.4	mg/L

Clarifier Effluent

Effluent Flow =	3,323	gpm
Turbidity =	2	NTU
Total Hardness =	98	mg/L as CaCO3
TDS =	438	mg/L
Alkalinity =	18	mg/L as CaCO3
Sulfate =	158	mg/L
Fe =	0.02	mg/L
Mn =	0.04	mg/L
DOC =	3.54	mg/L
Aluminum =	0.40	mg/L

MIEX Waste Brine

Effluent Flow =	1	gpm
Turbidity =	2.08	NTU
Total Hardness =	98	mg/L as CaCO3
TDS =	438	mg/L
Alkalinity =	18	mg/L as CaCO3
Sulfate =	158	mg/L
Fe =	0.02	mg/L
Mn =	0.04	mg/L
DOC =	0.60	mg/L
Aluminum =	0.40	mg/L

MIEX Effluent

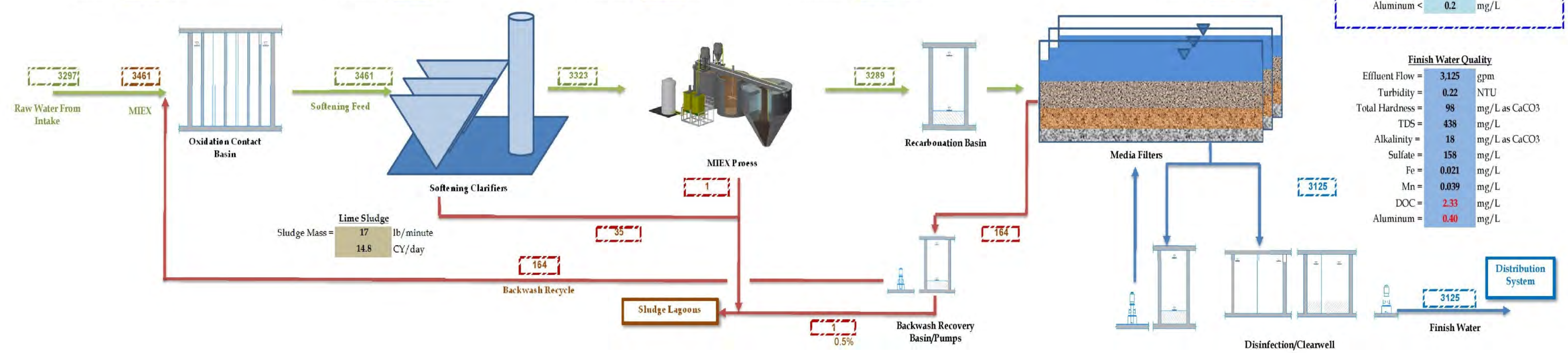
Effluent Flow =	3,289	gpm
Turbidity =	2	NTU
Total Hardness =	98	mg/L as CaCO3
TDS =	438	mg/L
Alkalinity =	18	mg/L as CaCO3
Sulfate =	158	mg/L
Fe =	0.02	mg/L
Mn =	0.04	mg/L
DOC =	2.33	mg/L
Aluminum =	0.40	mg/L

Media Filtrate

Effluent Flow =	3,125	gpm
Turbidity =	0.22	NTU
Total Hardness =	98	mg/L as CaCO3
TDS =	438	mg/L
Alkalinity =	18	mg/L as CaCO3
Sulfate =	158	mg/L
Fe =	0.02	mg/L
Mn =	0.04	mg/L
DOC =	2.33	mg/L
Aluminum =	0.40	mg/L

Treated Water Design Criteria

Finished Water =	4.5	GPD
Total Hardness =	125	mg/L as CaCO3
TDS <	500	mg/L
Sulfate <	250	mg/L
Fe <	0.3	mg/L
Mn <	0.05	mg/L
TOC <	1.5	mg/L
Aluminum <	0.2	mg/L



Lime Sludge

Sludge Mass =	17	lb/minute
	14.8	CY/day

Finish Water Quality

Effluent Flow =	3,125	gpm
Turbidity =	0.22	NTU
Total Hardness =	98	mg/L as CaCO3
TDS =	438	mg/L
Alkalinity =	18	mg/L as CaCO3
Sulfate =	158	mg/L
Fe =	0.021	mg/L
Mn =	0.039	mg/L
DOC =	2.33	mg/L
Aluminum =	0.40	mg/L

Figure 3.5.2.3 - Alternative Train No. 3 - Pretreatment Oxidation, MIEX Pretreatment, Lime Softening Clarification (including Flocculation, Coagulation, and Sedimentation); Media Filtration; Chlorine

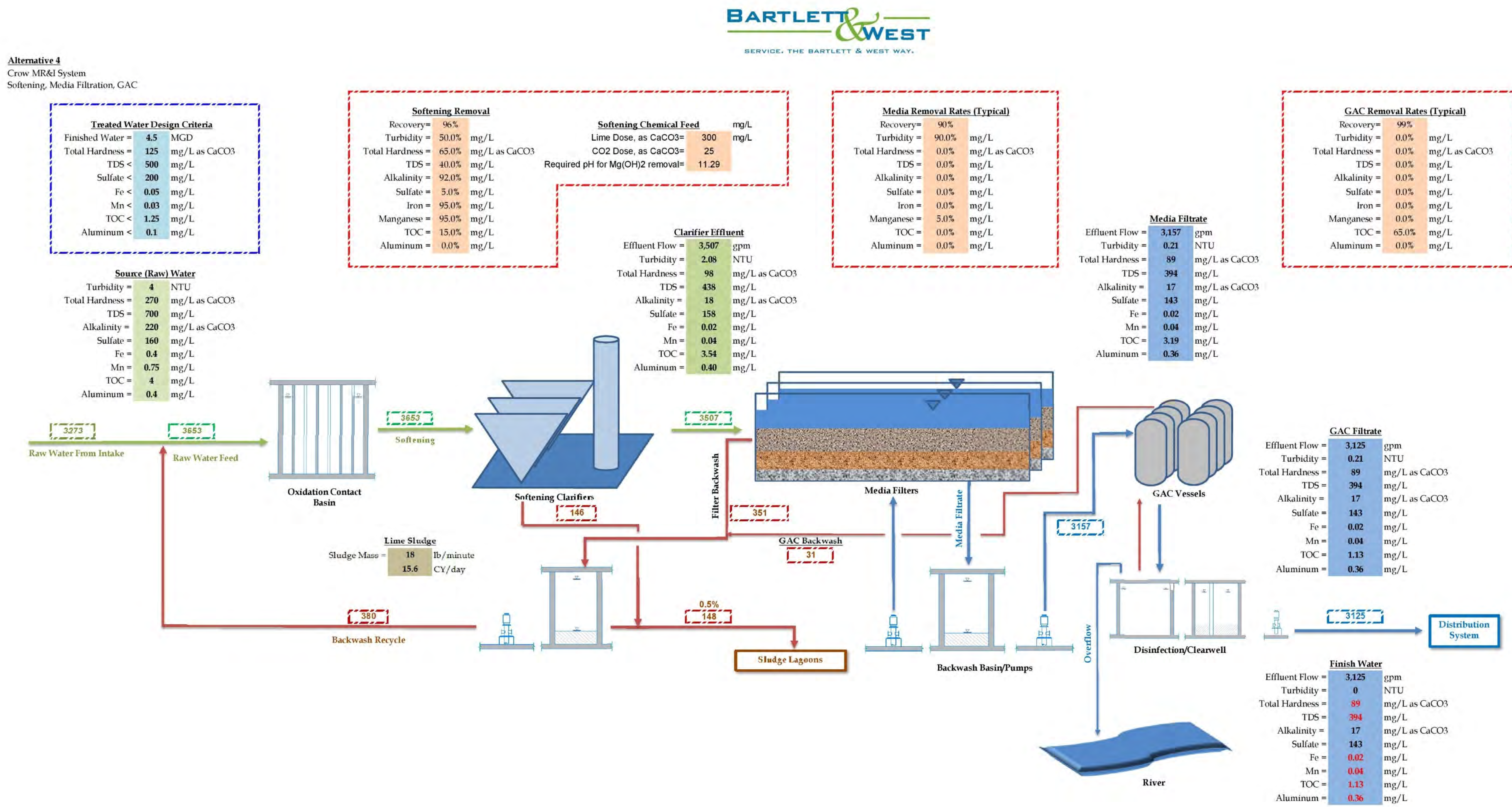


Figure 3.5.2.4 - Alternative Train No. 4 - Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, and Sedimentation); Media Filtration; GAC Vessels, Chlorine

