

City of St. Joseph, Missouri
Facilities Plan

**Technical Memorandum Nos. TM-CSO-12
and TM-WW-3**

Screening and Grit Removal Facilities



By



Work Order No. 09-001
B&V Project 163509

December 11, 2009

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- Appendix A Opinion of Probable Capital Cost Breakdown
- Appendix B Opinion of Probable O&M Cost Breakdown
- Appendix C Opinion of Probable Net Present Worth Breakdown

Screening and Grit Removal Facilities

1.0 Executive Summary

The purpose of this assessment is to evaluate alternative screening and grit removal technologies and alternatives for both the Water Protection Facility (WPF) and the future high rate treatment (HRT) facility. In addition, grit removal was evaluated for flow from the Missouri Avenue Diversion Structure since WPF staff have concerns about grit accumulation in the pipeline from the diversion structure to the In-plant Influent Pump Station.

The following groupings of alternatives were considered for the WPF and HRT flows:

- Alternative 1 – Provide a combined screening and grit removal facility for flows to both the WPF and HRT. Combined facilities offer the advantage of lower costs and single point handling of screenings and grit.
- Alternative 2 – Provide separate screening and grit removal facilities for the WPF and HRT. Separate facilities offer the advantage of being able to utilize existing WPF facilities or WPF property.
- Alternative 3 – Provide a combined screening facility for both the WPF and HRT, but separate grit removal facilities for each. This alternative offers the advantage of combining screening facilities while still utilizing some existing WPF facilities and property for grit removal.

The following alternatives were considered for the Missouri Avenue Diversion Structure flow:

- Alternative A – Provide pipeline improvements to address grit accumulation.
- Alternative B – Provide a dedicated grit facility for flows from the Missouri Avenue Diversion Structure.
- Alternative C – Provide a dedicated horizontal grit chamber for flows from the Missouri Avenue Diversion Structure.

- Alternative D – Provide for periodic cleaning of the pipeline to prevent grit build-up.

WPF and HRT Flow

Alternatives 1, 2, and 3 represent three configurations for screenings and grit removal covering a range from a combined facility to handle both WPF and HRT flow to completely separate facilities dedicated to the WPF and HRT to a combination of the two. Sub-alternatives as described below were developed for each configuration using grit removal technologies deemed by City staff as appropriate for further consideration. These technologies included the existing aerated grit basins, vortex type grit removal equipment such as Smith & Loveless PISTA, and grit removal equipment manufactured by Hydro International including the Eutek Headcell, Storm King, and Grit King. Figure ES-1 presents an overview of the existing WPF and indicates possible locations for the facilities. Final locations will be determined when a siting study is conducted and detailed design performed.

- Alternative 1A – Upgrade existing aerated grit basins to process all flow (88 mgd) and screening facility near the existing grit basins.
- Alternative 1B – Screening and grit removal facility in location of existing aerated grit basins to process all flow (88 mgd).
- Alternative 1C-1 – Screening and vortex grit removal facility at north property to process all flow (88 mgd).
- Alternative 1C-2 – Screening and Eutek Headcell grit removal facility at north property to process all flow (88 mgd).
- Alternative 2A – Upgrade existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) near the existing grit basins, and screening and grit removal facility to process HRT flow (61 mgd) in alternate location.
- Alternative 2B – Upgrade existing aerated grit basins to process HRT flow (61 mgd), screening facility to process HRT flow (61 mgd) near the



200' 100' 0 200' 400'
APPROX SCALE IN FEET



ST. JOSEPH, MISSOURI
FACILITIES PLAN

PN 163509
POSSIBLE SCREENING AND
GRIT FACILITY LOCATIONS

BLACK & VEATCH
DECEMBER 2009

FIGURE ES-1

existing grit basins, and screening and grit removal facility to process WPF flow (34 mgd) in alternate location.

- Alternative 2C – Eutek Headcell grit removal facility retro-fitted in existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) at north property, screening and Storm King/Grit King grit removal facility to process HRT flow (61 mgd) at west property.
- Alternative 3A-1 – Screening to process all flow (88 mgd) at north property, vortex grit removal to process HRT flow (61 mgd) at north property, and vortex grit removal to process WPF flow (34 mgd) near existing grit basins.
- Alternative 3A-2 – Screening to process all flow (88 mgd) at north property, Storm King/Grit King grit removal to process HRT flow (61 mgd) at north property, and Eutek Headcell grit removal to process WPF flow (34 mgd) in existing grit basins.

Table ES-1 provides a summary of the sub-alternatives and the initial evaluation. After initial screening, the following five sub-alternatives were selected for further evaluation based on costs, present worth, and non-economic factors:

- Alternative 1C-1
- Alternative 1C-2
- Alternative 2C
- Alternative 3A-1
- Alternative 3A-2

Each of the five alternatives listed above was evaluated using the criteria of project capital investment, operation and maintenance (O&M) costs, net present worth, and non-economic factors. Table ES-2 presents the results of the project capital, O&M, and net present worth analysis for each of the alternatives.

Table ES-1 Screening and Grit Removal Alternatives						
Alternative	Screens	Grit System	Location	Description	Potential Benefit	Preliminary Screening Action
1A	Front Cleaned Bar Rack 1/2" opening	Aerated Grit System	Existing WPF grit basins	Upgrade existing aerated grit basins to process all flow (88 mgd), screening facility near the existing grit basins.	Maximize use of existing facilities. Locates operation in single spot nearest existing connection point.	Eliminated from further consideration due to poor performance of current aerated grit system and poor configuration of existing basins hindering performance at higher capacity.
1B	Front Cleaned Bar Rack 1/2" opening	Vortex or Headcell	Existing WPF grit basin area	Screening and grit removal facility in location of existing aerated grit basins to process all flow (88 mgd).	New and better grit technology than existing aerated grit. Single spot location at nearest existing connection point to WPF.	Eliminated from further consideration. Initial facility layouts indicate 88 mgd cannot fit in this location.
1C-1	Front Cleaned Bar Rack 1/2" opening	Vortex	Alternate location	Screening and vortex grit removal facility at north property to process all flow (88 mgd).	New and better grit technology than existing aerated grit. Single spot location better for operation. Though somewhat limited, alternate sites provide more space for facilities.	Alternative was selected for further consideration. Location north of Administration Building selected.
1C-2	Front Cleaned Bar Rack 1/2" opening	Headcell	Alternate location	Screening and Eutek Headcell grit removal facility at north property to process all flow (88 mgd).	New and better grit technology than existing aerated grit. Single spot location better for operation. Though somewhat limited, alternate sites provide more space for facilities.	Alternative was selected for further consideration. Note that Storm King / Grit King not applicable for a combined facility approach. Location north of Administration Building selected.
2A	Front Cleaned Bar Rack 1/2" opening	Aerated Grit System and Vortex or Storm King / Grit King	Existing WPF grit basins and alternate location for new facilities	Upgrade existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) near the existing grit basins, and screening and grit removal facility to process HRT flow (61 mgd) in alternate location.	Maximizes use of existing facilities. Locates grit and screen facility near each subsequent process (WPF or HRT).	Eliminated from further consideration due to poor performance of current aerated grit system and poor configuration of existing basins hindering performance at higher capacity.
2B	Front Cleaned Bar Rack 1/2" opening	Aerated Grit System and Vortex or Headcell	Existing WPF grit basins and alternate location for new facilities	Upgrade existing aerated grit basins to process HRT flow (61 mgd), screening facility to process HRT flow (61 mgd) near the existing grit basins, and screening and grit removal facility to process WPF flow (34 mgd) in alternate location.	Maximizes use of existing facilities.	Eliminated from further consideration due to poor performance of current aerated grit system and poor configuration of existing basins hindering performance at higher capacity.
2C	Front Cleaned Bar Rack 1/2" opening	Headcell and Storm King / Grit King	Existing WPF grit basins and alternate locations for new facilities	Eutek Headcell grit removal facility retro-fitted in existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) at north property, screening and Storm King / Grit King grit removal facility to process HRT flow (61 mgd) at west property.	Re-uses existing aeration basin structure.	Alternative was selected for further consideration. WPF screening facility located north of Administration Building and HRT screening and grit facility located west of WPF.
3A-1	Front Cleaned Bar Rack 1/2" opening	Vortex	Existing WPF grit basin area and alternate location for other new facilities	Screening to process all flow (88 mgd) at north property, vortex grit removal to process HRT flow (61 mgd) at north property, and vortex grit removal to process WPF flow (34 mgd) near existing grit basins.	Single spot location for screening. Utilizes existing WPF property at existing grit basins.	Alternative was selected for further consideration. Location north of Administration Building selected.
3A-2	Front Cleaned Bar Rack 1/2" opening	Headcell and Storm King / Grit King	Existing WPF grit basins and alternate location for other new facilities	Screening to process all flow (88 mgd) at north property, Storm King / Grit King grit removal to process HRT flow (61 mgd) at north property, and Eutek Headcell grit removal to process WPF flow (34 mgd) in existing grit basins.	Single spot location for screening. Utilizes existing grit basins for WPF grit removal equipment.	Alternative was selected for further consideration. Location north of Administration Building selected.

Table ES-2 Net Present Worth by Alternative ¹					
	Alternative 1C-1 (Vortex Grit Removal), \$	Alternative 1C-2 (Hydro International Grit Removal), \$	Alternative 2C (Hydro International Grit Removal), \$	Alternative 3A-1 (Vortex Grit Removal), \$	Alternative 3A-2 (Hydro International Grit Removal), \$
Net Project Capital Present Worth ²	19,566,000	20,509,000	31,481,000	22,221,000	25,859,000
O&M Present Worth ³	5,736,000	5,826,000	9,978,000	8,063,000	7,879,000
Total Net Present Worth	25,302,000	26,335,000	41,459,000	30,284,000	33,738,000
¹ . Costs are in May 2009 dollars. Present worth calculated with 20-year life cycle costs at 5% interest. ² . Net project capital present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year life cycle. Service life for determination of replacement frequency and salvage value was projected as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years. ³ . O&M costs were assumed to escalate at 5% per year.					

From a project capital cost standpoint, both Alternatives 1C-1 (based on Smith & Loveless PISTA vortex equipment) and 1C-2 (Eutek Headcell) were found to be approximately equivalent. The O&M evaluation demonstrated that the two alternatives were also essentially the same. Likewise, the net present worth analysis showed that the two alternatives were the least expensive options on the basis of net present worth. The net present worth of Alternative 1C-2 (\$26 million for the Eutek Headcell alternative) was about \$4 million less expensive over the 20-year life cycle than the next closest alternative. On the basis of non-economic criteria, all alternatives were similar; however, the Eutek Headcell equipment is proprietary and would require sole source negotiations with the manufacturer.

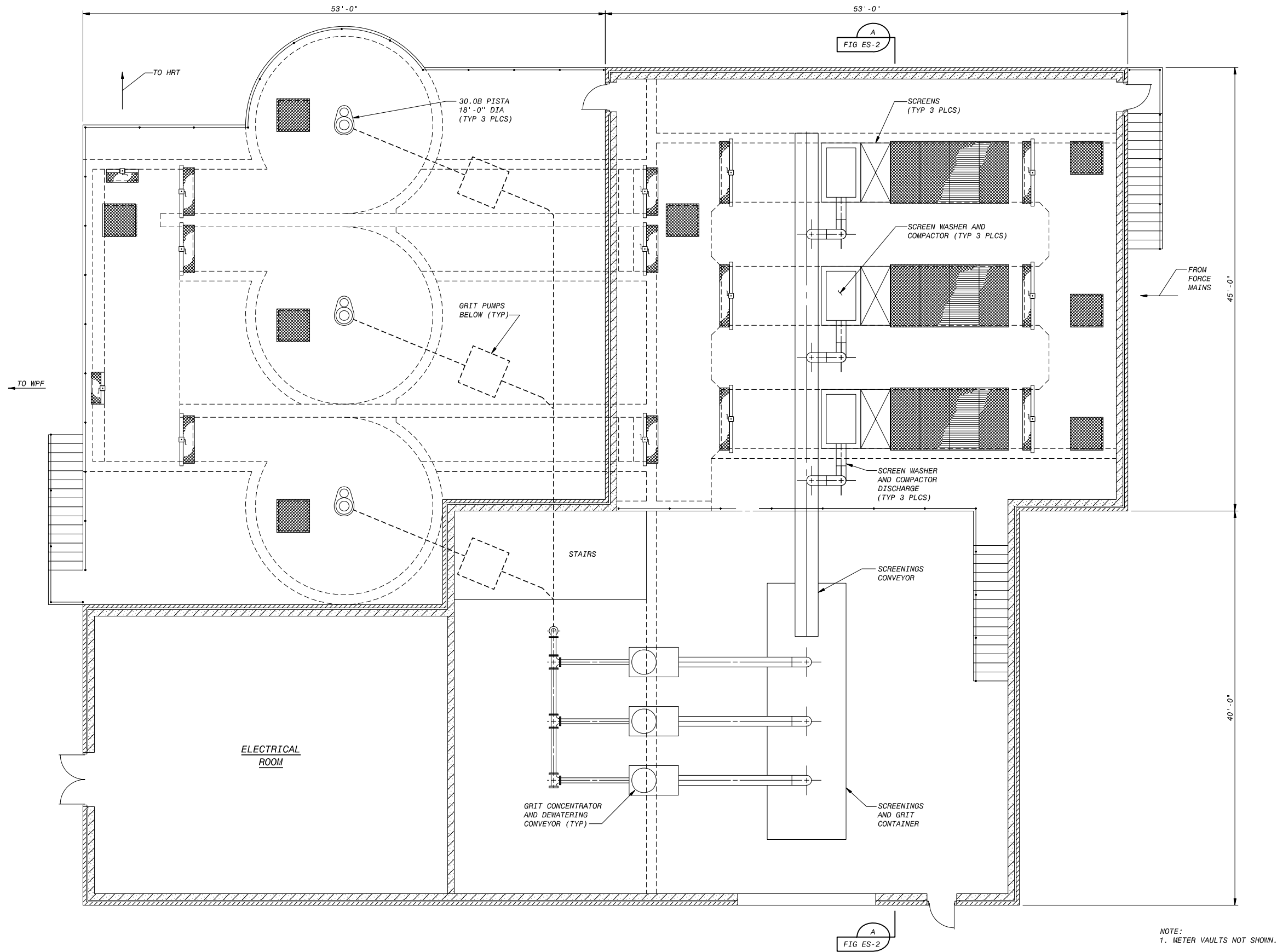
Due to the proprietary issues with the Eutek Headcell equipment, it is recommended that the City initiate the design for the 88 mgd combined screening and grit removal facility to treat WPF and HRT flows based on a vortex type system such as Smith & Loveless PISTA. Figure ES-2 shows a general layout of the recommended Alternative 1C-1. Figures ES-3 and ES-4 show a conceptual plan and section of the proposed screening and vortex grit removal facility. Locations of facilities shown are preliminary. Locations may be changed when a siting study is conducted and during detailed design.



200' 100' 0 200' 400'
 APPROX SCALE IN FEET



ST. JOSEPH, MISSOURI
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 PN 163509
 ALTERNATIVE 1C-1
 SCREENING AND GRIT REMOVAL
 FOR 88 MGD (VORTEX)
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 DECEMBER 2009
 FIGURE ES-2



PLAN
3/32" = 1'-0"

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CHK	APP
CYNET ID: 163509-1000-WTCH-C-0001B0177	XREF1 ID: ES-Screening & F. Plan.dwg				
SAVED: GLA10863, 12/7/2009 8:51:33 AM	XREF2 ID:				
DWG VER #: 1.3	XREF3 ID:				
PLOTTED: GLA10863, 12/7/2009 9:03:25 AM	XREF4 ID:				
USER: GLA10863	SW: FIGURE ES-3.dwg				

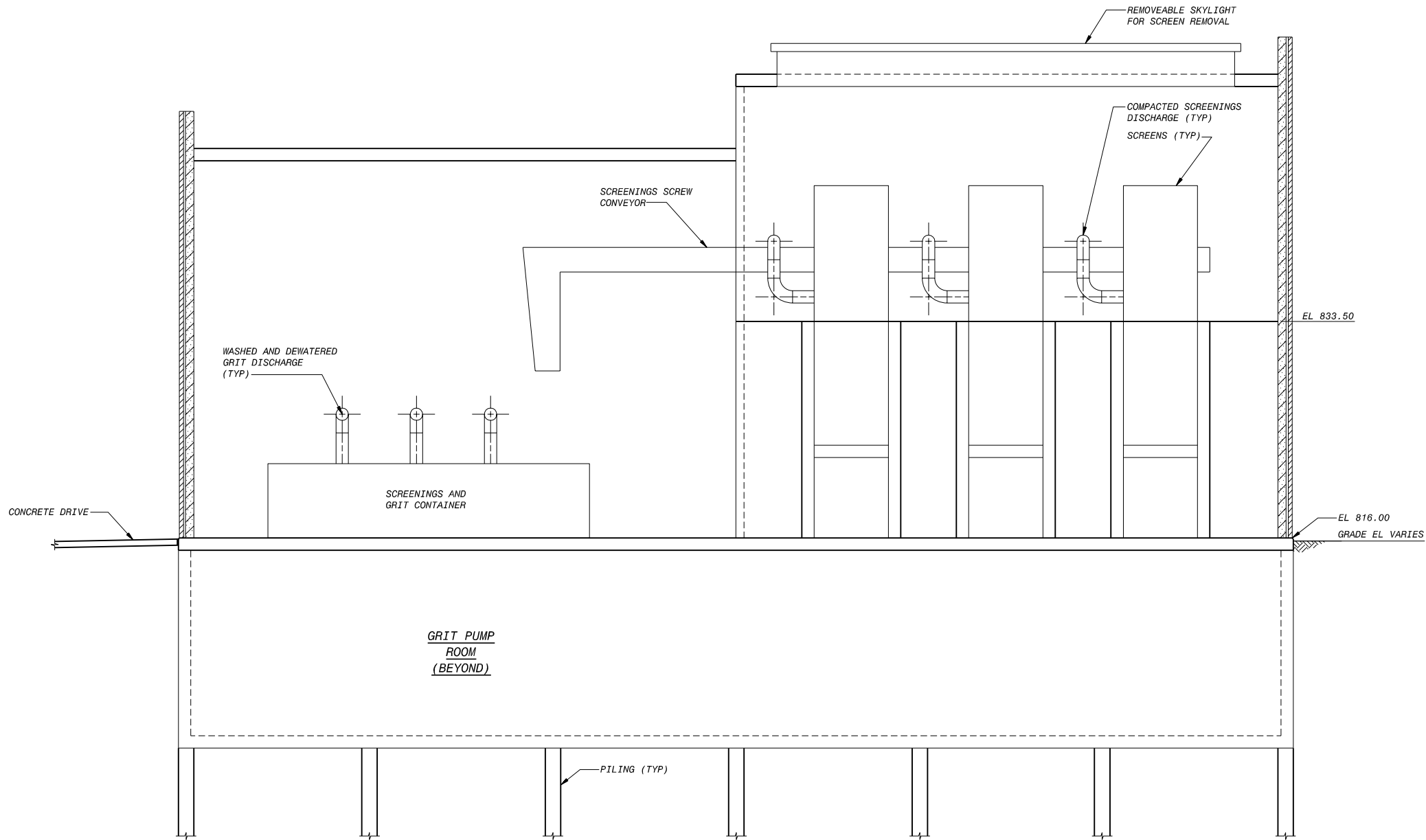
**BLACK & VEATCH**
Corporation
Kansas City, Missouri

ST. JOSEPH, MISSOURI
FACILITIES PLAN
ALTERNATIVE 1C-1
SCREENING AND GRIT REMOVAL
FOR 88 MGD (VORTEX) PLAN

DESIGNED: RCB
DETAILED: JKS
CHECKED:
APPROVED:
DATE:

PROJECT NO.
163509

FIG ES-3
SHEET
OF



SECTION
3/32" = 1'-0" A
FIG ES-3

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1				CYNET ID: 163509-1000-WTCH-C-0001BQTB XREF1 ID: ES-Screening_G_F_Sections.dwg
2				SAVED: GLA10863, 12/7/2009 9:05:07 AM XREF2 ID:
3				DWG VER #: 1.3 XREF3 ID:
4				PLOTTED: GLA10863, 12/7/2009 9:05:09 AM XREF4 ID:
5				USER: GLA10863 XREF5 ID:



ST. JOSEPH, MISSOURI
FACILITIES PLAN

ALTERNATIVE 1C-1
SCREENING AND GRIT REMOVAL
FOR 88 MGD (VORTEX) SECTION

DESIGNED: RCB
DETAILED: JKS
CHECKED:
APPROVED:
DATE:

PROJECT NO.

163509

FIG ES-4

SHEET
OF

Construction of facilities and equipment should be phased in order to provide initial capacity for the WPF and then expanded in the future when the HRT is constructed. Based on conceptual layouts and equipment selection, phasing would initially include three screen channels and two screens and two grit removal basins. Exact numbers and sizes of equipment may change during detailed design.

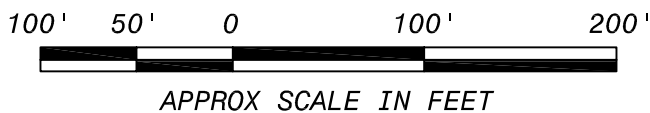
Missouri Avenue Diversion Structure Flow

Operations personnel have noticed significant grit accumulation in the pipeline from the diversion structure to the In-plant Influent Pump Station. In addition, pump wear at the In-plant Influent Pump Station suggests possible grit impacts. The following alternatives to address the grit issue were evaluated.

Alternative A included a hydraulic evaluation of the pipeline which indicated that the pipeline has some sections with very shallow slopes resulting in low velocities during low flows. Given the low velocities, it is understandable that there would be grit settlement issues in the pipeline. If the pipeline were reconstructed to eliminate the shallow slope segments, the resulting slope would still be insufficient to prevent the accumulation of grit in the pipeline. The cost of reconstructing the line would be high due to the depth of the line and the amount of existing piping that is in the same general path of or crosses the current pipeline. Figure ES-5 shows the south end of the plant where the pipeline forms a “Z” shaped bend to connect to the Transfer Pump Station. This reversal in pipeline direction is a potential area where grit would accumulate. The reversal could be eliminated as indicated in Figure ES-5; however, eliminating the reversal would not solve the issues with the downstream shallow slopes.

Alternative B would include constructing dedicated screening and grit facilities for flows from the Missouri Avenue Diversion Structure. The depth of the pipeline from the diversion structure (approximately 16 feet) and the fact that there would be additional headloss through the grit system would require that a pump station be constructed to lift the flow to near grade level. The cost of this pump station along with the cost of the screening and grit facilities would be several million dollars.

Alternative C would include constructing two (one standby) dedicated horizontal grit chambers. The grit chambers would have to be located at the elevation of the



PN 163509
MISSOURI AVENUE
PIPELINE MODIFICATIONS

FIGURE ES-5



pipeline (approximately 16 feet below grade). Grit chambers 2.5 feet wide and 90 feet long would be required in order to settle grit similar in size to the proposed WPF and HRT grit facilities. The grit chambers would need to be enclosed in a building and provided with odor control in order to prevent offsite odors. The cost of this grit chamber, building, and odor control would be several million dollars.

Alternative D provides for the periodic cleaning of the pipeline from the Missouri Avenue Diversion Structure. Preliminary quotes indicate that the cost of an initial cleaning for the line would be approximately \$16,400 not including disposal. The cost of disposal of the grit is approximately \$10,000. Subsequent cleaning of the line every one to two years would cost approximately \$8,000.

Periodic cleaning of the Missouri Avenue pipeline on a biannual basis is recommended given the high cost of constructing the other alternatives.

2.0 Purpose of Study

The purpose of this memorandum is to document an assessment of screening and grit removal improvements for both the existing WPF and future HRT facilities including combined and separate improvements for the WPF and HRT. Supplemental screening and grit removal facilities for flows to the WPF from the Missouri Avenue Diversion Structure were also considered. The objectives of this assessment included:

- Identification of possible screening technology alternatives for flows to the WPF.
- Identification of possible screening technology alternatives for flows to the future HRT facility.
- Identification of possible grit removal technology alternatives for flows to the WPF, considering improvements to existing facilities as well as replacement of existing facilities.
- Identification of possible grit removal technology alternatives for flow to the future HRT facility.
- Evaluation of providing dedicated screening and grit facilities for flows from the Missouri Avenue Diversion Structure.

- Evaluation of modifications to the line from the Missouri Avenue Diversion Structure to the In-plant Influent Pump Station and cleaning options to improve flushing and reduce grit accumulation.
- Development of conceptual level capital and operational costs to allow a present worth comparison of screening and grit removal alternatives.