Alternative 5
Crow MR&I System
Softening, Bio/GAC Media Filtration

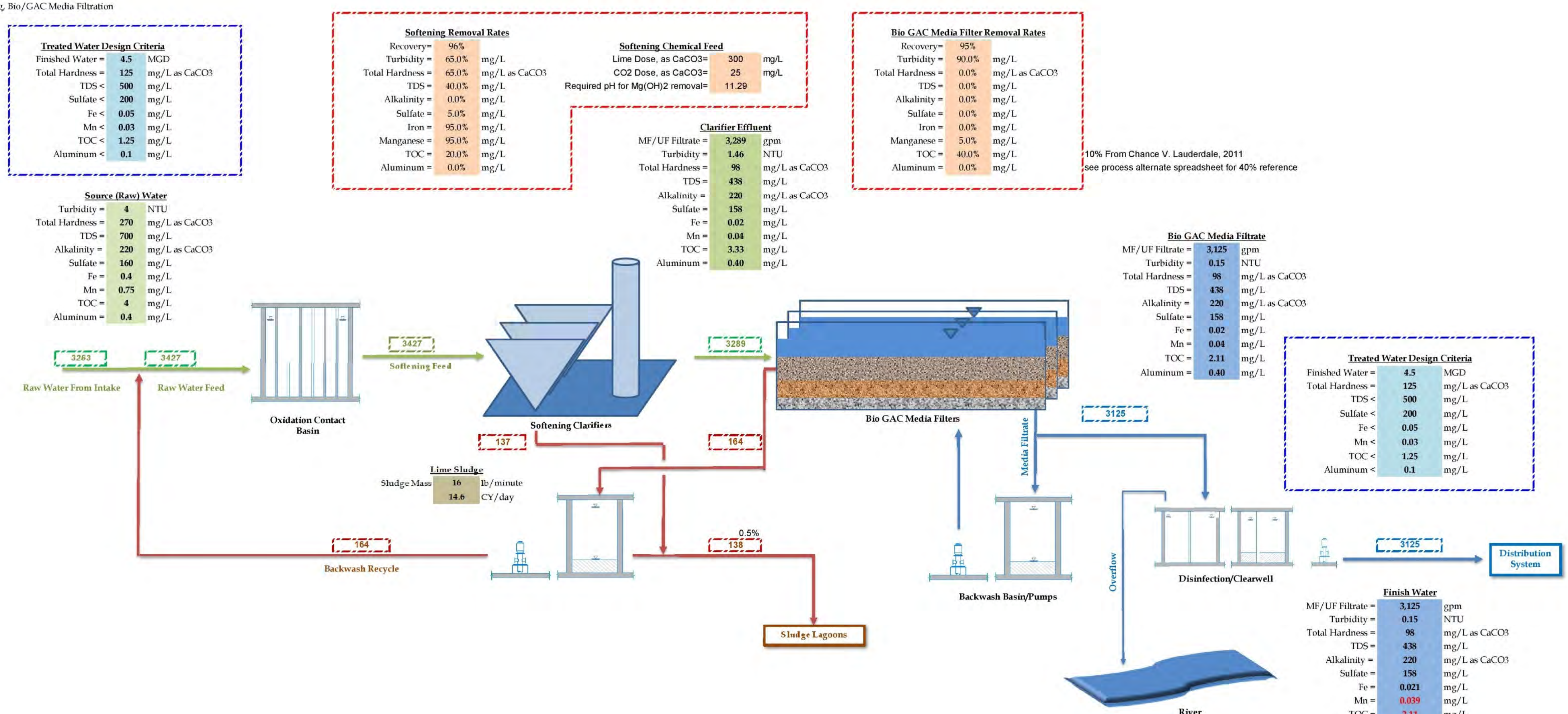


Figure 3.5.2.5 - Alternative Train No. 5 - Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Bio GAC Media Filtration, Chlorine

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an employee-owned company

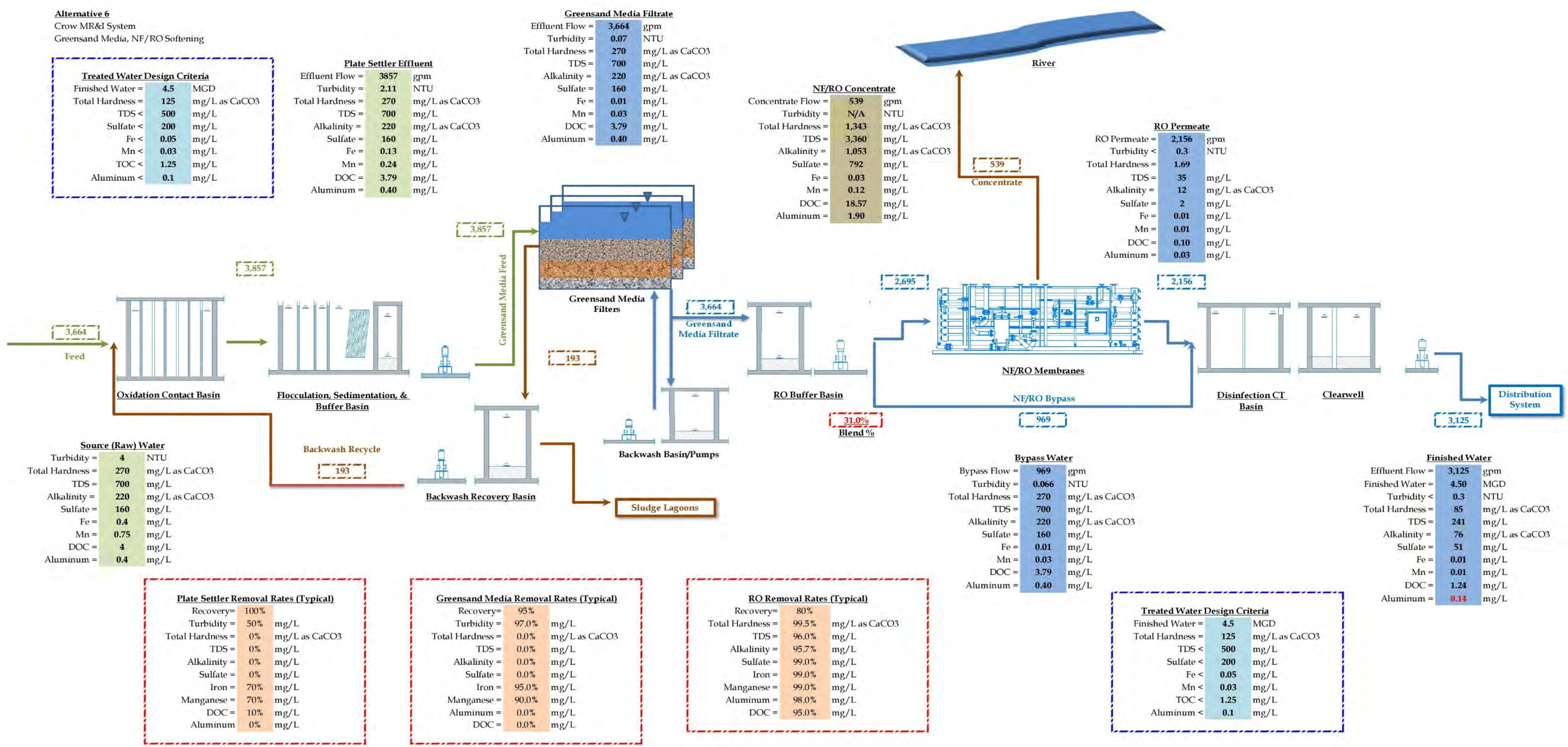


Figure 3.5.2.6 - Alternative Train No. 6 - (Pretreatment Oxidation, Coagulation, Sedimentation) Greensand Media Filtration; NF/RO Softening, Chlorine