The evaluation included flow impacts from the Combined Sewer Overflow (CSO) Program improvements. Separate wet and dry weather screening and grit removal facilities as well as combined wet/dry weather screening and grit facilities were considered. A preliminary evaluation of the hydraulics of the recommended alternative indicates that there is sufficient hydraulic head available provided improvements are made to the Whitehead and In-plant Influent Pump Stations. Hydraulic impacts of the recommended improvements will be discussed in the future technical memorandum (TM) TM-WW-7 – Hydraulic Analysis and Effluent Pump Station.

3.0 Overview of Existing System

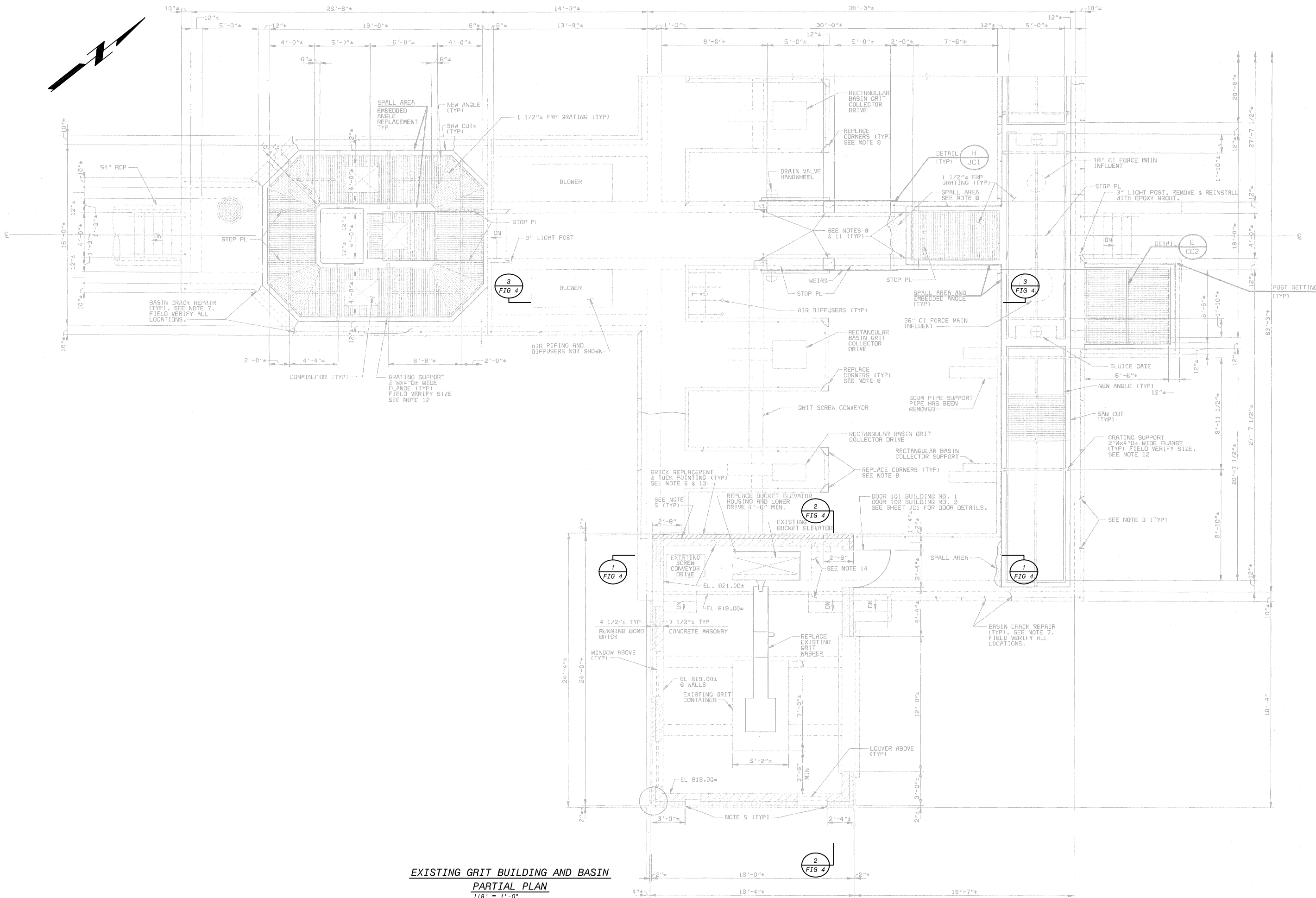
The WPF has two existing aerated grit basins constructed in 1965 as shown in Figures 1 and 2. Each basin is approximately 30 feet by 30 feet by 17 feet deep. City staff expressed several concerns about the existing grit basins including significant operation and maintenance costs of approximately \$17,000 per year for replacement parts and \$24,000 per year for labor. The existing in-basin equipment (including screw conveyor and bucket elevator) is over 20 years old. When repairs are needed, one basin must be taken out of service to repair the equipment. With one basin out of service, there is additional grit load to the primary clarifiers and subsequently to the anaerobic digesters. The vendor for the grit basin equipment is no longer in business and thus many replacement parts have to be specially fabricated at an increased cost. In addition, the grit handling facilities for each grit basin are not consolidated in one place, which has increased labor and repair costs. The basins themselves are not optimally configured for good grit separation since they are more square than rectangular in shape. A partial plan and sections of the existing grit basins are presented in Figures 3 and 4.



Figure 1 – Existing Aerated Grit Basin with Lowered Liquid Level



Figure 2 – Grit Basin (Center) and Grit Handling Superstructure (Looking North)



EXISTING GRIT BUILDING AND BASIN
PARTIAL PLAN
1/8" = 1'-0"

ST. JOSEPH, MISSOURI		FACILITIES PLAN		EXISTING GRIT BASIN PARTIAL PLAN	
DESIGNED: RCB		PROJECT NO.		163509	
DETAILED: JKS		FIG 3		SHEET OF	
CHECKED:		DATE:			
APPROVED:		PROJECT NO.		163509	
DATE:		FIG 3		SHEET OF	
REVISIONS AND RECORD OF ISSUE		NO. BY CK		DATE	
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DWG VER #: 1.3		XREF5 ID:		XREF6 ID:	
PLOTTER: GLA10863, 12/7/2009 9:13:18 AM		XREF7 ID:		XREF8 ID:	
USER: GLA10863		XREF9 ID:		XREF10 ID:	

4.0 Design Criteria

4.1 Design Hydraulic Capacity

Although a final location has not been established, it is anticipated that the HRT facilities will be located near the WPF. Therefore hydraulic capacities of screening and grit facilities need to consider flows that continue on to both the WPF and the HRT to achieve the objectives of the Phase IA CSO Long Term Control Plan (LTCP) improvements. The Phase IA improvements are proposed to provide an annual wet weather percent capture of approximately 60 percent by sending a combined 88 mgd through the headworks of the WPF and proposed HRT. The Phase IA CSO improvements include increasing the Whitehead Pump Station capacity to 80 mgd. Flows from the Whitehead Pump Station will be conveyed to the existing WPF site. Another 8 mgd of flow to the WPF will come from the Missouri Avenue Diversion Structure through the In-plant Influent Pump Station. The WPF is rated to treat a maximum flow of 27 mgd through primary treatment. Therefore, the remaining 61 mgd of flow will be treated with the future HRT. The combined screenings and grit facilities will be designed to handle the total 88 mgd. Figure 5 presents a schematic of the proposed improvements and projected flows.

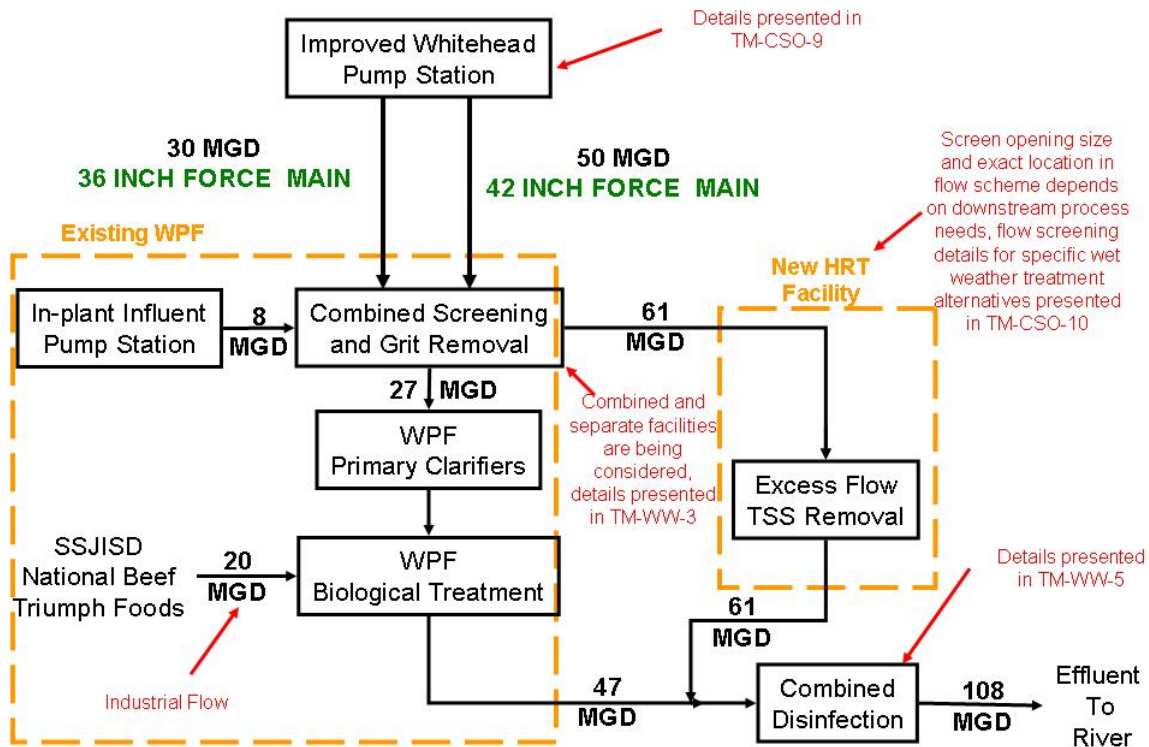


Figure 5 – Wet Weather Treatment Flow Schematic for Phase IA

Detailed descriptions of the flows indicated in Figure 5 are included in several other technical memorandums including TM-CSO-10 – Wet Weather Treatment Facilities and TM-CSO-11/TM-WW-5 – Disinfection Facilities.

4.1.1 Combined Screening and Grit Removal Facility

As presented in Figure 6, a combined screening and grit removal facility using a single treatment configuration for flow to the WPF and HRT was evaluated for this technical memorandum. With maximum design flows of 27 mgd and 61 mgd to the WPF and HRT, respectively, the combined screening and grit removal facility would have a maximum design capacity of 88 mgd.

An advantage of combined screening and grit removal is that the peak WPF and HRT flows undergo grit removal at the same facility. Therefore, the combined configuration provides greater flexibility to handle variations in flow rates from either the WPF or HRT if required during operation. This approach is the easiest to operate and

maintain since it requires only one point for grit handling and provides the most efficient use of space.

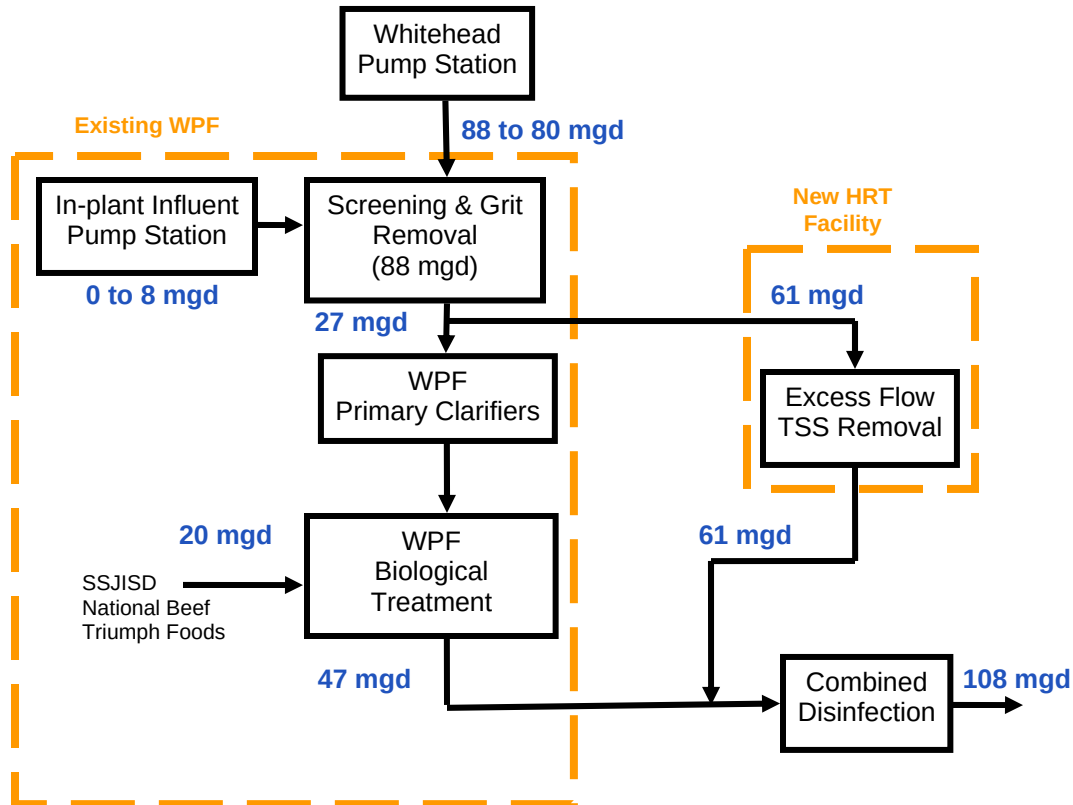


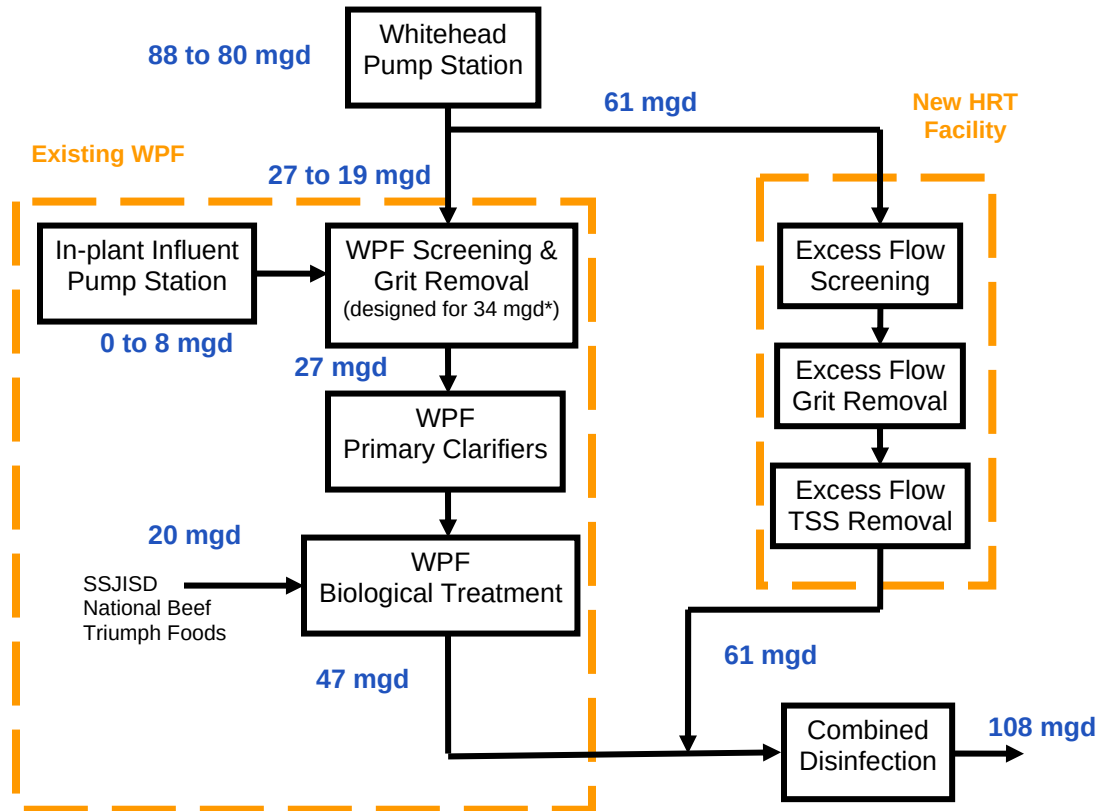
Figure 6 – Combined Screening and Grit Removal Facility

4.1.2 Separate Screening and Grit Removal Facilities

Figure 7 provides a schematic for separate WPF and HRT screening and grit removal facilities. In this configuration, the WPF and the HRT facilities each have their own dedicated headworks facility, independent from one another.

Separate facilities would require additional capacity to provide the same level of redundancy as is provided in a combined screening and grit removal facility (i.e., a combined screening and grit facility allows flows to be modulated between the WPF and HRT to achieve a maximum total screenings and grit removal capacity of 88 mgd, the separate facility does not). To address the reduced flexibility of separate facilities, the WPF screening and grit removal facility was sized for 34 mgd instead of 27 mgd to add

flexibility back to the system. Figure 7 reflects this condition at the WPF grit removal facility.



***Note:** The WPF screening and grit removal facility is being oversized to provide flexibility lost due to the screening and grit removal facilities being kept as separate facilities.

Figure 7 – Separate Screening and Grit Removal Facility

4.2 Design Screenings Loads

Screen openings of ½ inch were used to develop screen equipment costs for this memorandum. Since the existing plant and pump stations only have coarse screens (1-1/2 inch spacing), existing screenings data are not entirely applicable to the new screening facilities. Therefore, screening quantities were developed from the Design of Municipal Wastewater Treatment Plants (MOP 8), 4th Edition. Table 9.2 of MOP 8 provides a listing of screening and grit quantities for several locations around the United States. An average of the “combined systems” screenings results in 2.05 cubic feet per million gallons. MOP 8 also provides quantities of screenings based on opening size in

Figure 9.7 for separated sewer systems. For ½ inch screen opening, the figure indicates an average quantity of 7.5 cubic feet per million gallons and a maximum of approximately 15 cubic feet per million gallons. Table 9.3 in MOP 8 provides average quantities of screenings based on combined sewers of 0.47 to 11.26 cubic feet per million gallons. Based on these values and the existing upstream screens, a design value of 7.5 cubic feet per million gallons was used to determine the quantity of screenings from the proposed facilities. As noted in Table 9.3 of MOP 8, short duration wet weather events can lead to significantly higher volumes of screenings.

Densities for screenings were obtained from MOP 8 and range from 40 to 70 pounds per cubic foot for un-compacted screenings and a solids content of 10 to 20 percent. Table 1 provides estimated daily and yearly un-compacted screenings quantities for the ½ inch opening size.

Table 1			
Screenings Capture (un-compacted)			
Flow	Cubic Feet/Day	Tons/Day	Tons/Year
17 mgd Ave WPF	128	4.5	1,629
34 mgd Max WPF	255	8.9	Not Applicable
61 mgd Max HRT	458 ¹	16.0 ¹	488 ²
1. Quantities per day based on a day long wet weather event of 61 million gallons. A “wet weather day” does not imply that the WPF and HRT operated continuously at peak capacity for an entire day. Most rain events are shorter than a day in duration and therefore would not cause the WPF or the HRT to have a daily average equal to their maximum capacity of 27 mgd and 61 mgd, respectively. The volumes presented above are based on data acquired from modeling and historical WPF flows. 2. Tonnage per year based on total wet weather flow per year of 1,860 million gallons (from TM-CSO-10 – Wet Weather Treatment Facilities). 1,310 MG through HRT and 550 MG through the WPF.			

It is recommended that the screenings be washed and compacted to minimize the amount of putrescible material, minimize odors, and maximize density (reduce volume and weight hauled to the landfill). MOP 8 indicates that compactors can reduce water content by 50 percent and can reduce volume by a ratio of 6.5 to 1. Information obtained by screening equipment manufacturers indicates a capability to dewater screenings up to 50 percent solids content and a 4 to 1 compaction ratio. A 20 percent un-compacted, 40 percent compacted solids content and 4 to 1 compaction ratio was used to determine the volume and weight of screenings that will be hauled to and disposed of at the landfill.

Applying these reduction factors to the screenings quantities resulted in the volumes and tonnages listed in Table 2.

Table 2			
Screenings Capture (compacted)			
Flow	Cubic Feet/Day	Tons/Day	Tons/Year
17 mgd Ave WPF	32	2.2	814
34 mgd Max WPF	64	4.5	Not Applicable
61 mgd Max HRT	114 ¹	8.0 ¹	244 ²
1. Quantities per day based on a day long wet weather event of 61 million gallons. A “wet weather day” does not imply that the WPF and HRT operated continuously at peak capacity for an entire day. Most rain events are shorter than a day in duration and therefore would not cause the WPF or the HRT to have a daily average equal to their maximum capacity of 27 mgd and 61 mgd, respectively. The volumes presented above are based on data acquired from modeling and historical WPF flows. 2. Tonnage per year based on total wet weather flow per year of 1,860 million gallons (from TM-CSO-10 – Wet Weather Treatment Facilities). 1,310 MG through HRT and 550 MG through the WPF.			

4.3 Design Grit Loads

Table 3 provides an estimate of the monthly grit capture in the WPF’s existing aerated grit basins.

Table 3						
Monthly Grit Capture in 2007 and 2008						
Month	2007			2008		
	Grit, cu ft ¹	Headworks Flow, MG/month ²	Grit, cu ft/MG	Grit, cu ft ¹	Headworks Flow, MG/month ²	Grit, cu ft/MG
January	640	471	1.36	1,120	651	1.72
February	800	453	1.77	880	668	1.32
March	1,120	551	2.03	1,360	803	1.69
April	1,120	607	1.84	2,240	800	2.80
May	1,920	720	2.67	3,200	834	3.84
June	1,680	530	3.17	960	838	1.15
July	560	388	1.44	3,440	711	4.84
August	1,440	468	3.07	640	515	1.24
September	640	429	1.49	1,840	649	2.84
October	1,680	553	3.04	1,360	631	2.16
November	240	415	0.58	960	590	1.63
December	1,200	556	2.16	1,120	-- ³	--
Annual	13,040	6,140	2.12	19,120	7,689	2.34

Table 3						
Monthly Grit Capture in 2007 and 2008						
Month	2007			2008		
	Grit, cu ft ¹	Headworks Flow, MG/month ²	Grit, cu ft/MG	Grit, cu ft ¹	Headworks Flow, MG/month ²	Grit, cu ft/MG
1. Grit quantities calculated by multiplying the City provided number of dumpsters hauled by 80 cu ft/dumpster.						
2. Headworks flow data provided by the City (based on sum of average daily flow for all the days in a given month).						
3. The symbol "--" indicates data not available or unable to be determined.						

The quantities of grit from the existing aerated grit basins shown in Table 3 appear low when compared to values from MOP 8, 4th Edition. Table 9.2 of MOP 8 provides a listing of screening and grit quantities for several locations around the United States. An average of the “combined systems” grit results in 3.99 cubic feet per million gallons. Table 9.12 of MOP 8 gives a range for combined systems of 0.53 to 24.07 cubic feet per million gallons. Based on the MOP 8 information and the existing plant data, a design value of 3.99 cubic feet per million gallons was used for grit quantity calculations. This value represents a grit that has not been washed or dewatered.

Table 4 provides estimated daily and yearly unwashed grit quantities based on the values from MOP 8.

Table 4			
Grit Capture (unwashed)			
Flow	Cubic Feet/Day	Tons/Day	Tons/Year
17 mgd Ave WPF	68	2.7	991
34 mgd Max WPF	136	5.4	Not Applicable
61 mgd Max HRT	243 ¹	9.7 ¹	297 ²
1. Quantities per day based on a day long wet weather event of 61 million gallons. A “wet weather day” does not imply that the WPF and HRT operated continuously at peak capacity for an entire day. Most rain events are shorter than a day in duration and therefore would not cause the WPF or the HRT to have a daily average equal to their maximum capacity of 27 mgd and 61 mgd, respectively. The volumes presented above are based on data acquired from modeling and historical WPF flows.			
2. Tonnage per year based on total wet weather flow per year of 1,860 million gallons (from TM-CSO-10 – Wet Weather Treatment Facilities). 1,310 MG through HRT and 550 MG through the WPF.			

It is recommended that the grit be dewatered to reduce the amount of putrescible material, minimize odors, and maximize density (reduce volume and weight hauled to and disposed of at the landfill). MOP 8 indicates that the solids content of unwashed grit

varies greatly from 35 to 80 percent solids and a washed and dewatered grit should obtain a solids content of 70 to 80 percent. MOP 8 also indicates that a dewatered grit should have a density of between 90 to 100 pounds per cubic foot. Based on the MOP 8 information, an increase in solids content of 30 to 70 percent and a dewatered density of 100 pounds per cubic foot were used for grit quantity calculations. These reduction factors were applied to the unwashed grit quantities resulting in the volumes and tonnages presented in Table 5.

Table 5			
Grit Capture (washed and dewatered)			
Flow	Cubic Feet/Day	Tons/Day	Tons/Year
17 mgd Ave WPF	21	1.2	425
34 mgd Max WPF	42	2.3	Not Applicable
61 mgd Max HRT	76 ¹	4.2 ¹	127 ²
1. Quantities per day based on a day long wet weather event of 61 million gallons. A “wet weather day” does not imply that the WPF and HRT operated continuously at peak capacity for an entire day. Most rain events are shorter than a day in duration and therefore would not cause the WPF or the HRT to have a daily average equal to their maximum capacity of 27 mgd and 61 mgd, respectively. The volumes presented above are based on data acquired from modeling and historical WPF flows. 2. Tonnage per year based on total wet weather flow per year of 1,860 million gallons (from TM-CSO-10 – Wet Weather Treatment Facilities). 1,310 MG through HRT and 550 MG through the WPF. 3. Calculations assume an unwashed grit density of 80 lbs per cubic foot.			

MOP 8 indicates that typical grit removal designs have included the removal of 95 percent of 65-mesh (0.008 inch) particles. Modern equipment is now capable of removing 75 percent of 100-mesh (0.006 inch) material. Estimates of the size of grit particles removed vary from manufacturer to manufacturer partially due to equipment differences and differences in testing methods. For the equipment being considered for the WPF and HRT, the differences in percents and size of particles removed is not significant based on the downstream processes.

5.0 Overview of Screening and Grit Processing Technologies

5.1 Screening Technologies

The screening technologies discussed in this technical memorandum apply only to the screening opening size required for downstream grit removal equipment (vortex,

Hydro International Eutek Headcell, or Hydro International Storm King and Grit King). The screens for this grit removal equipment can generally be bar screens with ½ inch openings between bars. More complicated and expensive screens (perforated screens, traveling screens, drums, specialty screens, etc.) are not required for the grit removal equipment. This section presents a discussion of bar screens only. In addition to bar screens ahead of the grit removal facilities, finer screens with approximately ¼ inch (6 mm) openings are required for some of the HRT technologies. Those screening technologies are addressed in TM-CSO-10 – Wet Weather Treatment Facilities.

5.1.1 Bar Media Screens

There are many more options for bar type media than for other types of screens such as perforated plate media. These options include the following:

- Front Cleaned Bar Racks – This is the most commonly used style of automatically cleaned bar screens. Conceptually it is very similar to a manually cleaned bar rack, except that the rake is mechanically driven. Screenings are raked from the bottom up the face of the screen. There are a wide variety of manufacturers of this type of screen. An example is pictured on Figure 8.
- Step Screens – The bar media on this type of screen has a stepped profile. One set of the bars remain stationary, while the bars between the stationary bars are mechanically oscillated to move screenings up the face of the screen. These screens are typically used where smaller opening size is critical (¼ inch or smaller). In a combined sewer system, this type of screen may collect more material than is necessary to remove. Grit may also be entrapped in the screen and cause binding and damage to the screens. Representative vendors include Hycor, WesTech, and Huber. An example is pictured on Figure 9.
- Rotating Drum Screens – In addition to perforated plate media, the drum on the style of screen illustrated on Figure 10 can also be manufactured with bar media or mesh media. One advantage to this style is that each screen has an integral screenings washer/compactor/conveyor system as

opposed to separate components that must generally be provided with other screening technologies. Representative vendors include Andritz, GLV/Eimco, Huber, Hycor, Lakeside, and Waste Tech.

- Specialty CSO Screens – Specialty CSO screens with bar media have combs that penetrate from the downstream side of the screen face which are driven back and forth to dislodge screenings and return them to the influent sewer feeding the main wastewater treatment plant. These types of screens include the Romag screen, which can be provided in either a vertical configuration for mounting on top of an overflow weir wall or in a horizontal configuration for mounting above a channel. A vertical installation is pictured on Figure 11. The CDS/Copa Mechanically Raked Bar Screen consists of shorter bar lengths than is typical for the Romag screen and is mounted horizontally in an upflow configuration with screenings returned to the influent channel below, as illustrated on Figure 12.



Figure 8 – Front Cleaned Bar Rack



Figure 9 – Step Screen

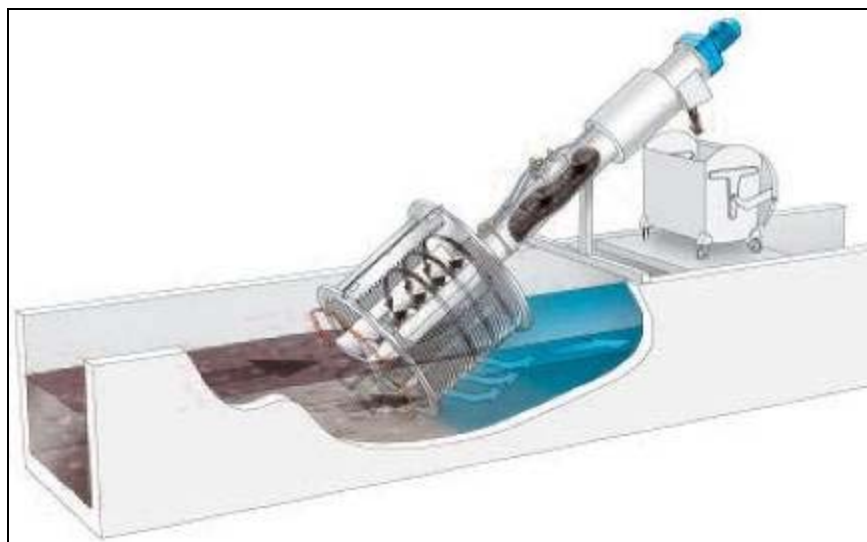


Figure 10 – Drum Screen



Source: <http://www.water-technology.net/contractors/stormwater/romag/>

Figure 11 – Specialty CSO Bar Screen – Vertical Configuration

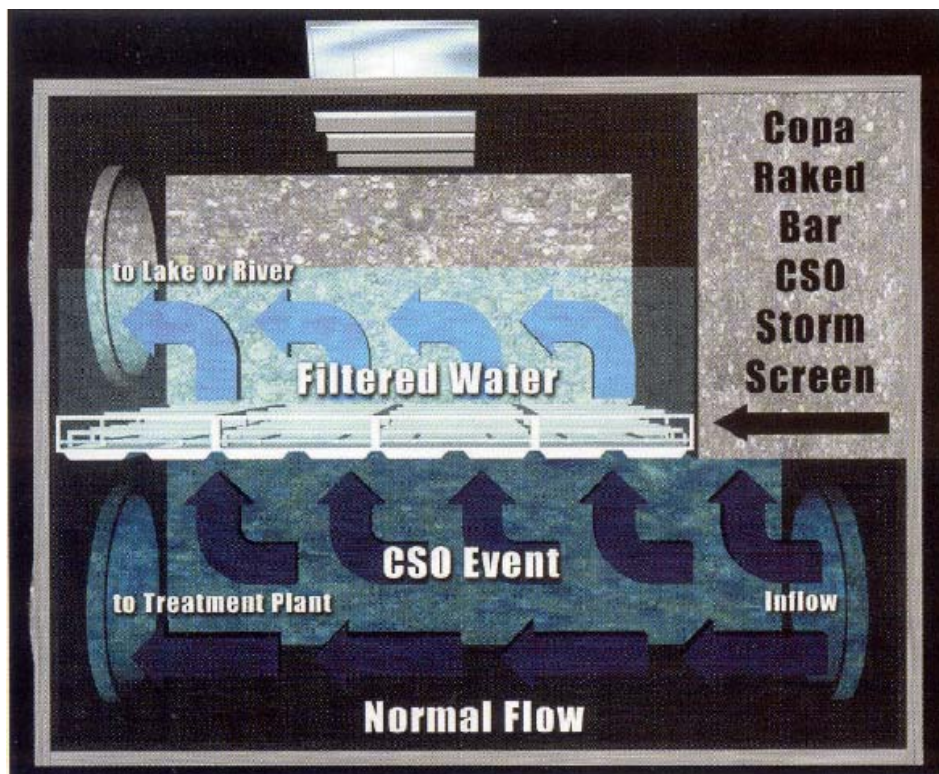


Figure 12 – Specialty CSO Bar Screen – Horizontal Configuration

Given the cost of various types of screens and the necessity to only provide a ½ inch opening for downstream grit removal equipment, the front cleaned bar rack screens are the most economical choice and were used to develop costs for the alternatives considered in this technical memorandum. JWC, Andritz, and Vulcan are common manufacturers of front cleaned bar rack screens.

Once the material is screened, it can be sent through a washing and dewatering unit to reduce the amount of putrescible material, minimize odors, and maximize density (reduce volume and weight hauled to the landfill). The screenings can be conveyed from the screens to the washing and dewatering units by screw conveyors, belt conveyors, or a sluice way. For this evaluation, a screw conveyor was used in order to provide a conservative opinion of costs. Final selection of conveying equipment will be determined during detailed design.

5.2 Grit Removal Technologies

Removing grit and heavy particles protects downstream processes, reduces maintenance, and reduces lost treatment volumes in digesters. Grit removal systems include processes to remove grit from the wastewater, dewater grit, and reduce disposal volume. The following sections provide descriptions of various grit removal technologies.

5.2.1 Aerated Grit Basins

Aerated grit basins use air, typically introduced along one side of a rectangular basin, to cause a spiral roll pattern perpendicular to the flow through the tank. Heavier particles drop to the bottom of the basin while lighter (organic) particles are suspended by the rolling pattern and are carried out of the basin. The rolling pattern caused by the air is independent of flow through the basin allowing aerated grit basins to work over a wide range of flows. Heavier particles that settle to the bottom of the basin are collected into a grit trough or hopper and are then removed by chain and bucket collectors, screw augers, clamshell buckets, or pumps. Power consumption is greater than for other types of grit removal systems. Significant amounts of volatile organics and odors may be released from the wastewater in an aerated grit basin.

Due to problems associated with aerated grit basins, including many encountered with the existing aerated grit basins in St. Joseph, they were not evaluated in the cost comparison performed for this technical memorandum.

5.2.2 Vortex Degritters

Vortex type degritters (Figure 13) use radial flow around a cone shaped basin to separate grit from lighter organic material. Grit settles into a bottom hopper for storage and removal while an impeller or baffle system keeps light organics in suspension. Stored grit is fluidized and removed on a periodic basis by grit pumps and pumped to a grit classifier for concentrating, washing, and disposal.

Vortex type grit removal systems are available from numerous manufacturers including Jones & Atwood, Smith & Loveless, and WesTech. Construction drawings and specifications can be standardized to allow multiple manufacturers to competitively bid. Design data and budget pricing used in this evaluation were obtained for the Smith & Loveless PISTA units.

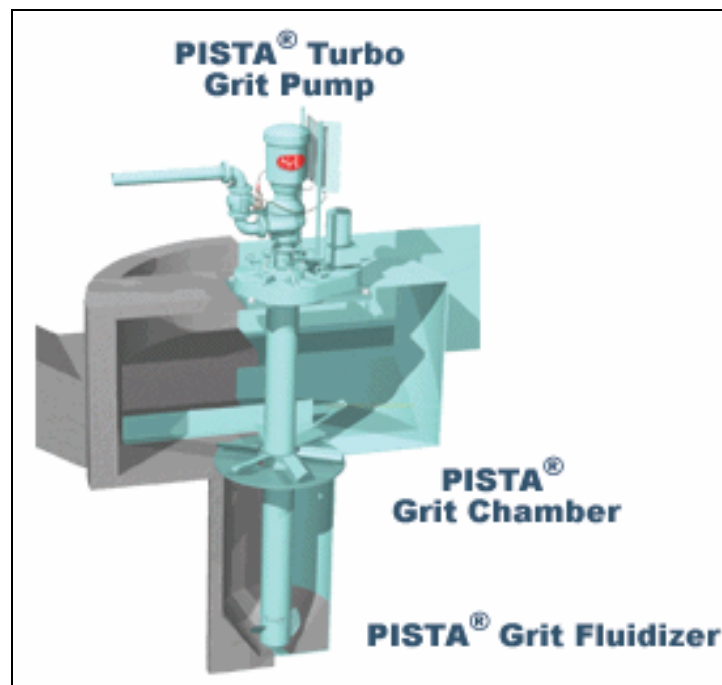


Figure 13 – Smith & Loveless PISTA

5.2.3 *Hydro International Eutek Headcell*

The Hydro International Eutek Headcell (Figure 14) is a proprietary grit removal system that also uses a vortex flow pattern to separate and remove grit from organic particles. The Eutek Headcell concept distributes influent flow into multiple stacked conical trays where grit only has to settle a short distance to be isolated from the main flow and be removed. As with the traditional vortex degritters, grit settles into a bottom hopper for storage and removal. Stored grit is fluidized and removed on a periodic or continuous basis by grit pumps and pumped to a grit classifier for concentrating, washing, and disposal. The Eutek Headcell is proprietary and can not be competitively bid with other types of grit removal systems. Design data and budget pricing were obtained from Hydro International for the Eutek Headcell alternatives evaluated in this memorandum.

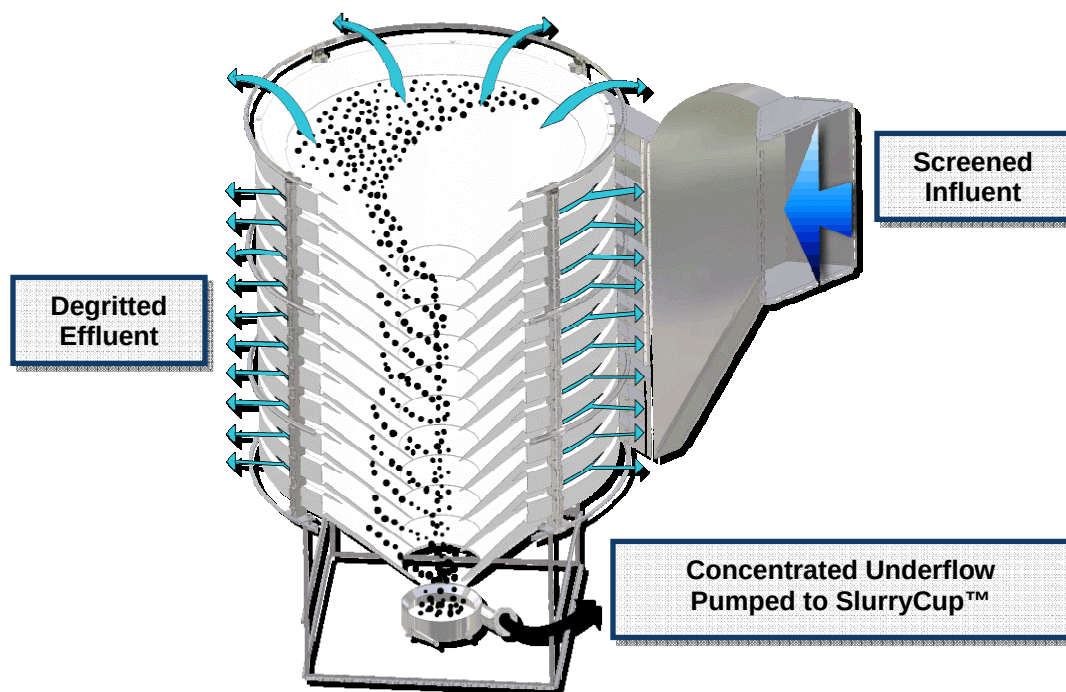


Figure 14 – Hydro International Eutek Headcell

5.2.4 *Hydro International Storm King and Grit King*

The Hydro International Storm King and Grit King is a proprietary two-stage grit separator system recommended by Hydro International for treatment of wet weather flow. The Storm King is a vortex separation chamber as indicated in Figure 15. Flow is introduced into the Storm King through a tangentially positioned inlet causing a rotational flow path around the dip plate. Flow spirals down the wall of the basin and solids settle out by gravitational and rotational forces as indicated in Figure 16 (red arrow). Settled solids collect in the base as the center cone directs flow up and around the center shaft into the inside of the dip plate cylinder (blue arrow). The upward flow rotates at a slower velocity than the outer downward flow. The resulting “shear” zone scrubs out the finer particles. The flow passes down through the Swirl-Cleanse screen which captures floatables and neutrally buoyant material. An air regulated siphon provides a backwash mechanism to prevent the screen from blinding. Screened effluent is discharged from the unit as indicated by the light blue arrow in Figure 16. The collected screenings and settleable solids are pumped to a Grit King for further processing. Design data and budget pricing were obtained from Hydro International for the Storm King and Grit King alternatives evaluated in this memorandum.

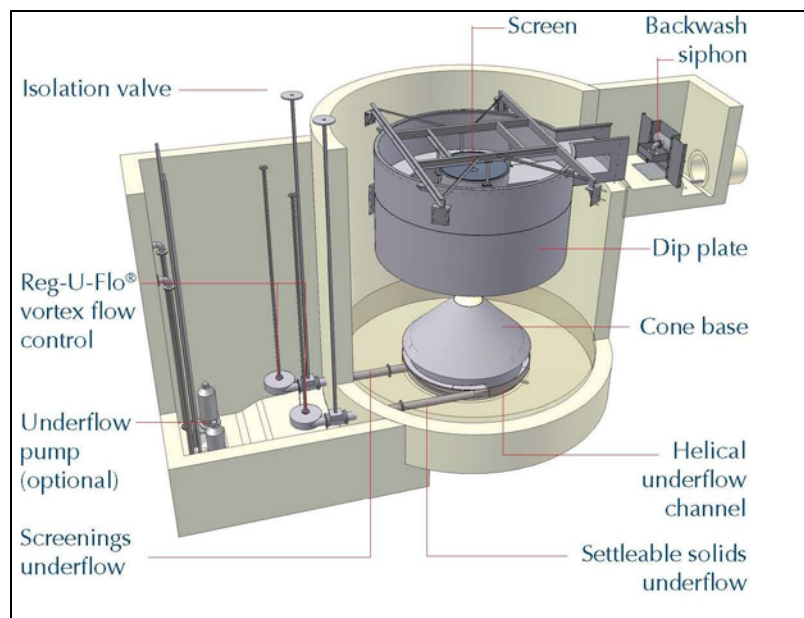


Figure 15 – Hydro International Storm King

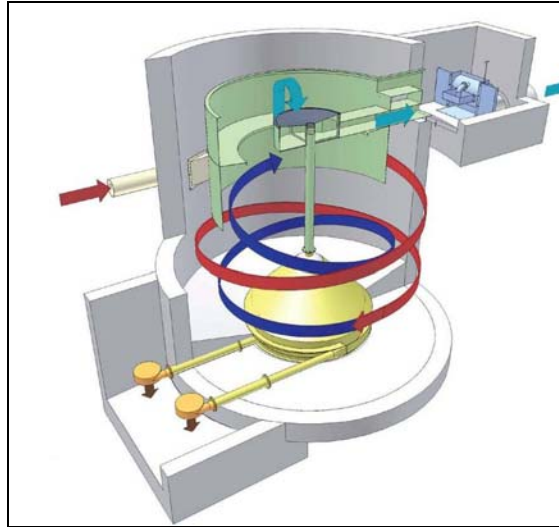


Figure 16 – Hydro International Storm King Flow Pattern

The Grit King is a hydrodynamic vortex separator designed to remove grit, sediment, and sand from liquids using vortex motion and boundary layer effects to aid gravitational settlement. Figure 17 shows a Grit King with the flow patterns indicated by the red and blue arrows. Grit pumps will be required to pump grit from the Storm King to the Grit King. The Grit King should be able to be elevated with grit dewatering equipment located underneath and should not require additional grit pumping.

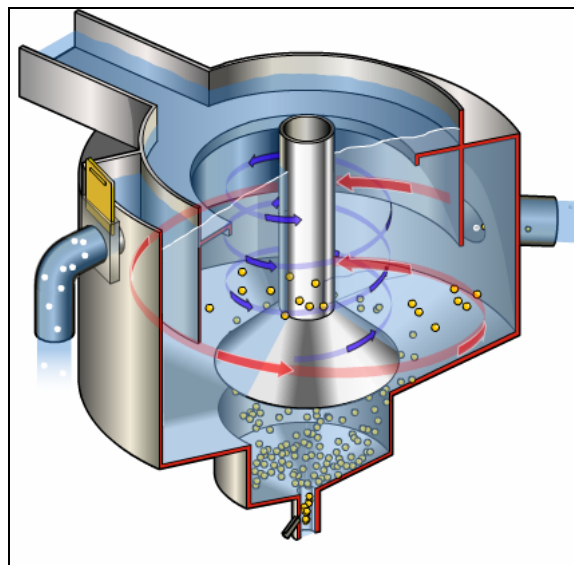


Figure 17 – Hydro International Grit King

Table 6 provides a comparison of grit technologies that were considered in the evaluation for this technical memorandum.

Table 6 Comparison of Grit Removal Systems			
Manufacturers and Models	Forced Vortex Jones & Attwood, Smith & Loveless, and WesTech	Hydraulic Vortex Hydro International Storm King and Grit King Dynamic Separator	Gravity Separation Hydro International Eutek Headcell Grit Removal System
Headloss ¹	6 to 18 inches ²	45 inches through Storm King, 8 inches through Grit King	12 inches ³
Advantages	• Low head loss • Multiple manufacturers for competitive bidding • Can use “fluidizing vanes” instead of flushing water (Smith & Loveless only) • Less expensive equipment	• Hydraulic designs with no submerged moving parts • No power required • No flushing water required for Storm King • Can include screening technology	• Small footprint • Hydraulic design with no submerged moving parts • No power required for settling trays
Disadvantages	• Motorized, submerged, moving parts • Larger footprint due to increased channel length requirements	• Significant headloss • Requires flushing / fluidizing water for Grit King • Proprietary • Larger footprint (Storm King) and structure costs due to large diameter	• Requires flushing / fluidizing water • Proprietary
1. Headloss values are from manufacturer data. Actual headloss depends on flow, channel design, and downstream water level. These items must be determined during detailed design. 2. Headloss includes basin and effluent control weir, but not influent and effluent channel losses. 3. Headloss does not include effluent weir losses.			

All three technologies presented in Table 6 offer benefits that were determined to merit further consideration in this evaluation.

5.2.5 Grit Processing

Grit material captured by the grit removal system can be sent either through a grit classifier or through a grit washer to further reduce the volume of the material. Besides

volume reduction, grit washers also provide the added benefit of washing organics from the grit. Organics that are not removed from grit are a source of odor. For this reason, grit washing is recommended prior to the grit being deposited in a dumpster for hauling to a landfill. A comparison of grit classifiers and grit washers is presented in Table 7. Both Hydro International and Smith & Loveless recommend washers and dewatering conveyors, and this equipment was included in the development of costs for the alternatives. Exact equipment used may change during detailed design of the facilities.

Table 7 Grit Separation and Classification Equipment		
Type	Grit Classifier	Grit Washer
Manufacturers	• Various	• Lakeside • Huber • WesTech • Hydro-International
Picture		
Advantages	• Dewateres grit from vortex basin using a concentrator and inclined screw • Concentrator separates grit hydraulically with no moving parts • Only motor required is for inclined screw	• Dewateres and washes grit using a stirrer and inclined screw (may be used with a concentrator) • Removes most organics that become trapped in captured grit – reduces odors • Well washed grit reduces volume/weight
Disadvantages	• Does not effectively remove odorous organics that become trapped in the captured grit	• Requires two motors • May require wash water • More expensive than classifiers

6.0 Development of Alternatives

All flow from the Whitehead and In-plant Influent Pump Stations requires screening and grit removal prior to treatment. Splitting flow from the Whitehead Pump Station between the WPF and the HRT facility can be done either before or after the flow has passed through the screening and grit removal facilities. Three combinations of screenings and grit facilities arrangements were considered:

- Alternative 1 – A combined screening and grit removal facility for flows to both the WPF and HRT. Combined facilities offer the advantage of lower costs and single point handling of screenings and grit.
- Alternative 2 – Separate screening and grit removal facilities for the WPF and HRT. Separate facilities offer the advantage of being able to utilize existing WPF facilities or WPF property.
- Alternative 3 – A combined screening facility for both the WPF and HRT, but separate grit removal facilities for each. This alternative offers the advantage of combining screening facilities while still utilizing some existing WPF facilities and property for grit removal.