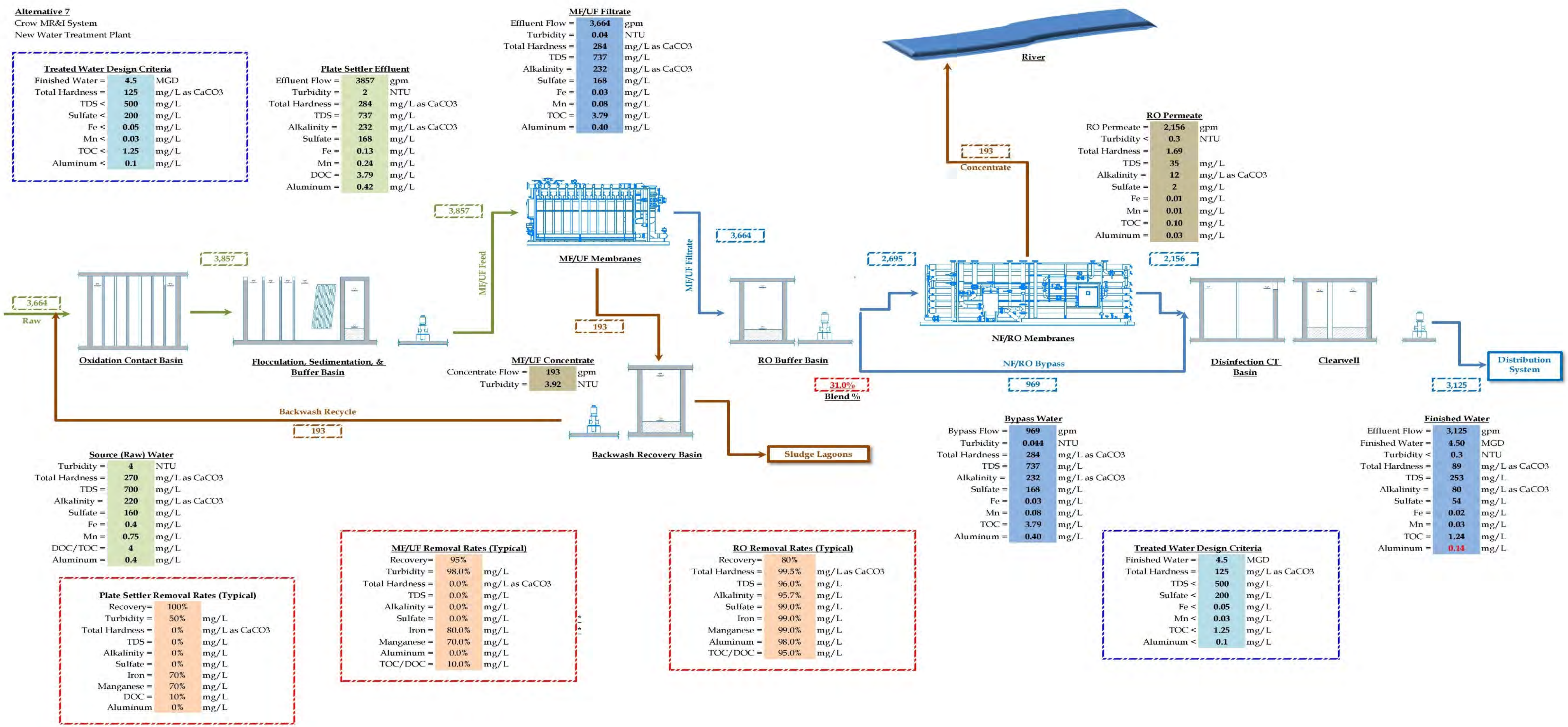


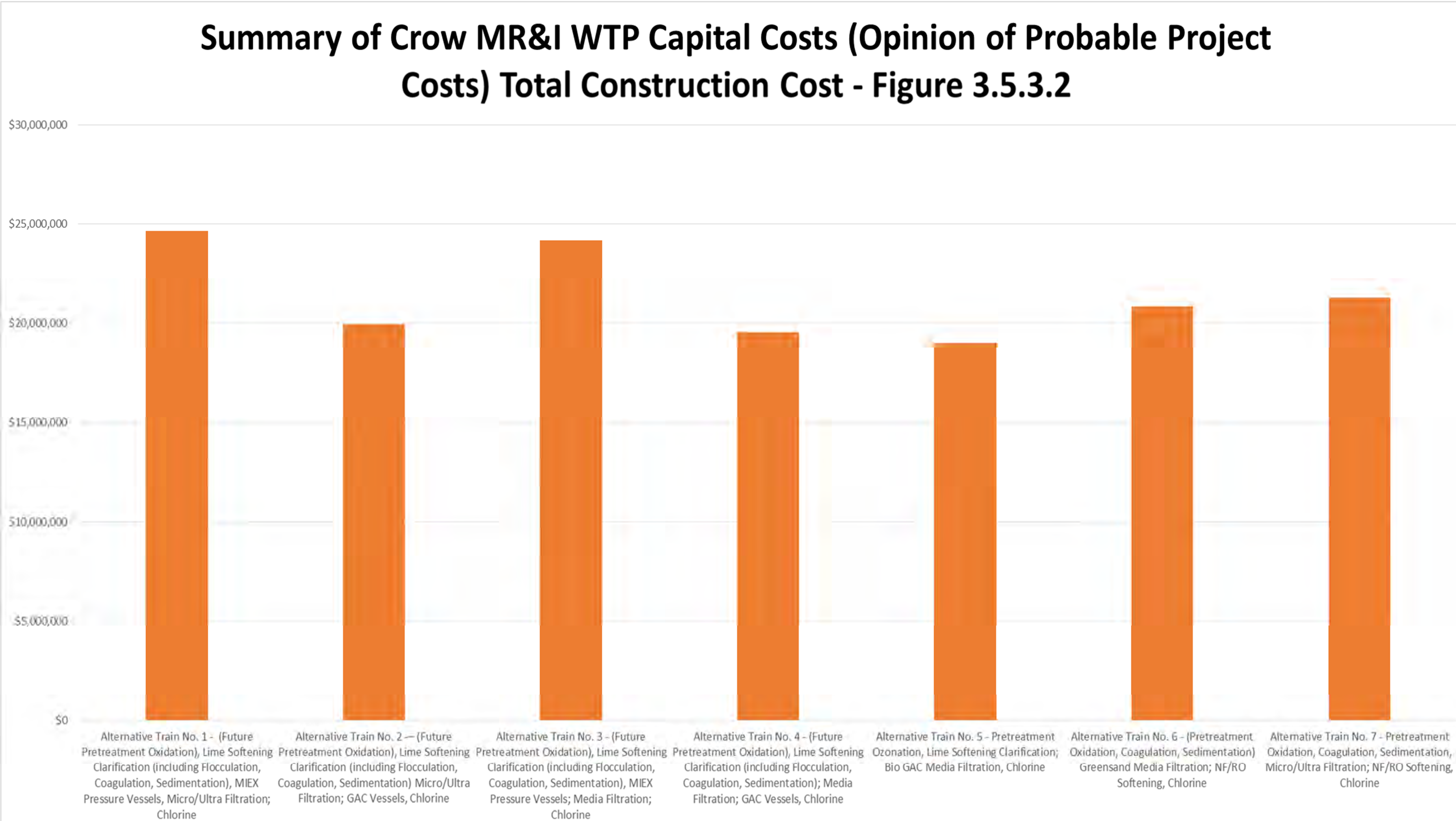
Figure 3.5.2.7 - Alternative Train No. 7 - Pretreatment Oxidation, Coagulation, Sedimentation, Micro/Ultra Filtration; NF/RO Softening, Chlorine

3.5.3 Treatment Train Cost Estimates-Capital and OM&R

The below table provides a summary of the estimated Capital Costs of the options considered. Complete breakdown of the estimates are include in Appendix E. These costs will be re-evaluated upon the completion of all planned bench and pilot testing. Based on the design and planning level of this report (Feasibility) it is estimated that these costs are accurate to approximately 15-20% +/-.

Summary of Crow MR&I WTP Capital Costs (Opinion of Probable Project Costs)	Figure 3.5.3.1
Treatment Train Alternative Descriptions	**Total Construction Cost**
Alternative Train No. 1 - (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels, Micro/Ultra Filtration; Chlorine	$24,633,000
Alternative Train No. 2 -– (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation) Micro/Ultra Filtration; GAC Vessels, Chlorine	$19,975,500
Alternative Train No. 3 - (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels; Media Filtration; Chlorine	$24,167,250
Alternative Train No. 4 - (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Media Filtration; GAC Vessels, Chlorine	$19,551,150
Alternative Train No. 5 - Pretreatment Ozonation, Lime Softening Clarification; Bio GAC Media Filtration, Chlorine	$19,033,650
Alternative Train No. 6 - (Pretreatment Oxidation, Coagulation, Sedimentation) Greensand Media Filtration; NF/RO Softening, Chlorine	$20,824,200
Alternative Train No. 7 - Pretreatment Oxidation, Coagulation, Sedimentation, Micro/Ultra Filtration; NF/RO Softening, Chlorine	$21,279,600