Sub-alternatives were considered based on varying the location(s) of the facilities as well as different grit removal systems. Table 8 summarizes the alternatives and sub-alternatives considered. Figure 18 indicates possible locations for facilities that are discussed throughout the alternative development. The areas considered are north of the Administration Building, west of the WPF, and at or near the existing aerated grit basins. The final location of the screening and grit facilities will be determined during detailed design.

Table 8	
Screening and Grit Removal Alternatives	
Alternative Number	Description
1 – Combined Screening and Grit Removal Facility for WPF and HRT	
1A	Existing Grit Basin Upgrade and Screening for 88 mgd
1B	Existing Grit Basin Replacement and Screening for 88 mgd
1C	Screening and Grit Removal for 88 mgd



200' 100' 0 200' 400'
APPROX SCALE IN FEET



ST. JOSEPH, MISSOURI
FACILITIES PLAN
PN 163509
POSSIBLE SCREENING AND GRIT FACILITY
LOCATIONS
BLACK & VEATCH
DECEMBER 2009
FIGURE 18

Table 8	
Screening and Grit Removal Alternatives	
Alternative Number	Description
2 – Separate Screening and Grit Removal Facilities for WPF and HRT	
2A	Existing Grit Basin Upgrade, Screening for 34 mgd and Screening and Grit Removal for 61 mgd
2B	Existing Grit Basin Upgrade, Screening for 61 mgd and Screening and Grit Removal for 34 mgd
2C	Screening for 34 mgd, Grit Removal for 34 mgd, and Screening and Grit Removal for 61 mgd
3 – Combined Screening and Separate Grit Removal Facilities for WPF and HRT	
3A	Screening for 88 mgd, Grit Removal for 34 mgd, and Grit Removal for 61 mgd

As discussed in Section 5.0, the Hydro International Eutek Headcell, the Smith & Loveless PISTA, and the Hydro International Storm King and Grit King (for the 61 mgd wet weather option) were the grit removal technologies evaluated within each alternative.

6.1 Preliminary Screening of Alternatives

A preliminary screening meeting was held with the City on May 8, 2009 to solicit input about which alternatives merited further evaluation. With the exception of Alternative 3A, the alternatives listed in Table 8 were presented and discussed during this meeting. Alternative 3A was developed after the meeting as layouts were being developed. Combined screening and separated grit removal was determined to be an alternative that should be evaluated further since it offers the advantage of combined screening facilities while still utilizing existing facilities and existing City property for WPF grit removal. The following sections summarize the discussion and results of the screening meeting and additional evaluations.

6.1.1 Alternative 1A – Existing Grit Basin Upgrade and Screening for 88 mgd

Alternative 1A upgrades the existing grit basin and includes a screening facility located near the existing grit basins. This alternative was considered because it has the potential to maximize use of existing facilities. While the existing aerated grit basins have enough volume to achieve the necessary detention time recommended for grit

removal at 88 mgd, the square configuration of the existing basins is not conducive to efficient grit removal. A longer, horizontal basin is the preferred configuration for an aerated grit basin. With the existing basin configuration, baffling would be required to divide each basin into two parts (east to west baffle). The concrete bottom of each portion (four total) would have to be modified to provide a separate grit hopper and elevator for each portion or a clamshell would need to be added to remove the grit. In addition, the grit aeration system would need to be modified to provide air to each portion.

The City cites significant maintenance costs associated with the basins as discussed in Section 3.0. The existing screw conveyor and bucket elevator for grit removal from the basins require frequent maintenance/refurbishing and do not perform adequately. The basins would require retrofit of a clamshell or other technology in order to provide reliable grit removal capabilities. Flow is currently constricted at the comminutors downstream of the grit basins, and it is anticipated that significant hydraulic modifications would be required to upgrade the basins to process over three times the current peak flow.

Based on past performance issues, the City does not support an upgrade of the existing aerated grit system. No further evaluation of this alternative was considered.

6.1.2 Alternative 1B – Existing Grit Basin Replacement and Screening for 88 mgd

This alternative includes a screening and grit removal facility in the location of the existing grit basins. The advantages of providing a new, combined grit facility within the footprint of the existing aeration basins would include a single point of grit handling, a new technology with reduced maintenance costs as compared to the existing system, and maximization of site space availability. However, based on a preliminary layout of an 88 mgd facility, there is not sufficient space to fit the required facilities between the existing clarifiers and the access road to the primary digesters considering that three screens and three grit basins as well as screenings and grit handling would be required. Therefore, no further consideration was given to this alternative.

6.1.3 Alternative 1C – Screening and Grit Removal for 88 mgd

This alternative includes a screening and grit removal facility in an alternate location. Alternative 1C (Figure 19) offers several advantages including: a single point of screenings and grit handling, a new grit removal technology that has reduced maintenance costs as compared to the existing system, and simpler construction. Pumping from the Whitehead and In-plant Influent Pump Stations would need to be adjusted in order to accommodate an alternate flow location.

For the initial evaluation of this alternative, two alternate locations were considered (a siting study to determine the final location will be completed at a future date). One location is the property to the west of the existing plant (west of secondary clarifiers), and the other location is the property just to the north of the Administration Building. The property located west of the secondary clarifiers has several disadvantages. First, the property would have to be purchased whereas the property to the north of the Administration Building already belongs to the City and is currently vacant other than the existing 36 inch and 42 inch force mains and some minor piping. The existing piping is located such that the screening and grit facilities could easily be located on the property to the north of the Administration Building without having to relocate the existing piping. Secondly, if the facility was placed on the property to the west, a large diameter pipeline would be required to take flow to the facility and then another would be required to return plant flow to the head of the plant near the existing grit basins. These two large diameter pipelines would have to be placed in some of the most congested areas on the plant site with a considerable amount of existing piping that would require relocation. If the screening and grit facilities are located to the north, it would only take one pipeline to deliver flow to the HRT (south of the In-plant Influent Pump Station where most of the congestion is located). The conceptual hydraulic evaluation indicated that there is sufficient head available to place the facilities to the north of the Administration Building. However, if the facilities are placed on the west property, the additional headloss of the return pipe to the head of the plant is significant and could be an issue once the detailed design is finalized. For these reasons, the combined 88 mgd facility located on the property to the north of the Administration Building was considered for further evaluation of Alternative 1C.



200' 100' 0 200' 400'
APPROX SCALE IN FEET



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FACILITIES PLAN
PN 163509
ALTERNATIVE 1C
COMBINED SCREENING AND GRIT FACILITY

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DECEMBER 2009

FIGURE 19

Alternative 1C was divided into two alternatives. Alternative 1C-1 considered the use of vortex equipment (Smith & Loveless PISTA) and Alternative 1C-2 considered the use of Hydro International Eutek Headcell equipment. Figure 19 shows a general layout of Alternative 1C for either a Smith & Loveless PISTA or Hydro International Eutek Headcell grit facility.

6.1.4 Alternative 2A – Existing Grit Basin Upgrade, Screening for 34 mgd, and Screening and Grit Removal for 61 mgd

This alternative includes upgrading the existing aerated grit basins to process WPF flow (34 mgd), a screening facility for WPF flow (34 mgd) near the existing grit basins, and a screening and grit removal facility to process HRT flow (61 mgd) in an alternate location. For the reasons discussed in Section 6.1.1, the City does not wish to consider any alternative that requires the upgrade and reuse of the existing aerated grit basins. Therefore this alternative was not evaluated further.

6.1.5 Alternative 2B – Existing Grit Basin Upgrade, Screening for 61 mgd, and Screening and Grit Removal for 34 mgd

This alternative includes upgrading the existing aerated grit basins to process HRT flow (61 mgd), a screening facility to process HRT flow (61 mgd) near the existing grit basins, and a screening and grit removal facility to process WPF flow (34 mgd) in an alternate location. This alternative was initially proposed because aerated grit is a reasonable technology to remove grit from wet weather flows and would maximize re-use of existing facilities. However, as discussed in the previous section, the City does not wish to consider any alternative that requires the upgrade and reuse of the existing aerated grit basins as they have not performed well in the past. Adding screening facilities near the existing grit basins would be difficult because of limited space. This alternative was not evaluated further.

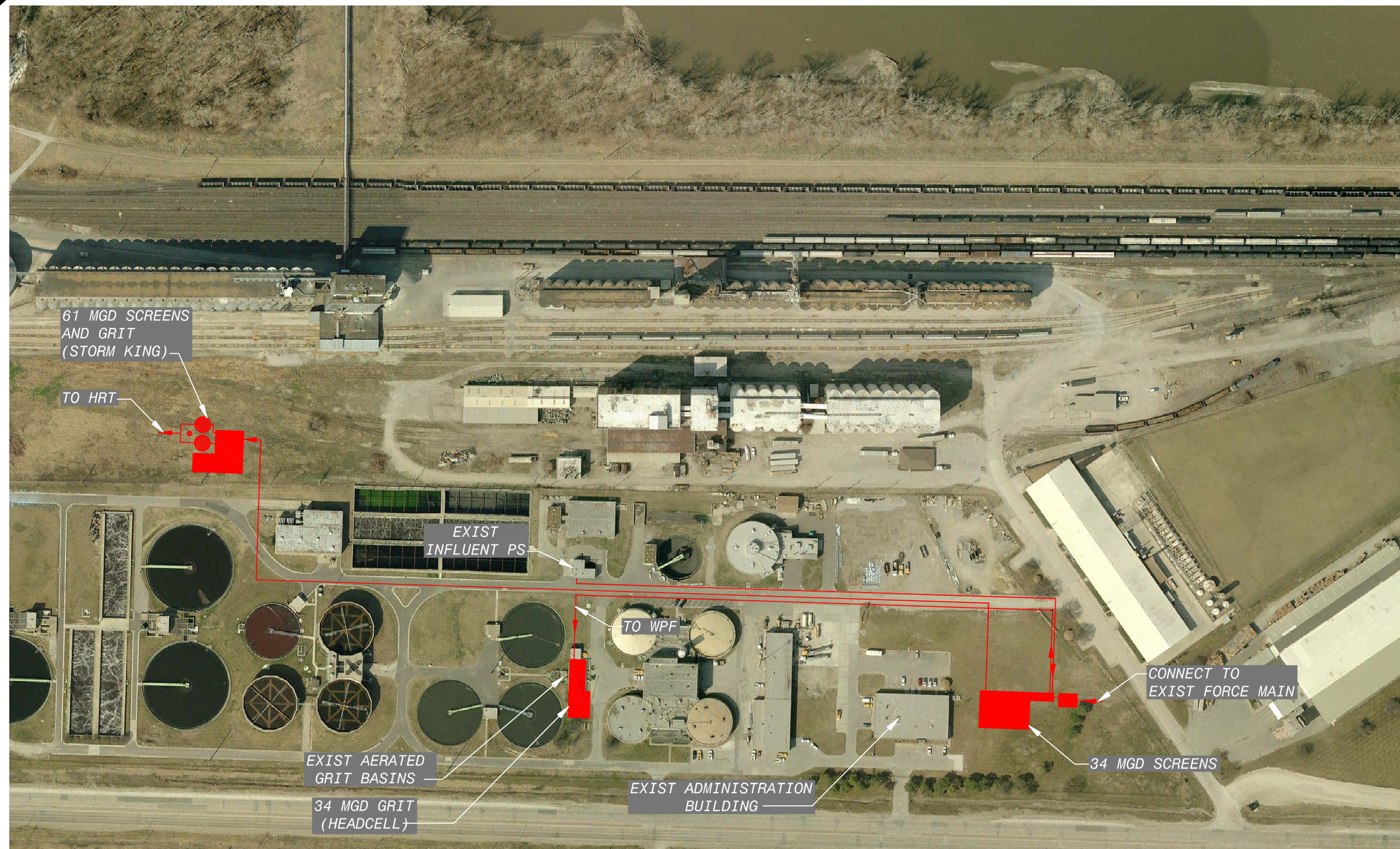
6.1.6 Alternative 2C – Screening for 34 mgd, Grit Removal for 34 mgd, and Screening and Grit Removal for 61 mgd

This alternative includes retro-fitting the existing aerated grit basins for WPF flow (34 mgd), a screening facility for WPF flow (34 mgd) near the existing grit basins or in an alternate location, and a screening and grit removal facility to process HRT flow (61 mgd) in an alternate location. Both Hydro International and Smith & Loveless were contacted regarding the possibility of fitting their grit removal equipment (34 mgd) within the existing grit basins. Hydro International was able to accomplish this by proposing four Eutek Headcell units (two for each of the existing grit basins). Smith & Loveless indicated that they could not fit their PISTA units within the existing grit basins. Pumping from the Whitehead and In-plant Influent Pump Stations would need to be adjusted in order to accommodate an alternate flow location.

As with all of the separate grit removal alternatives, this configuration introduces dual points of screening and grit handling and would require a greater footprint than any of the combined facility alternatives. Advantages of this alternative include utilization of the WPF site footprint of the existing grit facilities. Based on feedback from the City at the May 8, 2009 meeting, this alternative was evaluated further. The evaluation included the use of wet weather specific technologies, such as Hydro International Storm King and Grit King, for HRT flows. Several variations of this alternative were considered each similar to that shown in Figure 20.

One variation included Smith & Loveless PISTA units located near the existing grit basins. Screening facilities (34 mgd) would be located north of the Administration Building. HRT screening and grit removal (61 mgd) would be located on the property to the west of the WPF. Space near the existing grit basins would be very limited, especially for grit handling, but it could fit in the space with some temporary pumping and piping likely required during construction of the grit basins.

Another variation would be to use four Hydro International Eutek Headcell units in the existing grit basins (34 mgd plant flow) as indicated in Figure 21. As with the first variation, screening facilities (34 mgd) would be located north of the Administration Building and HRT screening and grit removal (61 mgd) would be located on the property to the west of the WPF.



200' 100' 0 200' 400'

APPROX SCALE IN FEET

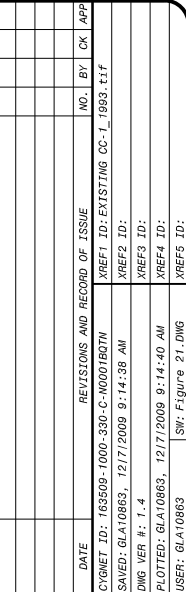


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FACILITIES PLAN

PN 163509
ALTERNATIVE 2C
SEPARATE WPF AND HRT FACILITIES

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FIGURE 20



EXISTING GRIT BASINS WITH EUTEK HEADCELL

DESIGNED: RCB
 DETAILED: JKS
 CHECKED:
 APPROVED:
 DATE:

PROJECT NO.

163509

FIG 21

SHEET
OF

EXISTING GRIT BASINS WITH EUTEK HEADCELL
1/4" = 1'-0"

A third variation would use screens and Smith & Loveless PISTA units located near the existing grit basins (34 mgd plant flow) and an HRT screening and grit removal facility (61 mgd) located on the property to the west of the WPF. It will be very difficult to locate both grit and screening facilities near the existing grit basins as the space is very limited.

The construction of a vortex grit removal facility near the existing grit basins will not be cost competitive with re-using the grit basins for the Eutek Headcell option. Therefore, the variation evaluated further was placing four Eutek Headcell units in the existing grit basins (34 mgd), locating screening facilities for the WPF to the north (34 mgd), and locating HRT screening and grit facilities (61 mgd) to the west.

Using the property to the west of the WPF for HRT screening and grit facilities will limit the ability to cost-effectively use the HRT screening and grit facility as a back-up for the WPF facilities since a pipeline will need to be constructed back to the existing grit basins. In addition, there is limited space to route this additional piping back to the existing grit basins. When using the property to the north, a connection could be made from the HRT pipeline to the WPF pipeline without having to construct another pipe in a congested area. Another concern is that the facility would have to be raised to accommodate the increased headloss back to the WPF. This would significantly increase the pumping cost for the Whitehead Pump Station for all flow conditions just to accommodate this backup arrangement.

6.1.7 Alternative 3A – Screening for 88 mgd, Grit Removal for 34 mgd, and Grit Removal for 61 mgd

This alternative includes screens to process the entire flow (88 mgd) at the north property, a grit removal facility to process HRT flow (61 mgd) at the north property, and a grit removal facility for WPF flow (34 mgd) at or near the existing aerated grit basins. This alternative was added as it has the advantage of combined screens while still allowing use of the existing grit basins (Eutek Headcell option) or space near the existing grit basins (vortex option). It would still require separate handling of grit (two locations), but all of the screenings and some of the grit would be concentrated at the screening and grit facility north of the Administration Building. Pumping from the Whitehead and In-

plant Influent Pump Stations would need to be adjusted in order to accommodate an alternate flow location. Figures 22 and 23 show these options (vortex or Eutek Headcell).

6.2 Summary of Screening and Grit Removal Alternatives for Further Evaluation

Table 9 lists screening and grit removal alternatives that were selected for further evaluation. Present worth was evaluated for each of these alternatives.

Table 9	
Alternatives for Further Evaluation	
Alternative Number	Description
1 – Combined Screening and Grit Removal Facility for WPF and HRT	
1C-1	Screening and Grit Removal for 88 mgd (Vortex)
1C-2	Screening and Grit Removal for 88 mgd (Eutek Headcell)
2 – Separate Screening and Grit Removal Facilities for WPF and HRT	
2C	Screening for 34 mgd, Grit Removal for 34 mgd, and Screening and Grit Removal for 61 mgd
3 – Combined Screening and Separate Grit Removal Facilities for WPF and HRT	
3A-1	Screening for 88 mgd, Grit Removal for 34 mgd, and Grit Removal for 61 mgd (Vortex)
3A-2	Screening for 88 mgd, Grit Removal for 34 mgd, and Grit Removal for 61 mgd (Eutek Headcell)

6.3 Selected Alternatives Descriptions

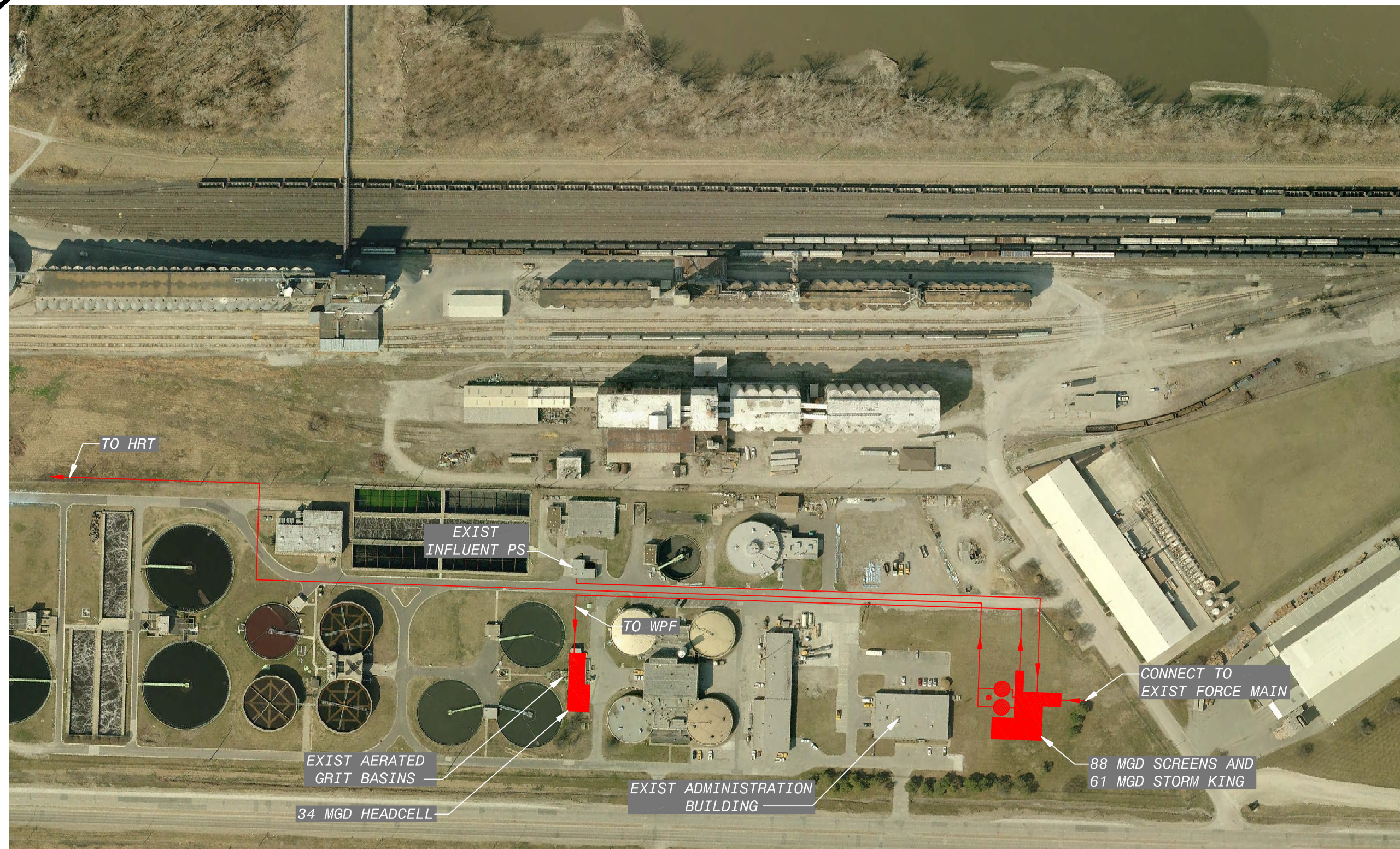
The following sections describe the alternatives selected for further evaluation. The number of units and capacity of units are preliminary and were selected for the purpose of comparing alternatives and developing costs. Detailed design may develop alternatives with different numbers and capacities of screening and grit units. The number of screens for each alternative includes one full standby unit (at peak hydraulic flow) in accordance with discussions with City staff. The number of grit removal units is based on providing capacity for the peak WPF or HRT flow with no standby.



200' 100' 0 200' 400'
APPROX SCALE IN FEET



ST. JOSEPH, MISSOURI
FACILITIES PLAN
PN 163509
ALTERNATIVE 3A-1
SCREENING FOR 88 MGD, GRIT REMOVAL FOR 34 MGD,
AND GRIT REMOVAL FOR 61 MGD - VORTEX
BLACK & VEATCH
DECEMBER 2009
FIGURE 22



200' 100' 0 200' 400'
APPROX SCALE IN FEET



ST. JOSEPH, MISSOURI
FACILITIES PLAN
PN 163509
ALTERNATIVE 3A-2
SCREENING FOR 88 MGD, GRIT REMOVAL FOR 34 MGD,
AND GRIT REMOVAL FOR 61 MGD - EUTEK HEADCELL
BLACK & VEATCH
DECEMBER 2009

FIGURE 23

6.3.1 Alternative 1C-1 – Screening and Grit Removal (Vortex) for 88 mgd

6.3.1.1 Design Criteria. Table 10 summarizes the preliminary design conditions for the proposed combined screenings and grit removal (vortex – Smith & Loveless PISTA) alternative located entirely at the property located north of the Administration Building. Peak and average flows were based on the design capacities of the WPF and the future HRT as described in Section 4.1.

Table 10	
Alternative 1C-1 (Vortex) – Design Criteria	
Peak Flow, mgd	88
Average Flow, mgd	17
Minimum Flow, mgd	10

6.3.1.2 Facility Sizing. The facility footprint located north of the Administration Building incorporates the area for the screens, screen washers and compactors, vortex units, grit pumps, grit washing and dewatering equipment, and screenings and grit container area. Vortex basin dimensions are based on recommendations from Smith & Loveless for their standard PISTA equipment. The building dimensions are based on previous projects where similar screens and grit removal equipment were designed for similar flow conditions. A brick and block building would cover the screens and screening and grit container area. The grit pumps would be located in a below-grade room at the same level as the bottom of the vortex units. The vortex units would be located outside and would be covered for odor control. A separate electrical room would be provided adjacent to the screening and grit container area. Table 11 presents preliminary process dimensions and equipment. The screening equipment provides firm capacity with two units and has one standby. The grit removal equipment provides the 88 mgd peak capacity with all three units operating. There is not a standby unit for grit removal due to the high cost of the equipment.