Figure 3.5.3.1 - Alternatives Capital Cost Estimate Table

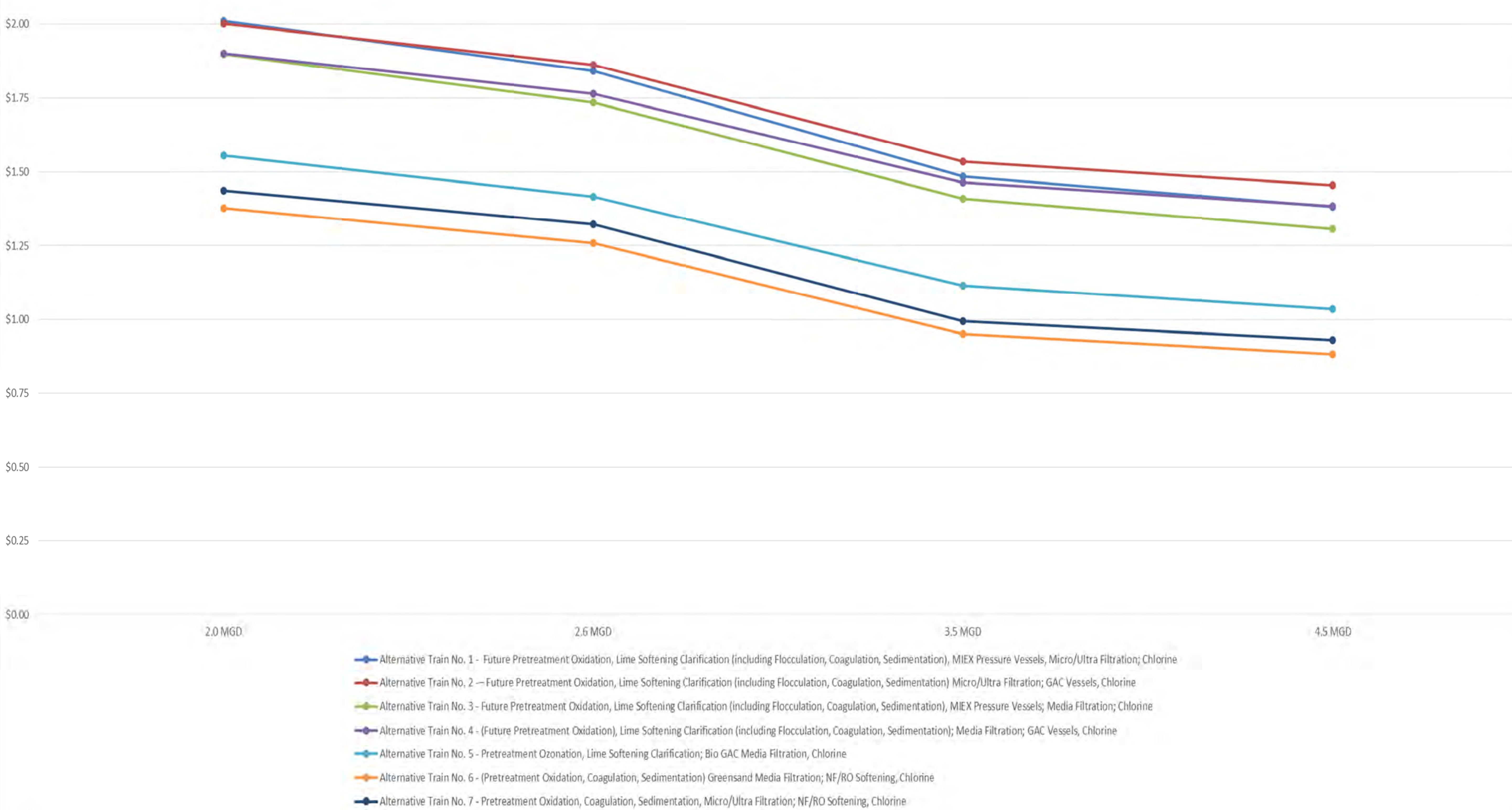

Summary of Crow MR&I WTP Capital Costs (Opinion of Probable Project Costs) Total Construction Cost - Figure 3.5.3.2
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$0
Alternative Train No. 1 - (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels, Micro/Ultra Filtration; Chlorine
Alternative Train No. 2 — (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation) Micro/Ultra Filtration; GAC Vessels, Chlorine
Alternative Train No. 3 - (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels; Media Filtration; Chlorine
Alternative Train No. 4 - (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Media Filtration; GAC Vessels, Chlorine
Alternative Train No. 5 - Pretreatment Ozonation, Lime Softening Clarification; Bio GAC Media Filtration, Chlorine
Alternative Train No. 6 - (Pretreatment Oxidation, Coagulation, Sedimentation) Greensand Media Filtration; NF/RO Softening, Chlorine
Alternative Train No. 7 - Pretreatment Oxidation, Coagulation, Sedimentation, Micro/Ultra Filtration; NF/RO Softening, Chlorine

The below table provides a summary of the estimated OM&R Costs of the options considered. Complete breakdown of the estimates are include in Appendix F. These costs will be re-evaluated upon the completion of all planned bench and pilot testing. Based on the design and planning level of this report (Feasibility) it is estimated that these costs are accurate to approximately 15-20% +/-.

Summary of Crow MR&I WTP O&M Costs (Opinion of Probable Project Costs)				
Figure 3.5.3.3	Cost per Thousand Gallons Produced-OM&R			
Treatment Train Alternative Descriptions	*2.0 MGD*	*2.6 MGD*	*3.5 MGD*	*4.5 MGD*
Alternative Train No. 1 - Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels, Micro/Ultra Filtration; Chlorine	$2.01	$1.84	$1.48	$1.38
Alternative Train No. 2 -– Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation) Micro/Ultra Filtration; GAC Vessels, Chlorine	$2.00	$1.86	$1.53	$1.46
Alternative Train No. 3 - Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels; Media Filtration; Chlorine	$1.90	$1.73	$1.41	$1.31
Alternative Train No. 4 - (Future Pretreatment Oxidation), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Media Filtration; GAC Vessels, Chlorine	$1.90	$1.76	$1.46	$1.38
Alternative Train No. 5 - Pretreatment Ozonation, Lime Softening Clarification; Bio GAC Media Filtration, Chlorine	$1.55	$1.42	$1.12	$1.04
Alternative Train No. 6 - (Pretreatment Oxidation, Coagulation, Sedimentation) Greensand Media Filtration; NF/RO Softening, Chlorine	$1.38	$1.26	$0.95	$0.88
Alternative Train No. 7 - Pretreatment Oxidation, Coagulation, Sedimentation, Micro/Ultra Filtration; NF/RO Softening, Chlorine	$1.44	$1.32	$1.00	$0.93

Figure 3.5.3.3 - Alternatives OM&R Cost Estimate Table

Summary of Crow MR&I WTP Capital Costs (Opinion of Probable Project Costs) - FIgure 3.5.3.4



3.6 Treatment Process Train Alternative Evaluation

Figure 3.6 Treatment Process Train Alternative Evaluation

Alternative	Capital Cost**	OM&R Cost ($/1000 at 4.5 MGD)**	TOC DBP Precursor Reduction Goal	Operator Level*
1	**$24,633,000**	**$1.38**	**No**	**Level 4 (90-100 points)**
2	**$19,975,000**	**$1.46**	**Yes**	**Level 4 (100-110 points)**
3	**$24,167,250**	**$1.31**	**No**	**Level 4 (110-120 points)**
4	**$19,551,150**	**$1.38**	**Yes**	**Level 4 (100-110 points)**
5	**$19,033,650**	**$1.04**	**No**	**Level 4 (100-110 points)**
6	**$20,824,200**	**$0.88**	**Yes**	**Level 4 (80-90 points)**
7	**$21,279,600**	**$0.93**	**Yes**	**Level 4 (75-85 points)**

*Operator Level Worksheets are provided in Appendix G. -

*Costs will be re-evaluated upon the completion of all planned bench and pilot testing. -

Evaluation Notes:

Alternative Train No. 1 - Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels, Micro/Ultra Filtration; Chlorine

- Highest Capital Cost due to MIEX system
- High O&M Cost due to High Lime Dosage rates, Lime Disposal, MIEX operating costs
- Will not meet TOC reduction goal, likely issues with DBP in distribution system

Alternative Train No. 2 – Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation) Micro/Ultra Filtration; GAC Vessels, Chlorine

- Lower Capital Costs
- Highest O&M Costs due to GAC replacement, reactivation
- Will meet TOC reduction goal; Lime softening and GAC combination

Alternative Train No. 3 - Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation), MIEX Pressure Vessels; Media Filtration; Chlorine

- 2nd highest Capital Costs due to MIEX System
- Higher O&M cost due to Lime dosage rates, Lime Disposal and MIEX operating costs

- Will not meet TOC reduction goal-MIEX & Lime not providing enough TOC reduction

Alternative Train No. 4 – Future Pretreatment Oxidation, Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Media Filtration; GAC Vessels, Chlorine

- 2nd lowest Capital Cost
- Higher O&M costs due to GAC Replacement and Reactivation and Lime costs
- Will meet TOC reduction goal; Lime softening and GAC combination

Alternative Train No. 5 – Pretreatment Oxidation (Ozone), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Bio GAC Media Filtration, Chlorine

- Lower Capital Cost
- Lower O&M costs, BAC provides filtration and TOC reduction
- Likely will not meet TOC reduction goal with additional GAC contactors following Bio Filtration step

Alternative Train No. 6 - (Pretreatment Oxidation, Coagulation, Sedimentation) Greensand Media Filtration; NF/RO Softening, Chlorine

- Middle capital Cost
- Lowest O&M Cost, Greensand performs dual filtration and FE-MN removal
- Will meet TOC Reduction goal, NF/RO process

Alternative Train No. 7 - Pretreatment Oxidation, Coagulation, Sedimentation, Micro/Ultra Filtration; NF/RO Softening, Chlorine

- Middle capital Cost
- 2nd lowest O&M Cost
- Will meet TOC Reduction goal, RO process

In the initial CTWRD MR&I Water Treatment decision analysis document (February 2015) the Crow Tribe identified the following items as important items to analyze in order to determine the Water Treatment process options:

- OM&R and Capital Costs
- Operation and Maintenance
    - Labor Intensity
    - Technical Difficulty
    - Operation, Maintenance, and Replacement (OM&R) costs
- High quality water-The Tribe wants to produce high quality water for Tribal members and to market to commercial/industrial users for potential revenue. High quality water is defined as follows by the Crow Tribe: Primary Drinking Water Standards, Softening Water, Secondary Drinking Water Standards, DBP compliance

These items along with those identified within this report will revaluated after all piloting and bench scale testing is complete.