Table 11 Alternative 1C-1 (Vortex) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
Screens	
Number	3 (includes one standby)
Screen Opening, inches	½
Flow each, mgd	44
Channel Width, ft	6
Channel Depth, ft	13.5
Screenings Washer and Compactor	
Number	3
Screenings Conveyor	
Number	1
Vortex Units	
Number	3
Peak Flow Capacity Each, mgd	30
Unit Size Designation	30.0B
Upper Chamber Diameter, ft	18
Lower Chamber Diameter, ft	5
Depth (from top of structure to grit withdrawal), ft	16
Grit Pumps	
Number	3
Grit Concentrator and Dewatering Conveyor	
Number	3

This alternative requires wash water for the screens and grit facilities. Based on preliminary information from manufacturers, a maximum of 36 gpm wash water would be required for the three screens and 150 gpm flushing water would be required for the grit equipment. Smith & Loveless indicates that there are many PISTA systems in operation that have no flushing water and are operating satisfactory. However, they indicate a recent trend by owners to use flushing water for PISTA systems. Plant effluent water can be used for these requirements, and WPF staff indicate that this quantity of effluent water should be available although piping does not currently exist to the new facilities. Costs for the delivery of effluent water are not included in this technical memorandum. A detailed evaluation of process water needs and costs will be conducted

as a part of TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

6.3.1.3 Proposed Improvements. Figure 19 provides a general layout of the proposed screening and grit removal facilities. A flowmeter vault would be required to be constructed for the 36 inch and 42 inch force mains to replace the current facilities located near the existing grit basins. A flowmeter vault would also need to be constructed on the line to the WPF after the screens and grit removal. This flowmeter along with a modulating sluice gate would regulate the flow to the plant during wet weather events. Since all flow is passing through both the screens and the grit removal basins, the split in flow could be made in the grit facility effluent channel. The proposed facilities are shown in red on Figure 19. New structures would be constructed to house the components of the screens and grit removal equipment. This arrangement should be considered preliminary. Final location of these facilities will be determined once all land acquisition needs have been identified and detailed design is performed.

6.3.2 Alternative 1C-2 – Screening and Grit Removal (Eutek Headcell) for 88 mgd

6.3.2.1 Design Criteria. Table 12 summarizes the preliminary design conditions for the proposed combined screenings and grit removal (Hydro International Eutek Headcell) alternative located entirely at the property located north of the Administration Building. Peak and average flows were based on the design capacities of the WPF and the future HRT as described in Section 4.1.

Table 12	
Alternative 1C-2 (Eutek Headcell) – Design Criteria	
Peak Flow, mgd	88
Average Flow, mgd	17
Minimum Flow, mgd	10

6.3.2.2 Facility Sizing. The facility footprint located north of the Administration Building incorporates the area for the screens, screen washers and compactors, Eutek Headcell units, grit pumps, grit washing and dewatering equipment, and screenings and grit container area. Eutek Headcell basin dimensions are based on recommendations from Hydro International for their standard equipment. The building dimensions are based on previous projects where similar screens and grit removal equipment were designed for similar flow conditions. A brick and block building would cover the screens and screening and grit container area. The grit pumps would be located in a below-grade room at the same level as the bottom of the Eutek Headcell units. The Eutek Headcell units would be located outside and would be covered for odor control. A separate electrical room would be provided adjacent to the screening and grit container area. Table 13 presents preliminary process dimensions and equipment. The screening equipment provides firm capacity with two units and has one standby. The grit removal equipment provides the 88 mgd peak capacity with all three units operating. There is not a standby unit for grit removal due to the high cost of the equipment.

Table 13 Alternative 1C-2 (Eutek Headcell) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
Screens	
Number	3 (includes one standby)
Screen Opening, inches	½
Flow each, mgd	44
Channel Width, ft	6
Channel Depth, ft	13.5
Screenings Washer and Compactor	
Number	3
Screenings Conveyor	
Number	1
Eutek Headcell Units	
Number	3
Peak Flow Capacity Each, mgd	29.3
Diameter, ft	12
Number of Trays, each	10
Depth (from top of structure to grit withdrawal), ft	23

Table 13 Alternative 1C-2 (Eutek Headcell) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
Basin Size, ft	16 by 16
Grit Pumps	
Number	3
Slurry Cup and Grit Snail	
Number	3

This alternative requires wash water for the screens and grit facilities. Based on preliminary information from manufacturers, a maximum of 36 gpm wash water would be required for the three screens and 183 gpm flushing water would be required for the grit equipment. Plant effluent water can be used for these requirements, and WPF staff indicate that this quantity of effluent water should be available although piping does not currently exist to the new facilities. Costs for the delivery of effluent water are not included in this technical memorandum. A detailed evaluation of process water needs and costs will be conducted as a part of TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

6.3.2.3 Proposed Improvements. Figure 19 provides a general layout of the proposed screening and grit removal facilities. A flowmeter vault would be required to be constructed for the 36 inch and 42 inch force mains to replace the current facilities located near the existing grit basins. A flowmeter vault would also need to be constructed on the line to the WPF after the screens and grit removal. This flowmeter along with a modulating sluice gate would regulate the flow to the plant during wet weather events. Since all flow is passing through both the screens and the grit removal basins, the split in flow could be made in the grit facility effluent channel. The proposed facilities are shown in red on Figure 19. New structures would be constructed to house the components of the screens and grit removal equipment. This arrangement should be considered preliminary. Final location of these facilities will be determined once all land acquisition needs have been identified and final design is performed.

6.3.3 Alternative 2C – Screening for 34 mgd, Grit Removal (Eutek Headcell) for 34 mgd, and Screening and Grit Removal (Storm King / Grit King) for 61 mgd

6.3.3.1 Design Criteria. Table 14 summarizes the preliminary design conditions for the proposed separate screenings and grit removal (Hydro International Eutek Headcell, Storm King, and Grit King) alternative. A 34 mgd WPF screening facility would be located north of the Administration Building, and a 34 mgd WPF grit removal facility (Eutek Headcell) would be located in the existing aerated grit basins. The 61 mgd HRT screening and grit removal facility (Storm King and Grit King) would be located on the property to the west of the WPF. Peak and average flows are based on the design capacities of the WPF and the future HRT as described in Section 4.1.

Table 14 Alternative 2C (Eutek Headcell, Storm King, Grit King) – Design Criteria	
34 mgd WPF Screens (north)	
Peak Flow, mgd	34
Average Flow, mgd	17
Minimum Flow, mgd	10
34 mgd WPF Eutek Headcell (in existing grit basins)	
Peak Flow, mgd	34
Average Flow, mgd	17
Minimum Flow, mgd	10
61 mgd HRT Storm King and Grit King (west)	
Peak Flow, mgd	61

6.3.3.2 Facility Sizing. The facility footprint located north of the Administration Building incorporates the area for the screens, screen washers and compactors, and screenings container area. The facility footprint located at the existing grit basins includes Eutek Headcell units, grit pumps, grit washing and dewatering equipment, and grit container area. The facility footprint located west of the WPF incorporates the area required for screens, screen washers and compactors, Storm King and Grit King units, grit pumps, grit washing and dewatering equipment, and screenings and grit container area. Eutek Headcell, Storm King, and Grit King dimensions are based on

recommendations from Hydro International for their standard equipment. The building dimensions are based on previous projects where similar screens and grit removal equipment were designed for similar flow conditions. A brick and block building would cover the screens and screening and grit container area. The grit pumps would be located in a below-grade room at the same level as the bottom of the Eutek Headcell and Storm King units. The Eutek Headcell and Storm King units would be located outside and would be covered for odor control. The Grit King unit would be located inside near the screenings and grit container. Separate electrical rooms would be provided adjacent to the screening and grit container areas. Table 15 presents preliminary process dimensions and equipment. The screening equipment provides firm capacity with one standby unit for each location. The grit removal equipment provides the capacity at each location with all units operating. There is not a standby unit for grit removal due to the high cost of the equipment.

Table 15 Alternative 2C (Eutek Headcell, Storm King, Grit King) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
<i>North Facilities (WPF)</i>	
Screens	
Number	2 (includes one standby)
Screen Opening, inches	½
Flow each, mgd	34
Channel Width, ft	4.5
Channel Depth, ft	13
Screenings Washer and Compactor	
Number	2
Screenings Conveyor	
Number	1
<i>Facilities at Existing Grit Basins (WPF)</i>	
Eutek Headcell Units	
Number	4
Peak Flow Capacity Each, mgd	8.5
Diameter, ft	9
Number of Trays, each	5
Depth (from top of structure to grit withdrawal), ft	16
Basin Size, ft	13 by 13

Table 15 Alternative 2C (Eutek Headcell, Storm King, Grit King) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
Grit Pumps	
Number	4
Slurry Cup	
Number	4
Grit Snail	
Number	2
West Facilities (HRT)	
Screens	
Number	3 (including one standby)
Screen Opening, inches	½
Flow each, mgd	30.5
Channel Width, ft	4.5
Channel Depth, ft	12.5
Storm King	
Number	2
Peak Flow Capacity Each, mgd	30.5
Diameter, ft	28
Depth (from top of structure to grit withdrawal), ft	26
Grit Pumps	
Number	3
Grit King	
Number	1
Peak Flow Capacity Each, mgd	3
Diameter, ft	9
Depth (from top of structure to grit withdrawal), ft	12
Grit Concentrator and Dewatering Conveyor	
Number	1

This alternative requires wash water for the screens and grit facilities. Based on preliminary information from manufacturers, a maximum of 54 gpm wash water would be required for the three screens and 238 gpm flushing water would be required for the grit equipment. Plant effluent water can be used for these requirements, and WPF staff indicated that this quantity of effluent water should be available although piping does not currently exist to new facilities. Costs for the delivery of effluent water are not included

in this technical memorandum. A detailed evaluation of process water needs and costs will be conducted as a part of TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

6.3.3.3 Proposed Improvements. Figure 20 provides a general layout of the proposed screening and grit removal facilities. A flowmeter vault would be required to be constructed for the 36 inch and 42 inch force mains to replace the current facilities located near the existing grit basins. Since only the 34 mgd screening facility is located at the north facilities, a splitter box would be required immediately after the 36 inch and 42 inch flowmeters. A flowmeter vault would also need to be constructed on the pipeline to the 34 mgd screens immediately after the splitter box. This flowmeter along with a modulating sluice gate in the splitter box would regulate the flow to the 34 mgd screen and WPF during wet weather events. The proposed facilities are shown in red on Figure 20. New structures would be constructed to house the components of the screens and grit removal equipment at the three different locations. This arrangement should be considered preliminary. Final location of these facilities will be determined once all land acquisition needs have been identified and final design is performed.

6.3.4 Alternative 3A-1 – Screening for 88 mgd, Grit Removal (Vortex) for 34 mgd, and Grit Removal (Vortex) for 61 mgd

6.3.4.1 Design Criteria. Table 16 summarizes the preliminary design conditions for the proposed combined screens with separate grit removal (vortex – Smith & Loveless PISTA) alternative. All of the screens and 61 mgd (wet weather flow) of grit removal would be located at the property north of the Administration Building, and 34 mgd (WPF) of grit removal would be located near the existing grit basins. Peak and average flows are based on the design capacities of the WPF and the future HRT as described in Section 4.1.

Table 16	
Alternative 3A-1 (Vortex) – Design Criteria	
88 mgd WPF and HRT Screens (north)	
Peak Flow, mgd	88
Average Flow, mgd	17
Minimum Flow, mgd	10
61 mgd HRT Vortex (north)	
Peak Flow, mgd	61
34 mgd WPF Vortex (near existing grit basins)	
Peak Flow, mgd	34
Average Flow, mgd	17
Minimum Flow, mgd	10

6.3.4.2 Facility Sizing. The facility footprint located north of the Administration Building incorporates the area for the screens, screen washers and compactors, vortex units, grit pumps, grit washing and dewatering equipment, and screenings and grit container area. The area near the existing grit basins incorporates the area for vortex units, grit pumps, grit washing and dewatering equipment and grit container area. Vortex basin dimensions are based on recommendations from Smith & Loveless for their standard PISTA equipment. The building dimensions are based on previous projects where similar screens and grit removal equipment were designed for similar flow conditions. A brick and block building would cover the screens and screening and grit container area. The grit pumps would be located in a below-grade room at the same level as the bottom of the vortex units. The vortex units would be located outside and would be covered for odor control. A separate electrical room would be provided adjacent to the screening and grit container area. Table 17 presents preliminary process dimensions and equipment. The screening equipment provides firm capacity with two units and has one standby. The grit removal equipment provides the peak capacity at each location with all units operating. There is not a standby unit for grit removal due to the high cost of the equipment.

Table 17 Alternative 3A-1 (Vortex) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
<i>North Facilities</i>	
Screens (88 mgd WPF and HRT)	
Number	3 (includes one standby)
Screen Opening, inches	½
Flow each, mgd	44
Channel Width, ft	6
Channel Depth, ft	13.5
Screenings Washer and Compactor	
Number	3
Screenings Conveyor	
Number	1
Vortex Units (61 mgd HRT)	
Number	2
Peak Flow Capacity Each, mgd	30.5
Unit Size Designation	30.0B
Upper Chamber Diameter, ft	18
Lower Chamber Diameter, ft	5
Depth (from top of structure to grit withdrawal), ft	16
Grit Pumps	
Number	2
Grit Concentrator	
Number	2
Dewatering Conveyor	
Number	2
<i>Facilities Near Existing Grit Basins</i>	
Vortex Units (34 mgd WPF)	
Number	2
Peak Flow Capacity Each, mgd	17
Unit Size Designation	20.0B
Upper Chamber Diameter, ft	16
Lower Chamber Diameter, ft	5.0
Depth (from top of structure to grit withdrawal), ft	14.5
Grit Pumps	
Number	2
Grit Concentrator	
Number	2
Dewatering Conveyor	
Number	2

This alternative requires wash water for the screens and grit facilities. Based on preliminary information from manufacturers, a maximum of 54 gpm wash water would be required for the three screens and 200 gpm flushing water would be required for the grit equipment. Smith & Loveless indicates that there are many PISTA systems in operation that have no flushing water and are operating satisfactory. However, they indicate a recent trend by owners to use flushing water for PISTA systems. Plant effluent water can be used for these requirements, and WPF staff indicated that this quantity of effluent water should be available although piping does not currently exist to new facilities. Costs for the delivery of effluent water are not included in this technical memorandum. A detailed evaluation of process water needs and costs will be conducted as a part of TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

6.3.4.3 Proposed Improvements. Figure 22 provides a general layout of the proposed screening and grit removal facilities. A flowmeter vault would be required to be constructed for the 36 inch and 42 inch force mains to replace the current facilities located near the existing grit basins. A flowmeter vault would also need to be constructed on the line to the WPF after the screens and before the grit removal. This flowmeter along with a modulating sluice gate would regulate the flow to the plant during wet weather events. Since all flow is passing through the screens but not the north grit removal basins, the split in flow could be made in the screening facility effluent channel. The proposed facilities are shown in red on Figure 22. New structures would be constructed to house the components of the screens and grit removal equipment at two different locations. This arrangement should be considered preliminary. Final location of these facilities will be determined once all land acquisition needs have been identified and detailed design is performed.

6.3.5 Alternative 3A-2 – Screening for 88 mgd, Grit Removal (Eutek Headcell) for 34 mgd, and Grit Removal (Storm King / Grit King) for 61 mgd

6.3.5.1 Design Criteria. Table 18 summarizes the preliminary design conditions for the proposed combined screens with separate grit removal (Hydro International Eutek Headcell, Storm King, and Grit King) alternative. All of the screens and 61 mgd (wet weather flow) of grit removal (Storm King and Grit King) would be located north of the Administration Building, and 34 mgd (WPF) of grit removal (Eutek Headcell) would be located in the existing grit basins. Peak and average flows were based on the design capacities of the WPF and the future HRT as described in Section 4.1.

Table 18 Alternative 3A-2 (Eutek Headcell, Storm King, Grit King) – Design Criteria	
88 mgd WPF and HRT Screens (north)	
Peak Flow, mgd	88
Average Flow, mgd	17
Minimum Flow, mgd	10
61 mgd HRT Storm King and Grit King (north)	
Peak Flow, mgd	61
34 mgd WPF Eutek Headcell (in existing grit basins)	
Peak Flow, mgd	34
Average Flow, mgd	17
Minimum Flow, mgd	10

6.3.5.2 Facility Sizing. The facility footprint located north of the Administration Building incorporates the area for the screens, screen washers and compactors, Storm King and Grit King units, grit pumps, grit washing and dewatering equipment, and screenings and grit container area. The area in and near the existing grit basins incorporates the area for the Eutek Headcell units, grit pumps, grit washing and dewatering equipment, and grit container area. Eutek Headcell basin dimensions are based on recommendations from Hydro International for their standard equipment. The building dimensions are based on previous projects where similar screens and grit removal equipment were designed for similar flow conditions. A brick and block

building would cover the screens and screening and grit container area. The grit pumps would be located in a below-grade room at the same level as the bottom of the Eutek Headcell and Storm King units. The Eutek Headcell and Storm King units would be located outside and would be covered for odor control. The Grit King unit would be located inside near the screenings and grit container. A separate electrical room would be provided adjacent to the screening and grit container area. Table 19 presents preliminary process dimensions and equipment. The screening equipment provides firm capacity with one standby unit. The grit removal equipment provides the capacity at each location with all units operating. There is not a standby unit for grit removal due to the high cost of the equipment.

Table 19	
Alternative 3A-2 (Eutek Headcell, Storm King, Grit King) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
North Facilities	
Screens (88 mgd WPF and HRT)	
Number	3 (includes one standby)
Screen Opening, inches	½
Flow each, mgd	44
Channel Width, ft	6
Channel Depth, ft	13.5
Screenings Washer and Compactor	
Number	3
Screenings Conveyor	
Number	1
Storm King (61 mgd HRT)	
Number	2
Peak Flow Capacity Each, mgd	30.5
Diameter, ft	28
Depth (from top of structure to grit withdrawal), ft	26
Grit Pumps	
Number	3
Grit King	
Number	1
Peak Flow Capacity Each, mgd	3
Diameter, ft	9

Table 19 Alternative 3A-2 (Eutek Headcell, Storm King, Grit King) – Preliminary Process Dimensions and Equipment Sizing	
Parameter	Value
Depth (from top of structure to grit withdrawal), ft	12
Grit Concentrator and Dewatering Conveyor	
Number	1
<i>Facilities at Existing Grit Basins</i>	
Eutek Headcell Units (34 mgd WPF)	
Number	4
Peak Flow Capacity Each, mgd	8.5
Diameter, ft	9
Number of Trays, each	5
Depth (from top of structure to grit withdrawal), ft	16
Basin Size, ft	13 by 13
Grit Pumps	
Number	4
Slurry Cup	
Number	4
Grit Snail	
Number	2

This alternative requires wash water for the screens and grit facilities. Based on preliminary information from manufacturers, a maximum of 54 gpm wash water would be required for the three screens and 238 gpm flushing water would be required for the grit equipment. Plant effluent water can be used for these requirements, and WPF staff indicated that this quantity of effluent water should be available although piping does not currently exist to new facilities. Costs for the delivery of effluent water are not included in this technical memorandum. A detailed evaluation of process water needs will be conducted as a part of TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

6.3.5.3 Proposed Improvements. Figure 23 provides a general layout of the proposed screening and grit removal facilities. A flowmeter vault would be required to be constructed for the 36 inch and 42 inch force mains to replace the current facilities

located near the existing grit basins. A flowmeter vault would also need to be constructed on the line to the WPF after the screens and before the grit removal. This flowmeter along with a modulating sluice gate would regulate the flow to the plant during wet weather events. Since all flow is passing through the screens but not the north grit removal basins, the split in flow could be made in the screening facility effluent channel. The proposed facilities are shown in red on Figure 23. New structures would be constructed to house the components of the screens and grit removal equipment at two different locations. This arrangement should be considered preliminary. Final location of these facilities will be determined once all land acquisition needs have been identified and detailed design is performed.

6.4 Flows from Missouri Avenue Diversion Structure to In-plant Influent Pump Station

Alternatives 1, 2 and 3, presented above, discuss the alternatives for the flow from the Whitehead and In-plant Influent Pump Stations. There is also plant flow from the Missouri Avenue Diversion Structure in a 30 inch pipeline to the In-plant Influent Pump Station. Currently, flow from the In-plant Influent Pump Station is combined with the flow from the Whitehead Pump Station in the inlet channel to the aerated grit basins. Operations personnel have noticed significant grit accumulation in the line from the Missouri Avenue Diversion Structure to the In-plant Influent Pump Station. In addition, pump wear at the In-plant Influent Pump Station suggests possible grit impacts. Alternatives A through D presented in Table 20 discuss options for grit removal for flows to the In-plant Influent Pump Station. Alternatives B and C provide methods of providing dedicated grit removal improvements for the flows from the Missouri Avenue Diversion Structure before they enter the In-plant Influent Pump Station. The decision to make improvements to the pipeline or provide grit removal for the flows from the Missouri Avenue Diversion Structure is independent of the evaluation of grit removal for flows from the Whitehead and In-plant Influent Pump Stations.

Table 20 Grit Removal Alternatives Evaluated for Flows from Missouri Avenue Diversion Structure	
Alternative	Description
A	Identify pipeline improvements to address grit accumulation
B	Construct a dedicated screening and grit facility for flows from the Missouri Avenue Diversion Structure
C	Construct a dedicated horizontal grit chamber for flows from the Missouri Avenue Diversion Structure
D	Provide for periodic cleaning of the line to prevent grit build-up

6.4.1 Alternative Screening

Grit removal options for the flows from the Missouri Avenue Diversion Structure were also discussed with the City at the May 8, 2009 meeting. The following sections summarize the discussion and results of the meeting.

6.4.1.1 Alternative A – Pipeline Improvements. It is possible that the grit accumulation in the pipeline routed between the Missouri Avenue Diversion Structure and the In-plant Influent Pump Station is due to the physical characteristics of the pipeline. Non-optimal slope, velocity, or configuration are potential causes of the grit accumulation experienced in this pipeline.

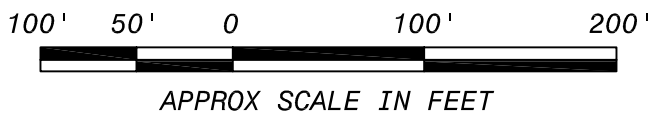
As indicated in Table 21, a hydraulic evaluation of the pipeline indicated that there are several segments with very shallow slopes that result in very low velocities under low flow conditions. Evaluation of plant flow data indicated flows at 2 mgd occur on a regular basis, and WPF staff confirmed flows from the Brown’s Branch Pump Station are as low as 1 mgd. The line segments with the shallowest slopes are located in the middle and end of the pipeline where rerouting of the original line occurred to accommodate the secondary treatment facilities constructed in the mid 1970s. Given the shallow slopes and low velocities in several of the Missouri Avenue pipeline segments, it is understandable that grit would accumulate in the pipeline over time.

Table 21 Hydraulics Evaluation – Pipeline between Missouri Avenue Diversion Structure and In-plant Influent Pump Station							
Line Segment	Upstream Invert, ft	Downstream Invert, ft	Length, ft	Slope, %	Velocity, fps (5 mgd)	Velocity, fps (2 mgd)	Velocity, fps (1 mgd)
1	797.50	796.21	189.75	0.68%	5.59	2.24	1.12
2	796.10	795.95	63.25	0.24%	3.83	1.53	0.77
3	795.95	795.90	9.2	0.54%	5.14	2.06	1.03
4	795.90	795.73	143.75	0.12%	2.96	1.18	0.59
5	795.73	795.42	249.55	0.12%	2.96	1.18	0.59
6	795.42	794.99	350.75	0.12%	2.96	1.18	0.59
7	794.99	794.79	232.3	0.09%	2.65	1.06	0.53
8	794.79	794.16	473.8	0.13%	3.05	1.22	0.61
9	794.16	794.14	64.4	0.03%	--	--	--
10	794.14	794.02	63.25	0.19%	3.51	1.40	0.70
11	794.02	794.00	10.35	0.19%	3.51	1.40	0.70
Total			1,850	0.19%			
Notes: 1. Velocities from FlowMaster software and based on Mannings Equation with n = 0.013. 2. Velocities assume a free outfall from each line segment.							

In addition to shallow slopes, the Missouri Avenue pipeline also has a “Z” shaped bend where the pipeline is connected to the Transfer Pump Station. This reversal in pipeline direction is a potential area where grit would accumulate. Normally, gravity pipelines should be designed with no changes in direction greater than 90 degrees in order to avoid sediment buildup at the change in direction.

One way to improve the velocities and limit grit accumulation would be to replace the entire line since the shallowest sections are in the middle and toward the end of the pipeline. However, even if the line were replaced, the resulting slope (0.19 percent) will still be shallow and the resulting low velocities will not be high enough to suspend solids during low flow periods. In addition, the existing line is very deep and there are a considerable number of existing pipelines that cross this one. Consequently the cost of replacing this line would be high.

The existing “Z” in the pipeline appears to have been added when the Transfer Pump Station was constructed in order to provide a connection to that pump station. It would be possible to eliminate the “Z” by constructing a diversion structure as indicated on Figure 24. The diversion structure would need to be a special cast-in-place concrete



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PIPELINE MODIFICATIONS

FIGURE 24



structure with a sluice gate to allow flow to the Transfer Pump Station when required. A precast manhole would also be required to tie back into the existing Missouri Avenue pipeline. Although this modification would improve the grit settling problems in this section of the pipeline, the shallow slopes in downstream segments and associated grit accumulation issues would likely remain. The projected 2009 capital cost for these improvements would be approximately \$215,000.