4 Bench Scales Testing

4.1 Bench Scale Testing Completed and Results

The following table contains a summary of the Bench Scale testing that has been completed or is planned to be completed. Results of the completed testing can be found in Appendix D of the report.

Figure 4.1 Bench Scale Testing Information

Bench Scale Testing						
Treatment Process	Bench Scale Testing Applicable	Testing Performed	Testing Dates	Testing Parameters	Testing Parties	Result Notes
Media Filtration	NA, Media Filtration Performance Data Available from Hardin, MT WTP-similar source water	NA	NA	NA	NA	Hardin WTP information See Report References
MF/UF	Yes, Accepted range removal percentages received from manufacturers	NA	NA	NA	NA	Accepted removal ranges shown in Mass Balance Diagram
BAC Filtration	NA	NA	NA	NA	NA	BAC typically is a longer bench/pilot testing requirement; typically piloted in applicable
NF/RO	Yes, Accepted range or removal percentages received from manufacturers	NA	NA	NA	NA	Accepted removal ranges shown in Mass Balance Diagram , ROSA Analysis provided in Appendix D
Lime Softening	Yes	Bench Scale Jar Testing	April-May 2015	TOC/DOC Reduction, UV 254, SUVA, Hardness Removal, Iron & Manganese Reduction	Water Technology Group, Denver CO (Merrick Industries)	Lime Dosage rate-200-300 mg/L TOC Reduction or 0-30%
Ion Exchange-MIEX®	Yes	Jar Testing	March 2015	DOC Removal, UVA Removal, Color Removal, Hardness Removal, Iron Removal, Manganese Removal	IXOM Watercare,Inc.	DOC Reduction=35% UVA Reduction=61% Hardness Reduction=53% Iron Reduction-Potassium Permanganate=95% Iron Reduction-MIEX=83%
GAC Post-Treatment	Yes	Bench Scale Column Testing	April-May 2015	DOC/TOC Removal; GAC breakthrough/ media lift	EPS Labs	EPS labs performing RSSCT Testing, initiated 6-5-15, results to be included in Final Pilot WTP Report
Pretreatment-Coag/Floc/Sed Clarifier or Plate Settlers	Yes	Bench Scale Jar Testing	April 2015	TOC/DOC, UV254, SUVA ORP, Iron, MN, pH, Turbidity	CTWRD & BW	Coagulant addition provided no visible improvement to the oxidation bench scale testing results
Ozone	Yes	Ozone Demand Study	February 2015	Iron, MN, Color, DOC/TOC, Bromide/Bromate, ORP	Pinnacle Ozone Solutions, LLC (Guardian Lab)	Optimum FE removal Dosage=0.79-1.25 O3 mg/L Iron Reduction=97%+ Manganese Reduction=90% TOC/DOC Reduction=0-5% Bromate Formation <1 ug/L

Oxidation-FE/MN Removal	Yes	Bench Scale Jar Testing	April 2015	TOC/DOC, ORP, Iron, MN, pH, Turbidity	CTWRD & BW	Chlorine-little to no positive affect Permanganate Iron Reduction=92%+ Manganese Reduction=80-90%
Greensand Filtration	Yes	Bench Scale Column Testing	Not yet determined	UV absorbance, TOC/DOC, Iron & Manganese	NA	Decision was made to not bench scale test, green sand will remove iron and manganese and provide filtration similar to what Hardin experiences
DBP Formation-SDS Testing	Yes	Lab Testing	Not yet determined	DBP; TTHM, HAA5	CTWRD & BW	Testing Initiated 5-29-15, results to be included in Final Pilot WTP Report

4.2 Bench Scale Testing Planned

As noted above in section 4.1, Bench scale testing is currently ongoing for GAC-RSSCT testing and SDS testing. The test result from these tests will be included within the Final Pilot WTP Report. Greensand media column testing, BAC media column testing, will not be bench scale testing. Preliminary Simulated Distribution Testing (SDS) will be performed prior to and during piloting in order to determine necessary DBP levels and TOC reduction goal.

4.3 Water Age-DBP/SDS Testing

Based on preliminary system modeling the water age of the most remote area of the Crow MR&I system is approximately 40-50 days. The longest residence times occur in the northern areas of the Pryor Extension as well as the Cloud Peak extension. The addition of the primary disinfectant when leaving the distribution plant may cause the potential for formation of disinfection by-products. In order to accurately determine the necessary TOC/DOC levels associated with the DBP formation for this time period a Simulated Distribution Simulation (SDS) is needed. Regulated disinfection by-products and their maximum contaminant levels are listed in Appendix B. The best way to reduce the DBP formation in the planned large distribution system will be to remove the precursors before the treated water leaves the WTP.

A DBP formation potential analysis is used to evaluate the greatest amount of DBP formation that is possible in a given source water. The longer the distribution time, the closer this DBP Formation Potential value is to the SDS value. In all cases SDS is the preferred test as it represents similar conditions to what is expected in the distribution system. In order to capture the DBP formation of the treated water and simulate the expected water age in the distribution system, a SDS test is performed. To execute this testing, samples will be collected from the filtered raw water and blended with ultrapure water (TOC≈0) to create varying levels of TOC in the samples. The SDS testing will target TOC/DOC level of 0.50, 1.0, and 1.5. After collecting the samples a water stability analysis and calculation will be conducted to determine the Langelier Stability Index. This index will provide a determination of the amount of buffer (sodium hydroxide or borate) dosing necessary to stabilize the pH at approximately 8. These samples will be chlorinated, and then held in a container to simulate free chlorine contact time. The samples will be dosed with free chlorine at a dosage to yield approximately 2.0 mg/l free chlorine residual at the end of the contact period. Sample pH, temperature, total chlorine, and free chlorine residual will be checked and recorded. Samples will be capped with Teflon covers in clean amber glass bottles or clear glass bottles covered in aluminum foil and stored for 15, 30, 45 (and potentially longer if needed) days at room temperature (or refrigerator or cooler), in the dark (exact sample times will be dependent on the testing lab schedule). Sample pH, temperature, total chlorine, and free chlorine residual will be rechecked and recorded at the end of the storage period. Samples will then be withdrawn and placed in special sample vials (from the certified testing laboratory) containing sufficient sodium thiosulfate to dechlorinate the sample. Blank samples (distilled deionized water) will also be prepared and subjected to all the same chemical additions. Total trihalomethanes (TTHM) and total haloacetic acids (HAA5) will be determined for each sample by an independent laboratory. A similar test will be conducted, except after the free chlorine contact time, ammonium sulfate will be added (at a 1 to 4 NH_3-N to Cl_2 weight ratio) to convert from a free chlorine residual to a combined chlorine residual. The remainder of the test will remain as indicated previously except total chlorine will be analyzed in lieu of free chlorine. A complete SDS testing protocol with conditions of testing are included in Appendix H.

SDS results will be provided in within the Final Pilot WTP Design Report. Data will be presented with both raw data and in graphical form. Graph will provide total THMs and HAA5s in ug/L and will be plotted with water age. Regulatory limits for THMs (80 ug/L) and HAA5s (60 ug/L) will also be plotted in order to show the project data versus regulation limits. The key data that will be confirmed through this process is the TOC/DOC goal of 1.25 mg/L.

5 Pilot Scale Testing

5.1 Pilot Scale Testing Alternatives

Based on the information presented in the previous section the following alternatives are being considered for further pilot testing:

Alternative Train No. 1 - Will not be piloted due to high capital costs, high OM&R costs, and inability to reduce DBP precursors.

- Option will not be piloted
- High capital costs & OM&R cost will be revaluated after all piloting and bench scale testing is complete
- The process will need to include additional TOC/DOC removal

Alternative Train No. 2 – Will not be piloted due to having the highest OM&R costs of the options evaluated

- Option will not be piloted
- High OM&R cost will be revaluated after all piloting and bench scale testing is complete
- Lime and GAC usage rate will be evaluated further

Alternative Train No. 3 - Will not be piloted due to high capital costs, high OM&R costs, and inability to reduce DBP precursors.