6.4.1.2 Alternative B – Dedicated Screening and Grit Facility. Alternative B involves providing a dedicated screening and grit removal facility for the flows from the Missouri Avenue Diversion Structure. The grit facility for this alternative would be either a forced vortex or gravity separation technology as are being considered for the grit removal facilities for flows from Whitehead Pump Station. As noted previously, grit removal would also require the addition of ½ inch screens upstream of the grit units.

Removal of grit from the Missouri Avenue Diversion Structure flows from the WPF system is the primary advantage of this alternative. Disadvantages include the introduction of another point of screenings and grit handling, additional site footprint requirements, and concerns with fitting the facilities into the hydraulic profile of the pipeline to the In-plant Influent Pump Station. Any screening and grit removal systems would use more head than is available in the Missouri Avenue pipeline (which is already hydraulically challenged). The only solution to the lack of head would be to construct a pump station to pump the flow up to a screening and grit facility located at ground level. The pump station would need to be similar in capacity to the Brown's Branch or the In-plant Influent Pump Station and would require a deep wetwell.

This alternative is not recommended given the high cost (several million dollars) of constructing a pump station as well as screening and grit removal facilities. In addition, unless the remainder of the pipeline was replaced, it would still have segments that have very shallow slopes. Replacing the line at a shallower depth and greater slope may be difficult given all the existing pipes in the same area.

6.4.1.3 Alternative C – Dedicated Horizontal Grit Chamber. This alternative is similar to Alternative B in that it would provide a dedicated grit removal facility for the

flows from the Missouri Avenue Diversion Structure. In Alternative C, a horizontal grit chamber would be provided as the grit removal technology.

Based on feedback received at the May 8, 2009 meeting, City staff is divided on their opinion on the effectiveness of a horizontal grit chamber for grit removal in this location. The advantage of such a system is its simplicity and reduced number of moving parts requiring ongoing O&M efforts. Disadvantages of this technology include odor concerns and methods of grit collection.

From an initial review, two chambers (one standby) approximately 2.5 feet wide by 90 feet long would be required to settle a 150 micron particle (similar to the size used for Alternatives 1, 2, and 3). The spare chamber would be used when the other is taken out of service to be drained and cleaned. The grit chambers would need to be at the same depth as the pipeline, which is approximately 16 feet below grade. In addition, clamshell equipment would be required to remove the grit from the entire length of the chambers. Grit chambers like this are typically open. However, given the amount of organic material present in the wastewater, the size of grit to be removed, and the proximity of commercial businesses, the facility should be enclosed in a building and provided with odor control to minimize odors traveling off-site. The size of the facility would require it to be at least partially located south of the WPF property, and some additional property would need to be purchased for the facilities.

This alternative is not recommended given the size of the grit chambers required, depth required, and the fact that the chambers will need to be enclosed in a building and provided with odor control. The cost of these facilities would be several million dollars.

6.4.1.4 Alternative D – Periodic Cleaning of Line. Another possible solution to the grit accumulation issue is to provide periodic cleaning of the pipeline. Ace Pipe Cleaning, Inc. was contacted to provide an estimate for the cost of providing periodic cleaning of grit from the Missouri Avenue pipeline. On September 10, 2009, Mr. Wayne Major with Ace Pipe Cleaning, Inc. visited the site and inspected the pipeline. Ace's estimate to initially clean the line (the pipeline has not been cleaned in at least 8 years according to City staff) is approximately \$16,400. This price does not include water for

cleaning or disposal of grit removed from the line. Approximately \$10,000 would be required to dispose of the grit if the line is half full.

Additional periodic cleaning of the line is recommended at roughly one to two year intervals (interval may be changed based on amount of grit encountered). The cost for additional cleanings every one to two years is approximately \$8,000 and assumes that grit is flushed through the system. The disadvantage of this alternative is that it will be a periodic maintenance cost.

6.4.2 Recommendation

Periodic cleaning of the Missouri Avenue Pipeline is recommended given the high cost of constructing the other alternatives.

7.0 Evaluation of Alternatives

The combined and separate screening and grit removal facilities alternatives described in Section 6.0 for flows from the Whitehead and In-plant Influent Pump Stations were evaluated based on economic and non-economic criteria.

7.1 Economic Evaluation

Economic evaluation of the selected screening and grit removal alternatives was based on life cycle costs using a 20-year present worth basis and capital and O&M costs developed for each alternative.

7.1.1 Opinion of Probable Project Costs

Capital project costs for the alternatives considered were developed based on conceptual layouts of the alternatives. All project costs are presented in May 2009 dollars (Engineering News Record (ENR) Building Cost Index (BCI) equal to 4773).

Building areas required for the various treatment alternatives were estimated based on the facilities needed to provide the required equipment and previous Black & Veatch project experience. Building costs were determined, assuming brick and block wall construction. Piles were assumed to be 70 feet deep based on the 2004 DRG/CDM

Wastewater Treatment Plant Expansion, R-32 project drawings and the 1973 Geotechnical Report by L. Robert Kimball.

Equipment costs for the screens and grit removal equipment were based on preliminary quotations provided by Smith & Loveless (PISTA) or Hydro International (Eutek Headcell and Storm King/Grit King). Equipment installation was projected at 40 percent of the equipment cost for all equipment. Table 22 provides a summary of the opinion of the probable project costs for each of the alternatives.

A cost for the pipelines to convey flow from the screening and grit facilities to the WPF and HRT has been included and is based on the facilities' locations identified for each alternative. The cost for the pipelines will need to be confirmed once the final site location is established during detailed design.

Other associated construction costs were projected by applying a percentage to appropriate project costs as indicated in Footnote 3 of Table 22.

Additional site related costs such as land acquisition, remediation, and flood protection have been included in the capital costs as placeholders. When the final locations of these facilities are known in detailed design, a more accurate projection of the site associated costs can be determined. Site area for each alternative is based on the footprint of any building or structures required for the alternative plus an approximate 50-foot buffer around the facility. The flood protection cost is based on the amount of fill required to bring the future screening and grit facility site(s) up to the approximate elevation of the WPF (El 816) which is the approximate elevation of most existing WPF roadways. It is possible that industrial land adjacent to the WPF site may be used for these facilities. Because the environmental history of this land is unknown at this time, a placeholder for site remediation was also included. A unit cost of \$150 per cubic yard of soil removed to a five foot depth over the area of the site was used to project site remediation costs. In addition, five feet of fill dirt would be utilized to replace the five feet of contaminated soil removed. This number should be considered as only a placeholder as site remediation costs are very specific to the site location and type of contamination encountered. Likewise, land acquisition costs were projected at \$1.33 per square foot based on preliminary guidance from the City; this value was based on the purchase price of the property located to the south of the WPF. Actual land costs may

vary significantly based on the site chosen. Determination of site related costs must be revisited once the actual site selection(s) have been finalized.

Appendix A presents additional details of the development of the conceptual capital costs.

Table 22
Summary of Opinion of Probable Project Costs ¹

Item	Alternative 1C-1 (Vortex Grit Removal), \$	Alternative 1C-2 (Hydro International Grit Removal), \$	Alternative 2C (Hydro International Grit Removal), \$	Alternative 3A-1 (Vortex Grit Removal). \$	Alternative 3A-2 (Hydro International Grit Removal). \$
Screening and Grit Facilities					
Structure, Valves, and Piping	5,861,000	5,423,000	7,310,000	7,167,000	6,624,000
Equipment	3,236,000	3,915,000	6,645,000	3,592,000	5,485,000
Miscellaneous Yard Structures and Piping	2,451,000	2,451,000	2,395,000	2,419,000	2,451,000
Flood Protection/Fill (placeholder) ²	111,000	111,000	185,000	111,000	111,000
Site Remediation (placeholder) ²	0	0	1,296,000	0	0
<i>Subtotal</i>	<i>11,658,000</i>	<i>11,899,000</i>	<i>17,831,000</i>	<i>13,289,000</i>	<i>14,671,000</i>
Electrical, I&C, Sitework, Contractor General Requirements ³	6,235,000	6,366,000	8,829,000	7,116,000	7,862,000
<i>Subtotal</i>	<i>17,893,000</i>	<i>18,265,000</i>	<i>26,660,000</i>	<i>20,405,000</i>	<i>22,533,000</i>
Contingency ⁴	4,473,000	4,566,000	6,665,000	5,101,000	5,633,000
Land Acquisition (placeholder) ^{2, 5}	0	0	53,000	0	0
Opinion of Probable Construction Cost	22,366,000	22,831,000	33,378,000	25,506,000	28,166,000
Engineering, Legal, and Administration ⁶	4,473,000	4,566,000	6,675,000	5,101,000	5,633,000
Opinion of Total Project Cost	26,839,000	27,397,000	40,053,000	30,607,000	33,799,000

Table 22
Summary of Opinion of Probable Project Costs ¹

Item	Alternative 1C-1 (Vortex Grit Removal), \$	Alternative 1C-2 (Hydro International Grit Removal), \$	Alternative 2C (Hydro International Grit Removal), \$	Alternative 3A-1 (Vortex Grit Removal). \$	Alternative 3A-2 (Hydro International Grit Removal). \$
1. All costs presented in May 2009 dollars (ENR BCI = 4773). 2. Site related costs are placeholders and must be revised following final siting of the facilities. Site related costs are provided for the site area required for the screening and grit facilities. 3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, and sitework costs. 4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, and site remediation costs. 5. Land acquisition cost is based on a projection provided by the City from a recent purchase of land directly south of the WPF. 6. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition.					

As shown in Table 22, Alternative 1C-1 (88 mgd Combined Screening and Vortex Grit Facilities) and Alternative 1C-2 (88 mgd Combined Screening and Eutek Headcell Grit Facilities) have the lowest associated project costs. As the project costs of these two alternatives are within 5 percent of each other, they are considered equivalent on a project cost basis for the purpose of this study.

7.1.2 Opinion of Probable Operations and Maintenance Costs

Projected O&M costs were developed for each alternative. The average flow for screening and grit removal of WPF flows during dry weather conditions was set at 17 mgd.

O&M costs associated with HRT screening and grit facilities are based on the volume of wet weather flow anticipated to be treated. Therefore, O&M cost projections for each alternative were based on providing wet weather treatment for volumes associated with average annual conditions. The HRT flow rates and total projected annual flow volume were developed in TM-CSO-10 – Wet Weather Treatment Facilities and are summarized in Tables 23 and 24.

Table 23 presents both the average number of rainy days and wet weather events projected to occur annually based on eight years of rainfall data analyzed for St. Joseph.

Table 23		
Wet Weather Event Statistics for St. Joseph, Missouri		
Time Period	Days with Rainfall	Wet Weather Events
Annual Average	74	50

Table 24 presents the estimated annual wet weather treatment volumes using the statistics developed from the historical WPF flow data, rainfall data, and LTCP CSO typical year modeling.

Table 24			
Annual Average Wet Weather Treatment Volume Delivered to WPF and HRT			
Time Period	Total Wet Weather Treated Volume, MG	Wet Weather Treatment Volume Through 27 mgd WPF Headworks, MG	Wet Weather Treatment Volume Through Proposed 61 mgd High Rate Treatment, MG
Annual Average	1,860	550	1,310
Notes 1. The volumes presented above do not include dry weather flow volumes. Dry weather volumes and corresponding dry weather O&M costs are additional to those presented and derived from this table. 2. A “wet weather day” does not imply that the WPF and HRT operated continuously at peak capacity for an entire day. Most rain events are shorter than a day in duration and therefore would not cause the WPF or the HRT to have a daily average equal to their maximum capacity of 27 mgd and 61 mgd, respectively. The volumes presented above are based on data acquired from modeling and historical WPF flows.			

It was projected that 1,860 million gallons (MG) of flow would be treated during the approximately 74 rainy days per year. Of this total volume, 1,310 MG of flow was projected to be treated by the proposed HRT facilities. The actual number and duration of rain events and wet weather HRT volume occurring during any given year will vary widely from the average. These projected values merely represent the anticipated long term average volumes that were used to derive O&M costs for the HRT alternative.

For the HRT screening and grit facilities O&M costs, labor and power were based on 50 wet weather events per year and disposal costs were based on the total wet weather flow of 1,860 MG per year.

Table 25 presents the unit costs employed for O&M cost development. Unit costs for power and labor were provided by the City with the remaining unit costs based on Black & Veatch experience with similar operating facilities. Annual O&M costs for each alternative were calculated by multiplying the unit costs by the quantities for each item required to operate and maintain the facilities over the course of a year. The annual O&M costs for each alternative are given in Table 26. Major O&M costs for the analysis of screening and grit removal included power, labor, and odor control.

Table 25 O&M Unit Costs ¹	
Power ²	\$0.10/kW-hr
Labor (including benefits and overhead) ²	\$32.78/hr
Landfill Disposal ²	\$30/ton
Equipment Maintenance	1% of capital cost per year
1. All costs provided in May 2009 dollars. Except for those indicated as City provided, all unit costs based on Black & Veatch project experience.	
2. Unit costs based on data provided by the City.	

Table 26 Annual O&M Costs by Alternative					
	Alternative 1C-1 (Vortex Grit Removal), \$	Alternative 1C-2 (Hydro International Grit Removal), \$	Alternative 2C (Hydro International Grit Removal), \$	Alternative 3A-1 (Vortex Grit Removal), \$	Alternative 3A-2 (Hydro International Grit Removal), \$
Dry and Wet Weather	273,000	277,000	475,000	384,000	375,000

The annual O&M cost of Alternatives 1C-1 and 1C-2 (vortex and Eutek Headcell options) are the lowest of the five alternatives. The O&M costs for these two alternatives are almost identical with the vortex (PISTA) cost slightly less primarily because of the lower cost of equipment and lower associated maintenance. Appendix B provides additional detail on the development of the O&M costs.

7.1.3 Opinion of Probable Net Present Worth

The project capital and O&M costs were used to develop life cycle costs for each alternative on a present worth basis. The present worth provides the equivalent amount of money that must be invested at a given interest rate at the start of the project in order to provide all funds necessary to construct, operate, and maintain the facilities and equipment throughout the design life of the project. The net present worth of an alternative is the sum of the present worth of the project capital and O&M costs less any remaining value of facilities at the end of the project's design life. By capturing both project capital and O&M expenses associated with the project, the net present worth

method allows the City to understand the full life cycle costs associated with each of the alternatives.

Table 27 summarizes the net present worth developed for each alternative. A 20-year study period was utilized in the present worth calculations; 2009 was assumed as “Year 0” for consistency of present worth calculations throughout the Facilities Plan. A five percent interest rate was applied. Service life for determination of replacement frequency and salvage value was estimated as follows: structures – 50 years and equipment, electrical, instrumentation and controls – 20 years.

Table 27 Net Present Worth by Alternative ¹					
	Alternative 1C-1 (Vortex Grit Removal), \$	Alternative 1C-2 (Hydro International Grit Removal), \$	Alternative 2C (Hydro International Grit Removal), \$	Alternative 3A-1 (Vortex Grit Removal), \$	Alternative 3A-2 (Hydro International Grit Removal), \$
Net Project Capital Present Worth ²	19,566,000	20,509,000	31,481,000	22,221,000	25,859,000
O&M Present Worth ³	5,736,000	5,826,000	9,978,000	8,063,000	7,879,000
Total Net Present Worth	25,302,000	26,335,000	41,459,000	30,284,000	33,738,000
1. Costs given in May 2009 dollars. Present worth calculated with 20-year life cycle costs at 5% interest. 2. Net project capital present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year life cycle. Service life for determination of replacement frequency and salvage value was projected as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years. 3. O&M costs were assumed to escalate at 5% per year.					

As presented in Table 27, the 20-year net present worth between the two Alternatives 1C-1 and 1C-2 (vortex and Eutek Headcell respectively) are within 5 percent of each other. For conceptual level pricing, these alternatives would be considered equal on a net present worth basis. Appendix C provides additional detail on the calculation of the net present worth for each alternative.

7.2 Sensitivity to Wet Weather Flow Volumes

The annual O&M costs for a screening and grit removal facility will increase as the volume of flow treated increases. However, this increase should be essentially equal among the alternatives evaluated. Especially considering the two lowest cost

alternatives, O&M costs (major costs of labor, power, and odor control) should increase proportionally.

7.3 Non-Economic Evaluation

Many factors besides construction and O&M costs can affect a facility planning decision. Although such factors may be difficult to quantify, some of them may potentially have cost implications. The following sections describe several non-economic factors for the various alternatives and provide a summary of non-economic advantages and disadvantages.

7.3.1 Non-Economic Criteria

7.3.1.1 Health and Safety. The health and safety of the surrounding community and plant personnel is one factor to consider. However, given that no chemicals (odor control is anticipated to use activated carbon) are used in any of the alternatives and basins will be covered and provided with odor control, it is unlikely that there will be any health and safety impacts on the surrounding community. None of the alternatives poses a greater risk than any other alternative to the health and safety of plant personnel.

7.3.1.2 Impacts on the Environment. All of the grit technologies evaluated have similar processes and removal efficiencies and none should have significantly more of an impact on the environment than the others.

7.3.1.3 Operability and Maintenance. Consolidation of facilities in a single location results in less operation and maintenance effort than having facilities in multiple locations.

7.3.1.4 Process Flexibility. Process flexibility refers to the ability to make adjustments to the process to handle different influent characteristics. There should not be a significant difference between Eutek Headcell, Storm King, and vortex type equipment as it pertains to handling changing influent characteristics.

7.3.1.5 Permitting Issues. Permitting should not be different for different screening and grit removal technologies or alternatives evaluated in this study.

7.3.1.6 Expandability. The Eutek Headcell option offers one advantage over the vortex units. The capacity is easily expandable by providing additional trays. However, in order to provide the additional height the structure must be constructed deeper which, as part of the initial construction, will increase construction costs. Since the need for expansion in the foreseeable future is unlikely, the advantage Headcell offers is considered minimal.

7.3.1.7 Public Acceptance. The alternatives do not appear to be significantly different in terms of general public acceptance.

7.3.1.8 Bidding. Alternatives that use vortex type systems offer a cost advantage over Headcell in that there are several different manufacturers that can bid vortex units. The Eutek Headcell equipment is proprietary and would require a negotiated price with the manufacturer.

7.3.2 Non-Economic Evaluation

The only significant non-economic difference is that the Eutek Headcell equipment is proprietary and would require a negotiated price with the manufacturer.

8.0 Conclusions and Recommendations

The following alternatives were considered for screening and grit removal of flows from the WPF and from a future HRT:

- Alternative 1C-1 – Screening and vortex grit removal facility at north property to process all flow (88 mgd).
- Alternative 1C-2 – Screening and Eutek Headcell grit removal facility at north property to process all flow (88 mgd).

- Alternative 2C – Eutek Headcell grit removal facility retro-fitted in existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) at north property, screening and Storm King/Grit King grit removal facility to process HRT flow (61 mgd) at west property.
- Alternative 3A-1 – Screening to process all flow (88 mgd) at north property, vortex grit removal to process HRT flow (61 mgd) at north property, and vortex grit removal to process WPF flow (34 mgd) near existing grit basins.
- Alternative 3A-2 – Screening to process all flow (88 mgd) at north property, Storm King/Grit King grit removal to process HRT flow (61 mgd) at north property, and Eutek Headcell grit removal to process WPF flow (34 mgd) in existing grit basins.

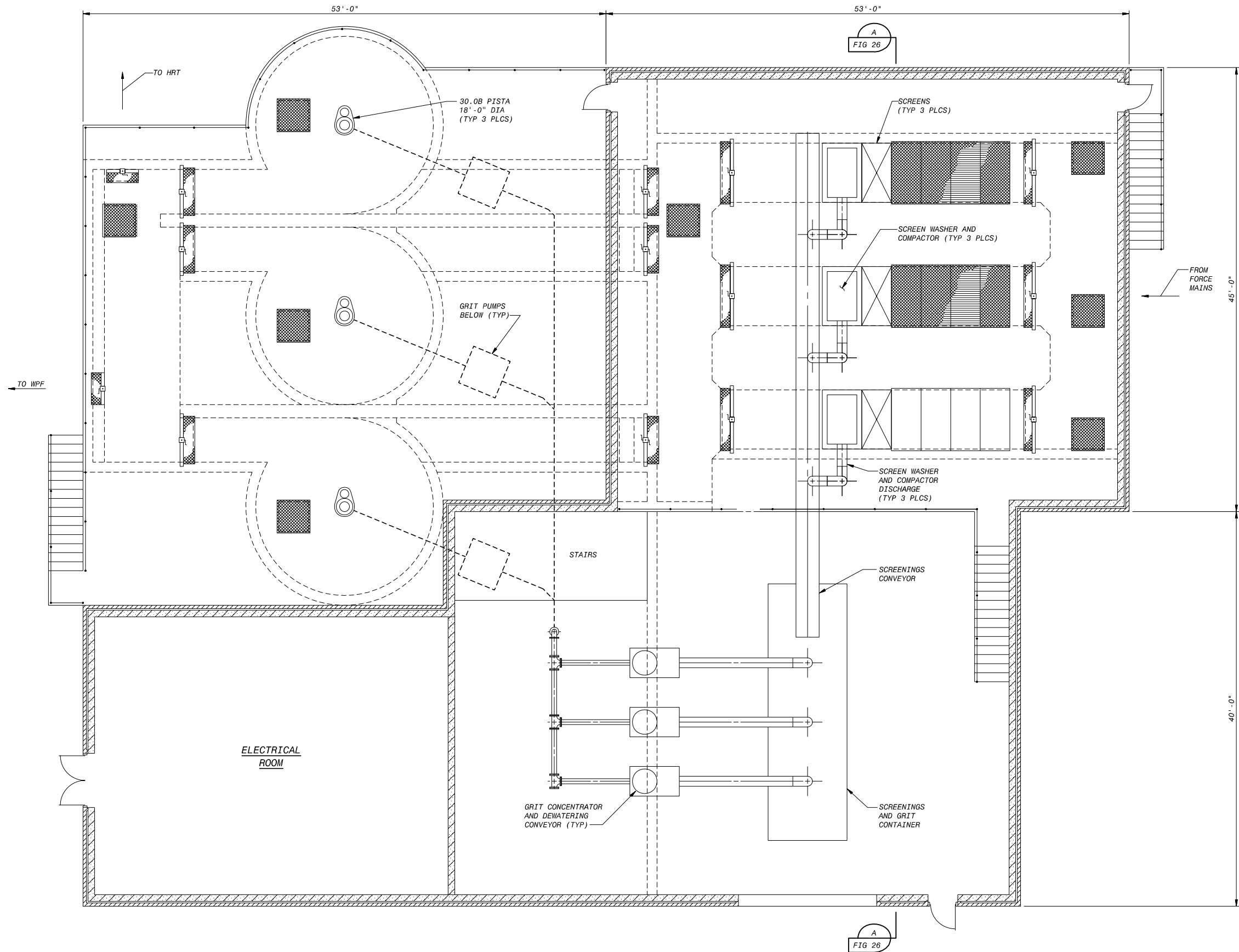
From a project capital cost standpoint, O&M cost standpoint, and present worth standpoint, Alternatives 1C-1 and 1C-2 are essentially equal. Based on non-economic criteria, neither of the alternatives has a significant advantage over the other. The vortex equipment (Alternative 1C-1) offers the advantage of being able to be competitively bid whereas the Eutek Headcell equipment (Alternative 1C-2) does not.

Due to the proprietary issues with the Eutek Headcell equipment, it is recommended that the City use an 88 mgd combined screening and grit removal facility to treat WPF and HRT flows based on a vortex type system as described in Alternative 1C-1. Figures 25 and Figure 26 show a conceptual plan and section of the proposed screening and vortex grit removal facility.

9.0 Phasing

Alternative 1C-1 offers the ability to stage the addition of some of the construction and equipment. The following paragraphs describe phasing opportunities given that the HRT is not likely to be constructed in the near future.

It is recommended that all three screen channels be constructed under the initial phase due to all screening facilities being contained within a single superstructure. Two



PLAN
3/32" = 1'-0"

NOTE:
1. METER VAULTS NOT SHOWN.