- Option will not be piloted
- High capital costs and OM&R cost will be revaluated after all piloting and bench scale testing is - complete -
- The process will need to include additional DOC removal

Alternative Train No. 4 – Will not be piloted due to having high OM&R costs

- Option will not be piloted
- High OM&R costs will be revaluated after all piloting and bench scale testing is complete
- Lime and GAC usage rate will be evaluated further

Alternative Train No. 5 – Pretreatment Oxidation (Ozone), Lime Softening Clarification (including Flocculation, Coagulation, Sedimentation); Bio GAC Media Filtration, Chlorine

- Option will be further evaluated during piloting process
- GAC Contactors will be necessary following Bio-GAC Filtration to lower DOC levels to meet goals
- Since it is likely the process will need to include additional DOC removal the option will be re-evaluated following GAC RSSCT and SDS testing to determine if option is cost effective
- Lime Softening Clarification will not be piloted due to size constraints and information collected thru bench scale testing

Alternative Train No. 6 - (Pretreatment Oxidation, Coagulation, Sedimentation) Greensand Media Filtration; NF/RO Softening, Chlorine

- Option will be further evaluated during piloting process
- Greensand filtration will not be piloted due accepted process values available

Alternative Train No. 7 - Pretreatment Oxidation, Coagulation, Sedimentation, Micro/Ultra Filtration; NF/RO Softening, Chlorine

- Option will be further evaluated during piloting process

Pilot Testing to Include:

- Oxidation- Permanganate & Ozone
- Pretreatment Coag-Floc-Sedimentation (Plate Settler)
- Filtration-MF/UF, Bio GAC Media Filter
- Softening-NF/RO

**Sufficient Information Available from Bench Scale testing for Greensand Media Filtration and Lime Softening Clarification

5.2 Pilot Scale Testing Plan

Pilot testing of the recommended design alternatives will be conducted. Pilot testing will further determine the TOC/DOC, iron, manganese reduction (along with other treatment goals identified) can be sustained for longer period of times. Piloting will collect a large quantity of data, examples of this information include:

- o Demonstration that the equipment will produce treated water that will meet all applicable federal and state standards.

- Further analyze softening process
- Provide physical design parameters (flux, recovery, backwash frequency, cleaning frequency, etc.) for basis of the final full-scale design.
- Demonstrate the ability of the system to provide verification of membrane integrity
- Determine the ability of the systems to remove total organic carbon (TOC) and other contaminants of concern such as aluminum, iron, and manganese
- Determine the impact of chemical additions (permanganate, ozone, polymer, coagulant) on the - membrane operation. -
- Determine oxidants such as ozone and permanganate are effectiveness in conjunction with filtration, settling, and other equipment
- Account for unforeseen conditions that may have otherwise gone undetected.
- Familiarize operators with the process equipment
- Determine biological activity formed and effect on TOC, metals, fouling, cleaning, and other parameters
- Determine the amount of reject water, system recovery, process efficiency, particulate/organism removal efficiencies, cold and warm water flux, fouling potential, operating and transmembrane pressure, and other design and monitoring considerations.

Pilot testing will provide accurate results so that factors for each process can be adjusted and optimized to determine ideal operating conditions. The data collected by the pilot study will be utilized by the Crow Tribe to determine the effectiveness of the final alternatives to meet water treatment goals outlined in previous section of this report. The data will also aid in the final design of the technology by determining the cost-effective implication and design criteria.

6 Design Schedule

6.1 Crow MR&I Water Treatment Plant Design Steps

Design process diagram and schedule are shown on the following figures.

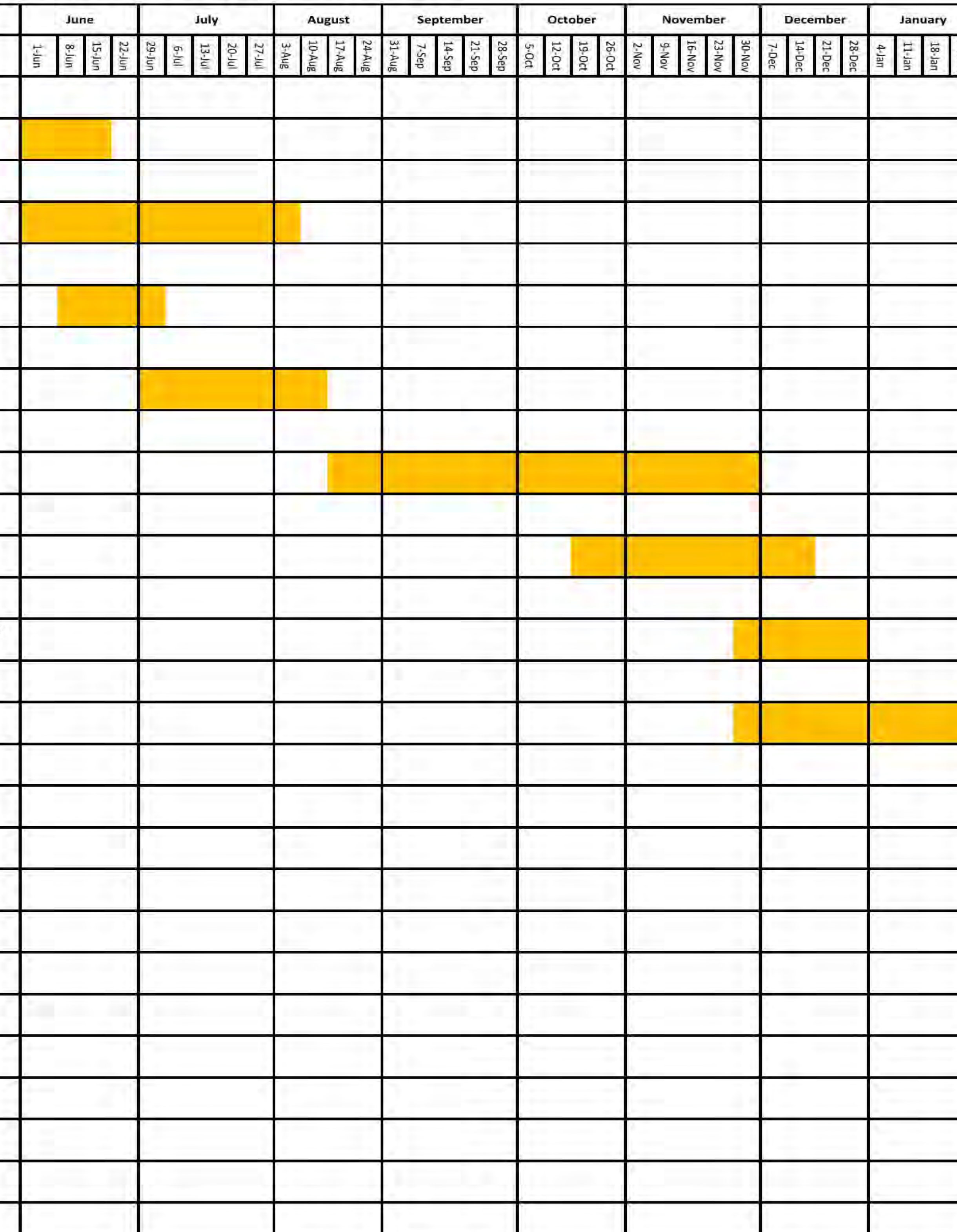
Schedule Items of Note:

- Operation of the Pilot WTP is being proposed to operate for a length of 3 months. Variations in raw water quality shown in Appendix A have shown the following:
    - Temperature fluctuation is not highly variable and only change from 5-20˚ C thought the year
    - TOC-DOC peak stays consistent between Mid/Late June through September
    - Turbidity levels are stable throughout the year with the exception of significant rain and snow events
    - Turbidity events will be stabilized due to the use of River Bank Filtration
    - Iron, Manganese, Hardness, Alkalinity, ORP have shown to be consistent and have little seasonally variation

Figure 6.1 Preliminary Design Schedule for the MR&I WTP

Design Process Schedule for the Crow MR&I Water Treatment Plant

Item #	Task	Description
1	Alternative Design Report	Analysis of Treatment Alternatives
2	Bench Scale & SDS Testing	Perform Bench and other lab testing identified in Task #1
3	Pilot Test Report, Plans, & Specifications	Prepare pilot planning, construction, and operating documents
4	Pilot Water Treatment Plant Construction	Construction facility described in Pilot plant Test Plans and Specifications
5	Pilot Plant Testing	Operate pilot water treatment plant and collect data
6	Final Alternative Analysis and Bench & Pilot Testing Results Report	Prepare and finalize Bench and Pilot testing data in report form along with updated analysis performed in Intial Alternative Report
7	WTP Process Decision Memo	Prepare and Transmit Memo of Process Decsion based on Recommendation of report noted in previous task
8	Preliminary Design Report	Perform preliminary design related to prcoess, floor plan, site layout, etc.
9	35% Design (2016)	Drawings, Costs, Specifications, and BOR & EPA Review at 35%l Design
10	Value Engineering Study (2016)	Conduct value engineering study of 35% design
11	95% Design (2016)	Drawings, Costs, Specifications, and BOR & EPA Review at 95% Design
12	100%/Final Design (2016)	Drawings, Costs, Specifications, and BOR & EPA Review at 100%/Final Design
13	Crow Tribe Bidding Process (2016)	Advertise, Bid, and Award Water Treatment Plant
14	Facility Construction (2016)	Construction and Startup of Water Treatment Plant



Design Process for Crow MR&I Water Treatment Plant -

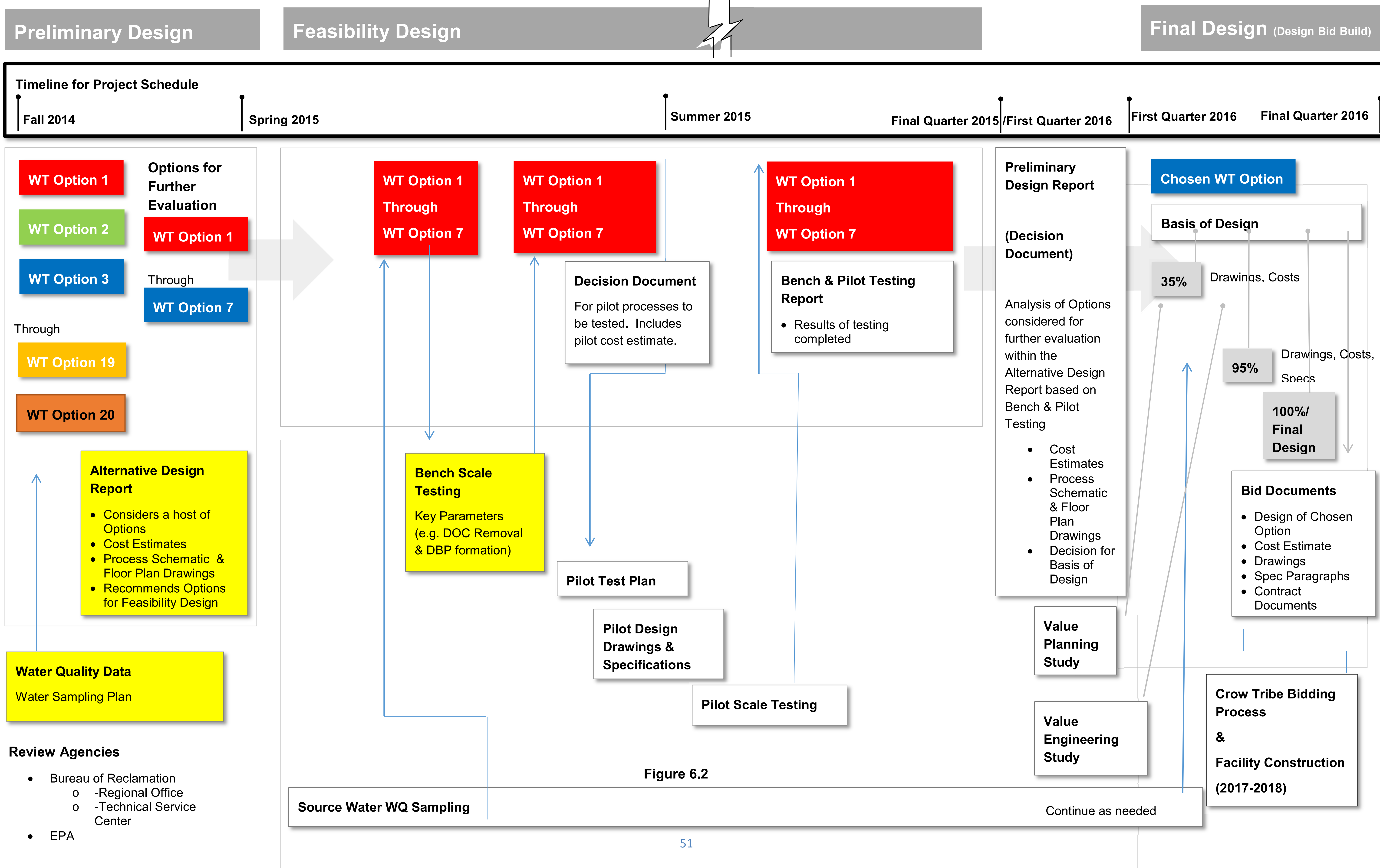


Figure 6.2

7 References

[1]"Crow MR&I Master Plan" –Crow Tribe Water Resource Department, and Bartlett & West, September 2014

[2] "Treatment of Concentrate" "-Desalination and Water Purification Research and Development Program Report No. 155", United State Department of the Interior, Bureau of Reclamation, 2009

[3] "City of Hardin Preliminary Engineering Report-Water System", City of Hardin and Great West Engineering, April 2010

-Hardin Treatment Information and Water Quality

[4] (EPA, 2015)"Drinking Water Treatability Database", http://iaspub.epa.gov/tdb/pages/treatment/findTreatment.do , US Environmental Protection Agency, June 2015

8 Appendices

Appendix C. Decommissioning and Reclamation Plan

Crow Tribe Water Resources

CROW MR&I SYSTEM
PILOT WATER TREATMENT PLANT PROJECT
Decommissioning and Reclamation Plan
MARCH 2015

CROW TRIBE

BARTLETT & WEST

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10.0 Monitoring 4

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1.0 Waste Material Handling & Disposal Facility Decommissioning

Waste material generated during the construction or operation of the pilot plant or aquifer test will be handled according to all applicable hazardous materials rules and regulations. Pilot test equipment operation such as ozone generation that produces potentially harmful substances, will be operated in a manner compliant with all applicable health and safety codes. Concentrate solid waste material generated during water treatment will be excavated from the evaporation pond and hauled to the nearest appropriate landfill. The St. Xavier Canister site will not be appropriate for landfill. The Reno Creek solid waste disposal site, Crow Agency Open Dump solid waste disposal site, or Lodge Grass Open Dump solid waste disposal site will be evaluated for appropriateness for placement of membrane backwash sludge and sediment sludge.

2.0 Facility Decommissioning

The supply and discharge pipelines, pilot plant building, and equipment would be removed from the ground surface. Following removal the materials will be stored in a secure area and protected from damage. The treatment skids (ozone, plate settler, ultrafiltration, and reverse osmosis) will be decommissioned in accordance with manufacture standards. Following decommissioning the skids would be shipped back to the respective manufacturers. The pipelines and structure would be salvaged by the Tribe.

3.0 Ensuring Subsurface Integrity

Subsurface work on the project includes a groundwater intake well of approximately 30’ depth, 7-10 observation wells, and 50 feet of pipeline trench of approximately 2’ depth and 2’ width at the Mission Loop Road Crossing. At the conclusion of aquifer testing and pilot plant operation, the groundwater intake wells and the observation wells will remain in place for potential later use during the ultimate intake construction. The groundwater well internal components will be removed and the casing will be capped until further need develops. The electrical service will be discontinued, but the service panels and lines will remain in place for future use unless the site is abandoned as an alternative for the full-scale plant intake location.

If the site is determined to be unfeasible for the full-scale plant intake, the electrical service will be completely removed and any buried lines will be abandoned. The groundwater well and observation wells will remain in place, but will be fully decommissioned by capping and sealing the wells below the surface and backfilling over the top of the wells.

4.0 Surface Reconstruction and Stabilization

Disturbed landscape will be returned to approximate original contours, with added geomorphic stabilization in areas weakened by construction and project activities. The area disturbed for construction of the settlement pond and pilot plant site will be backfilled and re-contoured to near pre-construction contours. Disturbed surfaces will be returned to original purpose. Erosion and sediment control best management practices (BMPs) will be implemented to protect the reclaimed area and adjacent features from sediment wash out, livestock, wind, or other significant factors such as human use during and after construction. BMPs and surface reconstruction/seeding will be established in the project Stormwater Pollution Prevention Plan (SWPPP).

5.0 Re-Establishing Surface Hydrology

Damaged or disturbed drainages, impoundments, stream banks or channels will be repaired or restored to match original or adjacent drainage patterns, profiles and dimensions. The characteristics of the original surface hydrology, in the potentially disturbed area, will be captured in applicable documentation such as photos, topographical survey or soil survey for guidance and comparison during the re-establishment/reclamation period. Other components impacting surface hydrology such as vegetation will be considered in the soil preparation and revegetation efforts.