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CHK	APP
CYNET ID: 163509-2000-WTCH-C-0001RMN	XREF1 ID: Screening Grit Facility Plan.dwg				
SAVED: GLA10863, 12/7/2009 9:19:11 AM	XREF2 ID:				
DWG VER #: 1.3	XREF3 ID:				
PLOTTED: GLA10863, 12/7/2009 9:19:14 AM	XREF4 ID:				
USER: GLA10863	SW: FIGURE 25 ALT 1C-1				

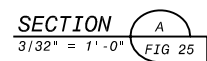


ST. JOSEPH, MISSOURI
FACILITIES PLAN
ALTERNATIVE 1C-1
SCREENING AND GRIT REMOVAL
FOR 88 MGD (VORTEX) FACILITY PLAN

DESIGNED: RCB
DETAILED: JKS
CHECKED:
APPROVED:
DATE:

PROJECT NO.
163509

FIG 25
SHEET
OF

FD5000
05000

screen units should be installed under the initial phase. This would provide a firm capacity in excess of the 34 mgd WPF flow with one screen as backup. In the future when the HRT is constructed, the third screen could be added. Another possible option would be to install only one mechanical screen and add one or two manual screens as backup. The final decision will be made during detailed design.

One vortex type unit (based on Smith & Loveless PISTA) would almost be large enough for the 34 mgd peak loading condition to the WPF, but there would be no backup. It is recommended that two vortex units be constructed under the initial phase and the equipment added. The third unit would be added when the HRT is constructed.

10.0 Hydraulic Evaluation of Recommended Alternative

The hydraulics of the proposed facilities were evaluated for the selected Alternative 1C-1 with combined screening and grit facilities located north of the Administration Building. The hydraulic gradeline appears to be satisfactory provided the pump modifications outlined in TM-CSO-9 – Whitehead Pump Station Improvements are constructed. In addition, because of the location and elevation of the proposed screening and grit facilities, it is likely that modifications (pump and motor replacement) will be required for the In-plant Influent Pump Station to maintain capacity. Hydraulic evaluations made for this TM are preliminary and will be further discussed in TM-WW-7 – Hydraulic Analysis and Effluent Pump Station.

11.0 References

The following references were utilized in the preparation of this memorandum:

- TM-CSO-10 – Wet Weather Treatment Facilities (Black & Veatch, November 17, 2009).
- Geotechnical Engineering Report (L. Robert Kimball, 1973).

Appendix A

Opinion of Probable Capital Cost Breakdown

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-1 - Combined 88 mgd Vortex - North Property
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
SPECIAL SITEWORK				
Major Piping				
18" Force Main	1,100	lin ft	180.00	198,000
42" Gravity to Existing Grit Basin Connection	1,150	lin ft	420.00	483,000
60" Gravity to West Wet Weather Treatment	2,180	lin ft	720.00	1,569,600
Pipeline Relocation	1	Lump Sum	200,000.00	200,000
Total - Special Sitework				2,450,600
FLOWMETER VAULTS				
42" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 42" FM Vault				303,745
36" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	21,688	lbs	5.50	119,284
36" Plug Valve	1	each	48,000.00	48,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 36" FM Vault				239,479
34 mgd Plant Influent (42" line)				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total Plant FM Vault				303,745
Total - Meter Vaults				846,969

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-1 - Combined 88 mgd Vortex - North Property
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
FLOWMETER EQUIPMENT				
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
Total - Flowmeter Equipment				105,000
SCREENING AND GRIT FACILITIES - 88 mgd VORTEX (PISTA) NORTH PROPERTY				
Earthwork				
Excavation	2,892	cu yd	20.00	57,840
Backfill	1,023	cu yd	25.00	25,575
Granular Fill	386	cu yd	35.00	13,510
Piling	238	each	4,550.00	1,082,900
Dewatering		Lump Sum		80,000
Cast-In-Place Concrete				
Slab on Grade	622	cu yd	530.00	329,660
Walls	1,248	cu yd	850.00	1,060,800
Suspended Slab	313	cu yd	950.00	297,350
Columns	20	cu yd	1,000.00	
Concrete Fill	293	cu yd	530.00	155,290
Equipment Bases	8	cu yd	445.00	3,560
Embedded Accessories		Lump Sum		67,568
Beam	20	cu yd	950.00	19,000
Masonry				
Brick	11,053	sq ft	13.00	143,689
Concrete Block Walls	11,053	sq ft	12.00	132,636
Hollow Core Slab	7137	sq ft	10.00	71,370
Bond Beam, 8"	100	lin ft	13.00	1,300
Thermal & Moisture Protection				
Built-up Roofing	7137	sq ft	2.50	17,843
Roof Insulation	7137	sq ft	2.50	17,843
Wall Insulation, 1 1/2"	11,053	sq ft	2.00	22,106
Metals				
Guard Rails	350	lin ft	55.00	19,250
Plate Covered Grating	1,320	sq ft	55.00	72,600
Platforms	3	each	20,000.00	60,000
Stairs	28	risers	650.00	18,200
Stair Landings, Grating	149	sq ft	150.00	22,350
Access Hatch	1	each	3,000.00	3,000
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	1	each	10,000.00	10,000
Finishes				
Painting	11,053	sq ft	7.00	77,371
Floor Sealer	11,053	sq ft	1.50	16,580
Miscellaneous				
Dampproofing	2,000	sq ft	1.50	3,000
Skylight (42 x 10 foot removable)	1	Lump Sum	30,000.00	30,000
Mechanical				
Slide Gates				
30"x84" self-contained	3	each	24,375.00	73,125
60"x57" self-contained	3	each	30,000.00	90,000
54"x84" self-contained	3	each	35,000.00	105,000
54"x84" self-contained	3	each	35,000.00	105,000
Sluice Gates (flow split)				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000
Valves				
Plug Valves, 6"	6	each	1,075.00	6,450
Mud Valves	3	each	500.00	1,500
Process Piping	41,550	lbs	5.50	228,525
Pipe Supports		Lump Sum		22,853

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-1 - Combined 88 mgd Vortex - North Property
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Miscellaneous Piping and Valves		Lump Sum		15,000
Fire Protection	7,137	sq ft	3.50	24,980
HVAC	7,137	sq ft	35.00	249,795
Plumbing	7,137	sq ft	10.00	71,370
Total - Screening and Grit Facilities				5,013,888
SCREENING AND GRIT EQUIPMENT				
Mechanically Cleaned Bar Screens (1/2")	3	each	246,000.00	738,000
Bar Screen Installation	40	percent		295,200
Screenings Washer & Compactor	3	each	97,500.00	292,500
Washer & Compactor Installation	40	percent		117,000
Grit Removal Equipment - Pista		Lump Sum		525,000
Grit Equipment Installation	40	percent		210,000
Grit Classifying and Washing			(included in Grit Equip cost)	
Grit Dewatering			(included in Grit Equip cost)	
Grit Pumps		Lump Sum		135,000
Installation	40	percent		54,000
Screenings Screw Conveyor	60	lin ft	2,000.00	120,000
Installation	40	percent		48,000
Total - Screening and Grit Equipment				2,534,700
SCREENING AND GRIT FACILITIES ODOR CONTROL				
Odor Control Equipment		Lump Sum		
Total - Odor Control				470,000
IN-PLANT INFLUENT PUMP STATION PUMP MODIFICATIONS				
Pump & Motor Modifications	3	each	30,000.00	90,000
Installation	40	percent		36,000
Total - Pump Station Modifications				126,000
	Subtotal			11,547,157
Electrical, Instrumentation, & Controls		Lump Sum	25%	2,887,000
	Subtotal			14,434,157
Typical Sitework		Lump Sum	10%	1,443,000
	Subtotal			15,877,000
General Requirements		Lump Sum	12%	1,905,000
Flood Protection (placeholder)	4,444	cu yd	25.00	111,111
Site Remediation (placeholder)	0	cu yd	150.00	0
	Subtotal			17,893,000
Contingency		Lump Sum	25%	4,473,000
Land Acquisition (placeholder)	0	sq ft	1.33	0
Opinion of Probable Construction Cost				22,366,000
Engineering, Legal, & Administration		Lump Sum	20%	4,473,000
Opinion of Probable Project Cost				26,839,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-2 - Combined 88 mgd Headcell - North Property
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
SPECIAL SITEWORK				
Major Piping				
18" Force Main	1,100	lin ft	180.00	198,000
42" Gravity to Existing Grit Basin Connection	1,150	lin ft	420.00	483,000
60" Gravity to West Wet Weather Treatment	2,180	lin ft	720.00	1,569,600
Pipeline Relocation	1	Lump Sum	200,000.00	200,000
Total - Special Sitework				2,450,600
FLOWMETER VAULTS				
42" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 42" FM Vault				303,745
36" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	21,688	lbs	5.50	119,284
36" Plug Valve	1	each	48,000.00	48,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 36" FM Vault				239,479
34 mgd Plant Influent (42" line)				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total Plant FM Vault				303,745
Total - Meter Vaults				846,969

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-2 - Combined 88 mgd Headcell - North Property
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
FLOWMETER EQUIPMENT				
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
Total - Flowmeter Equipment				105,000
SCREENING AND GRIT FACILITIES - 88 mgd HEADCELL NORTH PROPERTY				
Earthwork				
Structural Excavation	4,032	cu yd	20.00	80,640
Compacted Fill	1285	cu yd	25.00	32,125
Granular Fill	366	cu yd	35.00	12,810
Concrete, cast-in-place				
Slab on Grade/Footings	654	cu yd	530.00	346,620
Walls	805	cu yd	850.00	684,250
Suspended Slab and Beam	279	cu yd	950.00	265,472
Columns	20	cu yd	1,000.00	20,000
Concrete Fill	293	cu yd	530.00	155,290
Equipment Bases	8	cu yd	550.00	4,400
Embedded Accessories		Lump Sum		67,568
Beam	20	cu yd	950.00	19,000
Piling	218	each	4,550.00	991,900
Dewatering		Lump Sum		80,000
Masonry				
Brick, 4"	11,053	sq ft	13.00	143,689
Concrete Block				
8" Wall	11,053	sq ft	12.00	132,636
Hollow Core Slab	7,137	sq ft	10.00	71,370
Bond Beam, 8"	100	lin ft	13.00	1,300
Metal				
Alum Grating w/ 1/4" Checkered Plate	1,320	sq ft	55.00	72,600
Guardrail	375	lin ft	55.00	20,625
Platforms	3	each	20,000.00	60,000
Stairs	28	risers	650.00	18,200
Stair Landings	149	sq ft	150.00	22,350
3'x3' Access Hatch	1	each	3,000.00	3,000
Thermal & Moisture Protection				
Built-up Roofing	7137	sq ft	2.50	17,843
Roof Insulation	7137	sq ft	2.50	17,843
Wall Insulation, 1 1/2"	11,053	sq ft	2.00	22,106
Concrete Dampproofing	2,000	sq ft	1.50	3,000
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	1	each	10,000.00	10,000
Finishes				
Painting	11,053	sq ft	7.00	77,371
Floor Sealer	7,137	sq ft	1.50	10,706
Miscellaneous				
Skylight (42 x 10 foot removable)	1	Lump Sum	30,000.00	30,000
Mechanical				
Slide Gates				
30"x84" self-contained	3	each	24,375.00	73,125
60"x57" self-contained	3	each	30,000.00	90,000
54"x84" self-contained	3	each	35,000.00	105,000
54"x84" self-contained	3	each	35,000.00	105,000
Sluice Gates				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000
Valves				

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-2 - Combined 88 mgd Headcell - North Property
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Plug Valves, 6"	6	each	1,075.00	6,450
Mud Valves	3	each	500.00	1,500
Process Piping	41,550	lbs	5.50	228,525
Pipe Supports		Lump Sum		22,853
Miscellaneous Piping and Valves		Lump Sum		15,000
Fire Protection	7,137	sq ft	3.50	24,980
HVAC	7,137	sq ft	35.00	249,795
Plumbing	7,137	sq ft	10.00	71,370
Total - Screening and Grit Facilities				4,576,000
SCREENING AND GRIT EQUIPMENT				
Mechanically Cleaned Bar Screens (1/2")	3	each	246,000.00	738,000
Bar Screen Installation	40	percent		295,200
Screenings Washer & Compactor	3	each	97,500.00	292,500
Washer & Compactor Installation	40	percent		117,000
Grit Removal Equipment - Headcell		Lump Sum		1,010,000
Grit Equipment Installation	40	percent		404,000
Grit Classifying and Washing			(included in Grit Equip cost)	
Grit Dewatering			(included in Grit Equip cost)	
Grit Pumps		Lump Sum		135,000
Installation	40	percent		54,000
Screenings Screw Conveyor	60	lin ft	2,000.00	120,000
Installation	40	percent		48,000
Total - Screening and Grit Equipment				3,213,700
SCREENING AND GRIT FACILITIES ODOR CONTROL				
Odor Control Equipment		Lump Sum		
Total - Odor Control				470,000
IN-PLANT INFLUENT PUMP STATION PUMP MODIFICATIONS				
Pump & Motor Modifications	3	each	30,000.00	90,000
Installation	40	percent		36,000
Total - Pump Station Modifications				126,000
Subtotal				11,788,269
Electrical, Instrumentation, & Controls		Lump Sum	25%	2,947,000
Subtotal				14,735,269
Typical Sitework		Lump Sum	10%	1,474,000
Subtotal				16,209,000
General Requirements		Lump Sum	12%	1,945,000
Flood Protection (placeholder)	4,444	cu yd	25.00	111,111
Site Remediation (placeholder)	0	cu yd	150.00	0
Subtotal				18,265,000
Contingency		Lump Sum	25%	4,566,000
Land Acquisition (placeholder)	0	sq ft	1.33	0
Opinion of Probable Construction Cost				22,831,000
Engineering, Legal, & Administration		Lump Sum	20%	4,566,000
Opinion of Probable Project Cost				27,397,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 2C - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd),
Screens and Storm King at West Property (61 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
61 mgd WEST PROPERTY SCREENS AND GRIT				
SPECIAL SITEWORK				
Major Piping				
18" Force Main	1,100	lin ft	180.00	198,000
42" Gravity to Existing Grit Basin Connection	1,120	lin ft	420.00	470,400
60" Gravity to West Wet Weather Treatment	2,120	lin ft	720.00	1,526,400
Pipeline Relocation	1	Lump Sum	200,000.00	200,000
Total - Special Sitework				2,394,800
SCREENING AND GRIT FACILITIES - 61 mgd STORM KING & GRIT KING WEST PROPERTY				
Earthwork				
Structural Excavation	4,332	cu yd	20.00	86,640
Compacted Fill	1879	cu yd	25.00	46,975
Granular Fill	289	cu yd	35.00	10,115
Concrete, cast-in-place				
Slab on Grade/Footings	492	cu yd	530.00	260,760
Walls	460	cu yd	850.00	391,000
Suspended Slab and Beam	257	cu yd	950.00	243,759
Concrete Fill	196	cu yd	530.00	103,880
Columns	20	cu yd	1,000.00	20,000
Equipment Bases	8	cu yd	550.00	4,400
Embedded Accessories		Lump Sum		57,915
Beam	15	cu yd	950.00	14,250
Piling	191	each	4,550.00	869,050
Dewatering		Lump Sum		80,000
Masonry				
Brick, 4"	10,114	sq ft	13.00	131,482
Concrete Block				
8" Wall	10,114	sq ft	12.00	121,368
Hollow Core Slab	5,505	sq ft	10.00	55,050
Bond Beam, 8"	100	lin ft	13.00	1,300
Metal				
Plate Covered Grating	1,039	sq ft	55.00	57,145
Guardrail	375	lin ft	55.00	20,625
Platforms	3	each	20,000.00	60,000
Stairs	28	risers	650.00	18,200
Stair Landings	149	sq ft	150.00	22,350
3'x3' Access Hatch	1	each	3,000.00	3,000
Thermal & Moisture Protection				
Built-up Roofing	5,505	sq ft	2.50	13,763
Roof Insulation	5,505	sq ft	2.50	13,763
Wall Insulation, 1 1/2"	10,114	sq ft	2.00	20,228
Concrete Dampproofing	1,500	sq ft	1.50	2,250
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	1	each	10,000.00	10,000
Finishes				
Painting	5,505	sq ft	7.00	38,535
Floor Sealer	5,505	sq ft	1.50	8,258
Miscellaneous				
Skylight (42 x 10 foot removable)	1	Lump Sum	30,000.00	30,000
Mechanical				
Slide Gates				
30"x84" self-contained	3	each	24,375.00	73,125
60"x57" self-contained	3	each	30,000.00	90,000
54"x84" self-contained	2	each	35,000.00	70,000
54"x84" self-contained	2	each	35,000.00	70,000
Sluice Gates				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000
Valves				
Plug Valves, 6"	6	each	1,075.00	6,450

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 2C - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd),
Screens and Storm King at West Property (61 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Mud Valves	3	each	500.00	1,500
Process Piping	30,470	lbs	5.50	167,585
Pipe Supports		Lump Sum		16,759
Miscellaneous Piping and Valves		Lump Sum		15,000
Fire Protection	5,505	sq ft	3.50	19,268
HVAC	5,505	sq ft	35.00	192,675
Plumbing	5,505	sq ft	10.00	55,050
Total - Screening and Grit Facilities				3,682,000

SCREENING AND GRIT EQUIPMENT - 61 mgd STORM KING & GRIT KING WEST PROPERTY

Mechanically Cleaned Bar Screens (1/2")	3	each	221,000.00	663,000
Bar Screen Installation	40	percent		265,200
Screenings Washer & Compactor	3	each	97,500.00	292,500
Washer & Compactor Installation	40	percent		117,000
Grit Removal Equipment - Storm King (2)		Lump Sum		935,000
Grit Equipment Installation	40	percent		374,000
Grit King & Grit Snail		Lump Sum		229,700
Grit King & Grit Snail Installation	40	percent		91,880
Grit Pumps		Lump Sum		90,000
Installation	40	percent		36,000
Screenings Screw Conveyor	60	lin ft	2,000.00	120,000
Installation	40	percent		48,000
Total - Equipment				3,262,280

SCREENING AND GRIT FACILITIES ODOR CONTROL - 61 mgd

Odor Control Equipment		Lump Sum		
Total - Odor Control				470,000

34 mgd NORTH PROPERTY SCREENS, FLOWMETERS, AND SPLITTER BOX

FLOWMETER VAULTS

42" Force Main

Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	67	cu yd	950.00	63,333
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 42" FM Vault				348,078

36" Force Main

Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	21,688	lbs	5.50	119,284
36" Plug Valve	1	each	48,000.00	48,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 36" FM Vault				239,479

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 2C - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd),
Screens and Storm King at West Property (61 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
34 mgd Plant Influent (42" line)				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total Plant FM Vault				303,745
Total - Meter Vaults				891,302
FLOWMETER EQUIPMENT				
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
Total - Flowmeter Equipment				105,000
FLOW SPLITTER BOX				
Earthwork				
Structural Excavation	278	cu yd	20.00	5,560
Compacted Fill	167	cu yd	25.00	4,175
Granular Fill	11	cu yd	35.00	385
Concrete, cast-in-place				
Slab on Grade/Footings	17	cu yd	530.00	9,010
Walls	57	cu yd	850.00	48,450
Suspended Slab and Beam	6	cu yd	950.00	5,700
Miscellaneous				
Sluice Gates				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000
Access Hatch	1	each	3,000.00	3,000
Total - Flow Splitter Box				141,280
SCREENING FACILITIES - 34 mgd NORTH PROPERTY				
Earthwork				
Structural Excavation	151	cu yd	20.00	3,020
Compacted Fill	221	cu yd	25.00	5,525
Granular Fill	160	cu yd	35.00	5,600
Concrete, cast-in-place				
Slab on Grade/Footings	201	cu yd	530.00	106,530
Walls	208	cu yd	850.00	176,800
Suspended Slab and Beam	35	cu yd	950.00	33,250
Columns	20	cu yd	1,000.00	20,000
Concrete Fill	147	cu yd	530.00	77,910
Equipment Bases	8	cu yd	550.00	4,400
Embedded Accessories		Lump Sum		19,305
Piling	82	each	4,550.00	373,100
Dewatering		Lump Sum		80,000
Masonry				
Brick, 4"	7,782	sq ft	13.00	101,166
Concrete Block				
8" Wall	7,782	sq ft	12.00	93,384
Hollow Core Slab	3,090	sq ft	10.00	30,900
Bond Beam, 8"	100	lin ft	13.00	1,300

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 2C - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd),
Screens and Storm King at West Property (61 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Metal				
Plate Covered Grating	702	sq ft	55.00	38,610
Guardrail	375	lin ft	55.00	20,625
Platforms	1	each	20,000.00	20,000
Stairs	28	risers	650.00	18,200
Stair Landings	149	sq ft	150.00	22,350
3'x3' Access Hatch	1	each	3,000.00	3,000
Thermal & Moisture Protection				
Built-up Roofing	3,090	sq ft	2.50	7,725
Roof Insulation	3,090	sq ft	2.50	7,725
Wall Insulation, 1 1/2"	7,782	sq ft	2.00	15,564
Concrete Dampproofing	1,000	sq ft	1.50	1,500
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	1	each	10,000.00	10,000
Finishes				
Painting	3,090	sq ft	7.00	21,630
Floor Sealer	3,090	sq ft	1.50	4,635
Miscellaneous				
Skylight (42 x 10 foot removable)	1	Lump Sum	20,000.00	20,000
Mechanical				
Slide Gates				
30"x84" self-contained	2	each	24,375.00	48,750
60"x57" self-contained	2	each	30,000.00	60,000
Valves				
Plug Valves, 6"	6	each	1,075.00	6,450
Mud Valves	3	each	500.00	1,500
Process Piping	13,850	lbs	5.50	76,175
Pipe Supports		Lump Sum		7,618
Miscellaneous Piping and Valves		Lump Sum		5,000
Fire Protection	3,090	sq ft	3.50	10,815
HVAC	3,090	sq ft	35.00	108,150
Plumbing	3,090	sq ft	10.00	30,900
Total - Screening Facilities				1,722,000
SCREENING EQUIPMENT - 34 mgd NORTH PROPERTY				
Mechanically Cleaned Bar Screens (1/2")	2	each	222,000.00	444,000
Bar Screen Installation	40	percent		177,600
Screenings Washer & Compactor	2	each	97,500.00	195,000
Washer & Compactor Installation	40	percent		78,000
Screenings Screw Conveyor	45	lin ft	2,000.00	90,000
Installation	40	percent		36,000
Total - Equipment				1,020,600
SCREENING FACILITIES ODOR CONTROL - 34 mgd				
Odor Control Equipment		Lump Sum		
Total - Odor Control				286,482
34 mgd HEADCELL IN EXISTING GRIT BASINS				
STRUCTURE - 34 mgd HEADCELL				
Demolition at Exist Grit Basins Doghouses and Misc. Grit Basins				20,000
Baffle & Grit Pump Walls	75	cu yd	850.00	63,750
Suspended Slab	30	cu yd	950.00	28,500
Dampproofing	864	sq ft		0
Piping		Lump Sum		10,000
Washer & Compactor Bldg				
Slab on Grade	56	cu yd	530.00	29,680
Piles	54	each	4,550.00	245,700
Brick, 4"	3,300	sq ft	13.00	42,900
Concrete Block				

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 2C - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd),
Screens and Storm King at West Property (61 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
8" Wall	3,300	sq ft	12.00	39,600
Hollow Core Slab	1,500	sq ft	10.00	15,000
Built-up Roofing	1,500	sq ft	2.50	3,750
Roof Insulation	1,500	sq ft	2.50	3,750
Wall Insulation, 1 1/2"	3,300	sq ft	2.00	6,600
Rolling Aluminum Overhead, 14'	2	each	10,000.00	20,000
Piling	54	each	4,550.00	245,700
Painting	3,300	sq ft	7.00	23,100
Floor Sealer	1,500	sq ft	1.50	2,250
Fire Protection	1,500	sq ft	3.50	5,250
HVAC	1,500	sq ft	35.00	52,500
Plumbing	1,500	sq ft	10.00	15,000
Total - Existing Grit Basin Modifications				873,030
EQUIPMENT - 34 mgd HEADCELL				
Equipment				
Grit Removal Equipment - Headcell		Lump Sum		790,000
Grit Equipment Installation	40	percent		316,000
Grit Classifying and Washing			(included in Grit Equip cost)	
Grit Dewatering			(included in Grit Equip cost)	
Grit Pumps		Lump Sum		60,000
Installation	40	percent		24,000
Total - New Equipment in Existing Grit Basins				1,190,000
GRIT FACILITIES ODOR CONTROL - 34 mgd				
Odor Control Equipment		Lump Sum		
Total - Odor Control				184,614
IN-PLANT INFLUENT PUMP STATION PUMP MODIFICATIONS				
Pump & Motor Modifications	3	each	30,000.00	90,000
Installation	40	percent		36,000
Total - Pump Station Modifications				126,000
Subtotal				16,349,388
Electrical, Instrumentation, & Controls		Lump Sum	25%	4,087,000
Subtotal				20,436,388
Typical Sitework		Lump Sum	10%	2,044,000
Subtotal				22,480,000
General Requirements		Lump Sum	12%	2,698,000
Flood Protection (placeholder)	7,407	cu yd	25.00	185,185
Site Remediation (placeholder)	7,407	cu yd	150.00	1,111,111
Soil Replacement for Remediation (placeholder)	7,407	cu yd	25.00	185,185
Subtotal				26,659,000
Contingency		Lump Sum	25%	6,665,000
Land Acquisition (placeholder)	40,000	sq ft	1.33	53,200
Opinion of Probable Construction Cost				33,377,000
Engineering, Legal, & Administration		Lump Sum	20%	6,675,000
Opinion of Probable Project Cost				40,052,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-1 - Separate Facilities
Vortex near Exist Grit Basins (34 mgd), Vortex at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
SPECIAL SITEWORK				
Major Piping				
18" Force Main	1,100	lin ft	180.00	198,000
42" Gravity to Existing Grit Basin Connection	1,050	lin ft	420.00	441,000
60" Gravity to West Wet Weather Treatment	2,195	lin ft	720.00	1,580,400
Pipeline Relocation	1	Lump Sum	200,000.00	200,000
Total - Special Sitework				2,419,400
FLOWMETER VAULTS				
42" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 42" FM Vault				303,745
36" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	21,688	lbs	5.50	119,284
36" Plug Valve	1	each	48,000.00	48,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 36" FM Vault				239,479
34 mgd Plant Influent (42" line)				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total Plant FM Vault				303,745
Total - Meter Vaults				846,969