6.0 Soil Management and Handling

Soils in the project area have been delineated using the Natural Resource and Conservation Service (NRCS) web soil survey tool. Descriptions of the soil resources can be found in the project Environmental Assessment. Top soils will be segregated from excavated sub soils and fill materials and will be protected from erosion, degradation and contamination. Upon completion of the project, the top soil will be reapplied to surface of the recontoured area.

7.0 Site Preparation

Preparation of the site for revegetation will begin with proper pre-construction activities. Noxious weeds and noxious weed infested topsoil will be removed prior to seedbed preparation and disposed of in an appropriate landfill. Seedbed preparation will include removal of stiff clods, lumps, roots, litter, stones, and other foreign material greater than 6 inches from the surface, and filling of rills, gullies and depressions. Areas where topsoil was disturbed by excavation will be scarified or harrowed and raked prior to sowing seed or placement of fertilizer.

8.0 Revegetation

The revegetation effort, including seeding methods and seed mixes, will meet the requirements of the construction specifications which will be developed in cooperation with the BIA Environmental Resource Department and the local NRCS. Revegetation will occur in conjunction with site preparation and will generally include seeding and mulching. Seeding is generally done by broadcast, drill, or hydroseed methods. Seed mixes will include native species and may include a cover crop, unless the BIA or landowner desires otherwise. Seeding in previously cultivated/agricultural fields will be based on BIA approval.

9.0 Restoring Visual Resources

Impacts to visual resources will be minimized during establishment of the work limits within the project area before construction commences. Disturbed areas such as the backfilled evaporation pond will be dressed, seeded, mulched and returned to the original state as quickly as possible at the conclusion of construction. Temporary pipeline will be placed in such a way that minimizes eyesore during the project and will be removed at the conclusion of the project. Temporary project facilities such as electrical services will remain onsite until the project location is deemed unsuitable for the full-scale plant intake and or pipeline. If the site is deemed unsuitable, electrical service panels, boxes, wells heads, and other visible project facilities and materials will be removed from the site.

10.0 Weed and Pest Management

Noxious weeds and noxious weed infested topsoil will be removed prior to seedbed preparation and disposed of in an appropriate landfill. Until substantial completion for the SWPPP is met, the site will be monitored for noxious weeds.

11.0 Monitoring

Monitoring and reporting procedures will be developed in the project SWPPP. Land reclamation and revegetation goals will be a significant consideration in the development of the SWPPP.

12.0 References

BLM (Bureau of Land Management). 2011, October 18. Reclamation Policy Plan Requirements Retrieved December 3, 2014, from http://www.blm.gov/wy/st/en/programs/reclamation/plans.html

Appendix D. Public Notice Documentation

The Crow Nation and the Bureau of Reclamation, in cooperation with the Bureau of Indian Affairs, are preparing a project specific Environmental Assessment to evaluate potential environmental issues associated with the construction, running, and decommissioning of the Crow MR&I System Pilot Water Treatment Plant. Public comment period is now open. Comment is invited on environmental issues and conservation measures associated with the project. For further project information such as how to submit comments, visit: http://www.usbr.gov/gp/nepa/cmri/index.html Or call Christina Gomer with the Bureau of Reclamation (406)247-7753.

published June 22, 23, 2015

The Crow Nation and the Bureau of Reclamation, in cooperation with the Bureau of Indian Affairs, are preparing a project specific Environmental Assessment to evaluate potential environmental issues associated with the construction, running, and decommissioning of the Crow MR&I System Pilot Water Treatment Plant. Public comment period is now open. Comment is invited on environmental issues and conservation measures associated with the project. For further project information such as how to submit comments, visit: http://www.usbr.gov/gp/nepa/cmri/index.html Or call Christina Gomer with the Bureau of Reclamation (406)247-7753.

July 6, 2015

PUBLIC NOTICE

The Crow Nation and the Bureau of Reclamation, in cooperation with the Bureau of Indian Affairs, are preparing a project specific Environmental Assessment to evaluate potential environmental issues associated with the construction, running, and decommissioning of the Crow MR&I System Pilot Water Treatment Plant. Public comment period is now open. Comment is invited on environmental issues and conservation measures associated with the project. For further project information such as how to submit comments, visit: http://www.usbr.gov/gp/nepa/cmri/index.html Or call Christina Gomer with the Bureau of Reclamation (406) 247-7753.

MNAXLP

Publish: June 25, 2015

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From: Barb Eben [mailto:classifieds@bighorncountynews.com]
Sent: Thursday, June 25, 2015 5:00 PM
To: Michelle Ibach
Subject: Re: EA Legal Notice Crow MR&I SPWTP

Hello Michelle,
Your legal notice has been rescheduled to run a second week.
Barb

Barb Eben
Big Horn County News Classifieds/Legals
PO Box 926
Hardin, MT 59034
406-665-1008
406-665-1012 fax
classifieds@bighorncountynews.com

News Releases

Reclamation Releases Draft EA for Water Treatment Plant Pilot Study

Media Contact: Christina Gomer, (406) 247-7753

For Release: June 22, 2015

BILLINGS, Mont. -- The Bureau of Reclamation has released the Draft Environmental Assessment for the proposed Water Treatment Plant Pilot Study Project for public review and comment. The comment period will close on July 10.

The Crow Tribe, in cooperation with Reclamation and the Bureau of Indian Affairs, prepared the Draft EA to evaluate the environmental consequences of a three month water treatment plant pilot study, located in Big Horn County in south-central Montana.

The proposed project would gather information to aid in the design of a municipal, rural and industrial (MR&I) water system to serve the Crow Indian Reservation. The design and construction of the MR&I system was authorized as a part of the Crow Tribe Water Rights Settlement Act of 2010.

The Draft EA is available electronically at http://www.usbr.gov/gp/nepa/cmri/index.html.

Paper copies of the Draft EA can be viewed at the following locations:

Bureau of Reclamation
2nd Floor – Room 200 and 5th Floor – Room 514
2021 4th Avenue North
Billings, MT 59101

Bureau of Indian Affairs
Building #2, Room 69
Weaver Drive
Crow Agency, MT 59022

Crow Tribe Water Resource Department
189 Heritage Lane
Crow Agency, MT 59022

Comments on the Draft EA can be sent to: cmgomer@usbr.gov; Christina Gomer, Bureau of Reclamation, 2021 4th Avenue North, Billings, MT 59101; or, faxed to 406-247-7680. Comments will be accepted until midnight on Friday, July 10. For additional information or to request a hard copy of the Draft EA, please contact Christina Gomer, Bureau of Reclamation, at 406-247-7753 or cmgomer@usbr.gov.

# # #

Reclamation is the largest wholesale water supplier and the second largest producer of hydroelectric power in the United States, with operations and facilities in the 17 Western States. Its facilities also provide substantial flood control, recreation, and fish and wildlife benefits. Visit our website at www.usbr.gov and follow us on Twitter @USBR.

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United States Department of the Interior

BUREAU OF RECLAMATION
Great Plains Regional Office
P.O. Box 36900
Billings, MT 59107-6900

IN REPLY REFER TO:

GP-4200
ENV–6.00

JUN 24 2015

Dear Interested Parties:

The Bureau of Reclamation, the Crow Tribe, and the Bureau of Indian Affairs are announcing the availability and opportunity to comment on the Draft Environmental Assessment (Draft EA) for the Water Treatment Plant Pilot Study (Project), to be located in Big Horn County, Montana. The proposed Project would gather information to aid in the design of a municipal, rural, and industrial water system to serve the Crow Indian Reservation, as authorized in the Crow Tribe Water Rights Settlement Act of 2010.

The Draft EA can be viewed at the locations listed below or by visiting the Project website at http://www.usbr.gov/gp/nepa/cmri/index.html:

Locations:	Name	Address
	Bureau of Reclamation	2nd Floor (Room 200) 5th Floor (Room 514) 2021 4th Avenue North Billings, MT 59101
	Bureau of Indian Affairs	Building #2, Room 69 Weaver Drive Crow Agency, MT 59022
	Crow Tribe, Water Resource Department	189 Heritage Lane Crow Agency, MT 59022

Comments will be accepted until midnight on Friday, July 10, 2015 and may be submitted in the following ways:

Online: http://www.usbr.gov/gp/nepa/cmri/index.html

Project Contacts:	Name	Contact Information
	Christina Gomer Bureau of Reclamation	406-247-7753 cmgomer@usbr.gov
	Dan Stremcha Bureau of Reclamation	406-247-7308 dstremcha@usbr.gov

Titus Takes Gun
Crow Tribe Water Resources

406-638-4235
Titus.TakesGun@crow-nsn.gov

Mailing Address: Bureau of Reclamation
Attn: Crow MR&I Water Projects (GP-4000)
P.O. Box 36900
Billings, MT 59107-6900

For additional information or to request a hard copy of the Draft EA, please contact Christina Gomer at 406-247-7753 or cmgomer@usbr.gov.

Sincerely,

For

Michael J. Ryan
Regional Director