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-1 - Separate Facilities
Vortex near Exist Grit Basins (34 mgd), Vortex at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
FLOWMETER EQUIPMENT				
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
Total - Flowmeter Equipment				105,000
FLOW SPLITTER				
Miscellaneous				
Sluice Gates				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000
Total - Flow Splitter Box				65,000
SCREENING (88 mgd) AND GRIT (61 mgd - VORTEX) FACILITIES - NORTH PROPERTY				
Earthwork				
Excavation	2,769	cu yd	20.00	55,380
Backfill	911	cu yd	25.00	22,775
Granular Fill	355	cu yd	35.00	12,425
Piling	219	each	4,550.00	996,450
Dewatering		Lump Sum		80,000
Cast-In-Place Concrete				
Slab on Grade	583	cu yd	530.00	308,990
Walls	938	cu yd	850.00	797,300
Suspended Slab	286	cu yd	950.00	271,700
Columns	20	cu yd	1,000.00	20,000
Concrete Fill	293	cu yd	530.00	155,290
Embedded Accessories		Lump Sum		57,915
Beam	20	cu yd	950.00	19,000
Masonry				
Brick	10,045	sq ft	13.00	130,585
Concrete Block Walls	10,045	sq ft	12.00	120,540
Hollow Core Slab	7,137	sq ft	10.00	71,370
Thermal & Moisture Protection				
Built-up Roofing	7,137	sq ft	2.50	17,843
Roof Insulation	7,137	sq ft	2.50	17,843
Wall Insulation, 1 1/2"	10,045	sq ft	2.00	20,090
Metals				
Guard Rails	350	lin ft	55.00	19,250
Plate Covered Grating	1,320	sq ft	55.00	72,600
Platforms	3	each	20,000.00	60,000
Stairs	28	risers	650.00	18,200
Stair Landings, Grating	149	sq ft	150.00	22,350
Access Hatch	1	each	3,000.00	3,000
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	1	each	10,000.00	10,000
Finishes				
Painting	10,045	sq ft	7.00	70,315
Floor Sealer	7,137	sq ft	1.50	10,706
Miscellaneous				
Dampproofing	2,000	sq ft	1.50	3,000
Skylight (42 x 10 foot removable)	1	Lump Sum	30,000.00	30,000
Mechanical				
Slide Gates				
30"x84" self-contained	3	each	24,375.00	73,125
60"x57" self-contained	3	each	30,000.00	90,000
Sluice Gates (flow split)				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000
Valves				
Plug Valves, 6"	6	each	1,075.00	6,450

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-1 - Separate Facilities
Vortex near Exist Grit Basins (34 mgd), Vortex at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Mud Valves	3	each	500.00	1,500
Process Piping	41,550	lbs	5.50	228,525
Pipe Supports		Lump Sum		22,853
Miscellaneous Piping and Valves		Lump Sum		15,000
Fire Protection	7,137	sq ft	3.50	24,980
HVAC	7,137	sq ft	35.00	249,795
Plumbing	7,137	sq ft	10.00	71,370
Total - Screening and Grit Facilities				4,366,614
SCREENING (88 mgd) AND GRIT (61 mgd - VORTEX) EQUIPMENT - NORTH PROPERTY				
Mechanically Cleaned Bar Screens (1/2")	3	each	246,000.00	738,000
Bar Screen Installation	40	percent		295,200
Screenings Washer & Compactor	3	each	97,500.00	292,500
Washer & Compactor Installation	40	percent		117,000
Grit Removal Equipment - Pista		Lump Sum		350,000
Grit Equipment Installation	40	percent		140,000
Grit Classifying and Washing			(included in Grit Equip cost)	
Grit Dewatering			(included in Grit Equip cost)	
Grit Pumps		Lump Sum		90,000
Installation	40	percent		36,000
Screenings Screw Conveyor	60	lin ft	2,000.00	120,000
Installation	40	percent		48,000
Total - Screening and Grit Equipment				2,226,700
SCREENING (88 mgd) AND GRIT (61 mgd) FACILITIES ODOR CONTROL				
Odor Control Equipment		Lump Sum		
Total - Odor Control				470,000
GRIT FACILITIES NEAR EXISTING GRIT BASINS (34 mgd VORTEX)				
Complete Demolition and Removal of Existing Grit Basins				89,000
Earthwork				
Excavation	460	cu yd	20.00	9,200
Backfill	266	cu yd	25.00	6,650
Granular Fill	126	cu yd	35.00	4,410
Piling	114	each	4,550.00	518,700
Sheeting and Dewatering		Lump Sum		172,400
Cast-In-Place Concrete				
Slab on Grade	164	cu yd	530.00	86,920
Walls	324	cu yd	850.00	275,400
Suspended Slab	68	cu yd	950.00	64,600
Embedded Accessories		Lump Sum		19,305
Beam	10	cu yd	950.00	9,500
Masonry				
Brick	3,664	sq ft	13.00	47,632
Concrete Block Walls	3,664	sq ft	12.00	43,968
Hollow Core Slab	1,896	sq ft	10.00	18,960
Thermal & Moisture Protection				
Built-up Roofing	1,896	sq ft	2.50	4,740
Roof Insulation	1,896	sq ft	2.50	4,740
Wall Insulation 1 1/2"	3,664	sq ft	2.00	7,328
Metals				
Guard Rails	350	lin ft	55.00	19,250
Plate Covered Grating	0	sq ft	55.00	0
Platforms	1	each	20,000.00	20,000
Stairs	28	risers	650.00	18,200
Stair Landings, Grating	149	sq ft	150.00	22,350
Access Hatch	1	each	3,000.00	3,000
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	1	each	10,000.00	10,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-1 - Separate Facilities
Vortex near Exist Grit Basins (34 mgd), Vortex at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Finishes				
Painting	3,664	sq ft	7.00	25,648
Floor Sealer	1,896	sq ft	1.50	2,844
Miscellaneous				
Dampproofing	1,000	sq ft	1.50	1,500
Skylight (42 x 10 foot removable)	1	Lump Sum	30,000.00	30,000
Mechanical				
Slide Gates				
54"x84" self-contained	2	each	35,000.00	70,000
54"x84" self-contained	2	each	35,000.00	70,000
Valves				
Plug Valves, 6"	6	each	1,075.00	6,450
Mud Valves	3	each	500.00	1,500
Process Piping	13,850	lbs	5.50	76,175
Pipe Supports		Lump Sum		7,618
Miscellaneous Piping and Valves		Lump Sum		5,000
Fire Protection	1,896	sq ft	3.50	6,636
HVAC	1,896	sq ft	35.00	66,360
Plumbing	1,896	sq ft	10.00	18,960
Total - Grit Facilities				1,888,044
GRIT EQUIPMENT NEAR EXISTING GRIT BASINS (34 mgd VORTEX)				
Grit Removal Equipment - Pista		Lump Sum		300,000
Grit Equipment Installation	40	percent		120,000
Grit Classifying and Washing			(included in Grit Equip cost)	
Grit Dewatering			(included in Grit Equip cost)	
Grit Pumps		Lump Sum		60,000
Installation	40	percent		24,000
Total - Grit Equipment				504,000
GRIT FACILITIES (34 mgd) ODOR CONTROL				
Odor Control Equipment		Lump Sum		
Total - Odor Control				160,594
IN-PLANT INFLUENT PUMP STATION PUMP MODIFICATIONS				
Pump & Motor Modifications	3	each	30,000.00	90,000
Installation	40	percent		36,000
Total Pump Station Modifications				126,000
Subtotal				13,178,321
Electrical, Instrumentation, & Controls		Lump Sum	25%	3,295,000
Subtotal				16,473,321
Typical Sitework		Lump Sum	10%	1,647,000
Subtotal				18,120,000
General Requirements		Lump Sum	12%	2,174,000
Flood Protection (placeholder)	4,444	cu yd	25.00	111,111
Site Remediation (Placeholder)	0	cu yd	150.00	0
Subtotal				20,405,000
Contingency		Lump Sum	25%	5,101,000
Land Acquisition (placeholder)	0	sq ft	1.33	0
Opinion of Probable Construction Cost				25,506,000
Engineering, Legal, & Administration		Lump Sum	20%	5,101,000
Opinion of Probable Project Cost				30,607,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-2 - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Storm King at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
SPECIAL SITEWORK				
Major Piping				
18" Force Main	1,100	lin ft	180.00	198,000
42" Gravity to Existing Grit Basin Connection	1,150	lin ft	420.00	483,000
60" Gravity to West Wet Weather Treatment	2,180	lin ft	720.00	1,569,600
Pipeline Relocation	1	Lump Sum	200,000.00	200,000
Total - Special Sitework				2,450,600
FLOWMETER VAULTS				
42" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 42" FM Vault				303,745
36" Force Main				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	21,688	lbs	5.50	119,284
36" Plug Valve	1	each	48,000.00	48,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total 36" FM Vault				239,479
34 mgd Plant Influent (42" line)				
Earthwork				
Structural Excavation	402	cu yd	20.00	8,040
Compacted Fill	147	cu yd	25.00	3,675
Granular Fill	32	cu yd	35.00	1,120
Concrete, cast-in-place				
Slab on Grade/Footings	32	cu yd	530.00	16,960
Walls	24	cu yd	850.00	20,400
Suspended Slab and Beam	20	cu yd	950.00	19,000
Piping	32,100	lbs	5.50	176,550
42" Plug Valve	1	each	55,000.00	55,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total Plant FM Vault				303,745
Total - Meter Vaults				846,969

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-2 - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Storm King at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
FLOWMETER EQUIPMENT				
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
30" Magnetic Meter	1	Lump Sum	35,000.00	35,000
Total - Flowmeter Equipment				105,000
FLOW SPLITTER				
Miscellaneous				
Sluice Gates				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000
Total - Flow Splitter Box				65,000
SCREENING (88 mgd) AND GRIT (61 mgd - STORM KING) FACILITIES - NORTH PROPERTY				
Earthwork				
Excavation	4,144	cu yd	20.00	82,880
Backfill	1,371	cu yd	25.00	34,275
Granular Fill	357	cu yd	35.00	12,495
Piling	235	each	4,550.00	1,069,250
Dewatering		Lump Sum		80,000
Cast-In-Place Concrete				
Slab on Grade	617	cu yd	530.00	327,010
Walls	670	cu yd	850.00	569,500
Suspended Slab	296	cu yd	950.00	280,809
Columns	20	cu yd	1,000.00	20,000
Concrete Fill	293	cu yd	530.00	155,290
Embedded Accessories		Lump Sum		57,915
Beam	20	cu yd	950.00	19,000
Masonry				
Brick	11,053	sq ft	13.00	143,689
Concrete Block Walls	11,053	sq ft	12.00	132,636
Hollow Core Slab	7,137	sq ft	10.00	71,370
Thermal & Moisture Protection				
Built-up Roofing	7,137	sq ft	2.50	17,843
Roof Insulation	7,137	sq ft	2.50	17,843
Wall Insulation 1 1/2"	11,053	sq ft	2.00	22,106
Metals				
Guard Rails	350	lin ft	55.00	19,250
Plate Covered Grating	1,320	sq ft	55.00	72,600
Platforms	3	each	20,000.00	60,000
Stairs	28	risers	650.00	18,200
Stair Landings, Grating	149	sq ft	150.00	22,350
Access Hatch	1	each	3,000.00	3,000
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	1	each	10,000.00	10,000
Finishes				
Painting	11,053	sq ft	7.00	77,371
Floor Sealer	7,137	sq ft	1.50	10,706
Miscellaneous				
Dampproofing	1,000	sq ft	1.50	1,500
Skylight (42 x 10 foot removable)	1	Lump Sum	30,000.00	30,000
Mechanical				
Slide Gates				
30"x84" self-contained	3	each	24,375.00	73,125
60"x57" self-contained	3	each	30,000.00	90,000
54"x84" self-contained	2	each	35,000.00	70,000
54"x84" self-contained	2	each	35,000.00	70,000
Sluice Gates (flow split)				
42" circular frame with floorstand	1	each	25,000.00	25,000
60" circular frame with floorstand	1	each	40,000.00	40,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-2 - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Storm King at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Valves				
Plug Valves, 6"	6	each	1,075.00	6,450
Mud Valves	3	each	500.00	1,500
Process Piping	41,550	lbs	5.50	228,525
Pipe Supports		Lump Sum		22,853
Miscellaneous Piping and Valves		Lump Sum		15,000
Fire Protection	7,137	sq ft	3.50	24,980
HVAC	7,137	sq ft	35.00	249,795
Plumbing	7,137	sq ft	10.00	71,370

Total - Screening and Grit Facilities

4,450,585

SCREENING (88 mgd) AND GRIT (61 mgd - STORM KING) EQUIPMENT - NORTH PROPERTY

Mechanically Cleaned Bar Screens (1/2")	3	each	246,000.00	738,000
Bar Screen Installation	40	percent		295,200
Screenings Washer & Compactor	3	each	97,500.00	292,500
Washer & Compactor Installation	40	percent		117,000
Grit Removal Eq - Storm King		Lump Sum		935,000
Grit Equipment Installation	40	percent		374,000
Grit Kings & Grit Snail		Lump Sum		229,700
Grit King & Grit Snail Installation	40	percent		91,880
Grit Pumps		Lump Sum		90,000
Installation	40	percent		36,000
Screenings Screw Conveyor	60	lin ft	2,000.00	120,000
Installation	40	percent		48,000
Total - Screening and Grit Equipment				3,367,280

SCREENING (88 mgd) AND GRIT (61 mgd) FACILITIES ODOR CONTROL

Odor Control Equipment	Lump Sum			
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Total - Odor Control

470,000

GRIT FACILITIES IN EXISTING GRIT BASINS (34 mgd HEADCELL)

Demolition at Existing Grit Basins Doghouses and Misc.				20,000
Earthwork				
Excavation	0	cu yd	20.00	0
Backfill	0	cu yd	25.00	0
Granular Fill	44	cu yd	35.00	1,540
Piling	54	each	4,550.00	245,700
Sheeting and Dewatering		Lump Sum		134,000
Cast-In-Place Concrete				
Slab on Grade	56	cu yd	530.00	29,680
Walls	75	cu yd	850.00	63,750
Suspended Slab	67	cu yd	950.00	63,333
Embedded Accessories		Lump Sum		19,305
Beam	0	cu yd	950.00	0
Masonry				
Brick	3,300	sq ft	13.00	42,900
Concrete Block Walls	3,300	sq ft	12.00	39,600
Hollow Core Slab	1,500	sq ft	10.00	15,000
Bond beam, 8"	100	lin ft	13.00	1,300
Thermal & Moisture Protection				
Built-up Roofing	1500	sq ft	2.50	3,750
Roof Insulation	1500	sq ft	2.50	3,750
Wall Insulation 1 1/2"	3300	sq ft	2.00	6,600
Metals				
Guard Rails	350	lin ft	55.00	19,250
Plate Covered Grating	0	sq ft	55.00	0
Access Hatch	1	each	3,000.00	3,000
Doors				
FRP, single leaf	105	sq ft	140.00	14,700
FRP, double leaf	84	sq ft	100.00	8,400
Rolling Aluminum Overhead, 14'	2	each	10,000.00	20,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 3A-2 - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Storm King at North Property (61 mgd),
Screens at North Property (88 mgd)
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
Finishes				
Painting	3,300	sq ft	7.00	23,100
Floor Sealer	1,500	sq ft	1.50	2,250
Miscellaneous				
Dampproofing	1,000	sq ft	1.50	1,500
Skylight (42 x 10 foot removable)	1	Lump Sum	30,000.00	30,000
Mechanical				
Slide Gates				
54"x84" self-contained	4	each	35,000.00	140,000
54"x84" self-contained	4	each	35,000.00	140,000
Valves				
Plug Valves, 6"	6	each	1,075.00	6,450
Mud Valves	3	each	500.00	1,500
Process piping	13,850	lbs	5.50	76,175
Pipe Supports		Lump Sum		7,618
Miscellaneous Piping and Valves		Lump Sum		5,000
Fire Protection	1,500	sq ft	3.50	5,250
HVAC	1,500	sq ft	35.00	52,500
Plumbing	1,500	sq ft	10.00	15,000
Total - Grit Facilities				1,261,901
GRIT EQUIPMENT IN EXISTING GRIT BASINS (34 mgd HEADCELL)				
Grit Removal Equipment - Headcell		Lump Sum		790,000
Grit Equipment Installation	40	percent		316,000
Grit Classifying and Washing			(included in Grit Equip cost)	
Grit Dewatering			(included in Grit Equip cost)	
Grit Pumps		Lump Sum		90,000
Installation	40	percent		36,000
Total - Grit Equipment				1,232,000
GRIT FACILITIES (34 mgd) ODOR CONTROL				
Odor Control Equipment		Lump Sum		
Total - Odor Control				184,614
IN-PLANT INFLUENT PUMP STATION PUMP MODIFICATIONS				
Pump & Motor Modifications	3	each	30,000.00	90,000
Installation	40	percent		36,000
Total Pump Station Modifications				126,000
Subtotal				14,559,949
Electrical, Instrumentation, & Controls		Lump Sum	25%	3,640,000
Subtotal				18,199,949
Typical Sitework		Lump Sum	10%	1,820,000
Subtotal				20,020,000
General Requirements		Lump Sum	12%	2,402,000
Flood Protection (placeholder)	4,444	cu yd	25.00	111,111
Site Remediation (placeholder)	0	cu yd	150.00	0
Subtotal				22,533,000
Contingency		Lump Sum	25%	5,633,000
Land Acquisition (placeholder)	0	sq ft	1.33	0
Opinion of Probable Construction Cost				28,166,000
Engineering, Legal, & Administration		Lump Sum	20%	5,633,000
Opinion of Probable Project Cost				33,799,000

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Missouri Avenue Grit Evaluation - "Z" Removal
Probable Construction Cost

<u>Item Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost, \$</u>	<u>Total Cost, \$</u>
MISCELLANEOUS SITEWORK				
Major Piping				
30" Concrete Pipe	60	lin ft	460.00	27,600
8' Diameter Manhole	1	each	15,100.00	15,100
Total - Special Sitework				42,700
DIVERSION STRUCTURE				
10 ft x 10 ft Structure				
Earthwork				
Structural Excavation	381	cu yd	20.00	7,620
Compacted Fill	265	cu yd	25.00	6,625
Granular Fill	8	cu yd	35.00	280
Concrete, cast-in-place				
Slab on Grade/Footings	11	cu yd	530.00	5,830
Walls	26	cu yd	850.00	22,100
Suspended Slab and Beam	4	cu yd	950.00	3,800
30" circular frame with floorstand	1	each	15,000.00	15,000
3'x3' Access Hatch	1	each	3,000.00	3,000
Total - Diversion Structure				64,255
TOTAL MISSOURI AVENUE MODIFICATIONS				106,955
Electrical, Instrumentation, & Controls	Lump Sum		0%	0
Subtotal				106,955
Typical Sitework	Lump Sum		10%	11,000
Subtotal				118,000
General Requirements	Lump Sum		12%	14,000
Flood Protection (placeholder)	44	cu yd	25.00	1,111
Site Remediation (placeholder)	0	cu yd	150.00	0
Subtotal				133,000
Contingency	Lump Sum		25%	33,000
Land Acquisition (placeholder)	10,000	sq ft	1.33	13,300
Opinion of Probable Construction Cost				179,000
Engineering, Legal, & Administration	Lump Sum		20%	36,000
Opinion of Probable Project Cost				215,000

Appendix B

Opinion of Probable O&M Cost Breakdown

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-1 - Combined 88 mgd Vortex - North Property

Operation & Maintenance Cost

	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year		
Labor Costs						
Screens	2.5	365	32.78	29,914	Labor rate =	\$32.78
Pista	2.5	365	32.78	29,914		
Pumps	0.3	365	32.78	2,991		
Screenings & Grit Disposal	1.0	365	32.78	11,966		
Total Labor Costs/Year				\$74,785		

	Tons/Day	Days/ Year	\$/Ton	Yearly Cost
Disposal Cost				
Plant Flow				
Screenings	2.23	365	30	24,432
Grit	1.16	365	30	12,738
Wet Weather Flow		Tons/Year		
Screenings		244	30	7,324
Grit		127	30	3,818
Total Disposal Costs/Year				\$48,312
Total Tons/Year				1,610
Average Tons/Day				4.4
Base hauling on every other day trip and no weekends				
Distance to Landfill (miles)				8.0
	Cost/Trip	Trips/Year		
Hauling Cost (no labor)/Year	58	183		\$10,585
Total Hauling and Disposal/Year				\$58,897

Notes:

1. Hourly rate (including benefits) from Craig Rippey May 28, 2009
2. Landfill Disposal fee \$30/ton from Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Screening & Grit Equipment	\$2,534,700	1%	\$25,347

	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day
Power						
Screens	2.00	1	2	2.7	24	64
Screen Washer and Compactor	8.00	1	8	10.7	3	32
Pista Gear Drive	2.00	1	2	2.7	24	64
Pista Grit Pump	15.00	1	15	20.1	24	483
Dewatering Conveyor	1.00	1	1	1.3	24	32
		Total hp	28		Total kWhr	676

Power Consumption and Cost

kWhr/Day	676.0
Power Cost (\$/kWhr)	0.10
Power Cost/Year (\$)	\$24,673

Odor Control Cost (from Gayle VanDurme)	
Total Odor Control Power Cost/Year (\$)	\$15,194
Total Odor Control Cost (excludes power)/Year (\$)	\$74,169

St. Joseph, Missouri
 TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
 Alternative 1C-2 - Combined 88 mgd Headcell - North Property

Operation & Maintenance Cost

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year		
Screens	2.5	365	32.78	29,914	Labor rate =	\$32.78
Headcell	2.5	365	32.78	29,914		
Pumps	0.3	365	32.78	2,991		
Screenings & Grit Disposal	1.0	365	32.78	11,966		
Total Labor Costs/Year				\$74,785		

Disposal Cost	Tons/Day	Days/ Year	\$/Ton	Yearly Cost
Plant Flow				
Screenings	2.23	365	30	24,432
Grit	1.16	365	30	12,738
Wet Weather Flow		Tons/Year		
Screenings		244	30	7,324
Grit		127	30	3,818
Total Disposal Costs/Year				\$48,312
Total Tons/Year				1,610
Average Tons/Day				4.4
Base hauling on every other day trip and no weekends				
Distance to Landfill (miles)				8.0
	Cost/Trip	Trips/Year		
Hauling Cost (no labor)/Year	58	183		\$10,585
Total Hauling and Disposal/Year				\$58,897

Notes:

1. Hourly rate (including bennefits) from Craig Rippey May 28, 2009
2. Landfill Disposal fee \$30/ton per Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Screening & Grit Equipment	\$3,213,700	1%	\$32,137

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day
Screens	2.00	1.0	2.0	2.7	24	64
Screen Washer and Compactor	8.00	1.0	8.0	10.7	3	32
Headcell Grit Pump	15.00	1.0	15.0	20.1	24	483
Grit Snail	0.33	1.0	0.3	0.4	24	11
		Total hp	25		Total kWhr	590

Power Consumption and Cost

kWhr/Day	590.0
Power Cost (\$/kWhr)	0.10
Power Cost/Year (\$)	\$21,536

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$)	\$15,337
Total Odor Control Cost (excludes power)/Year (\$)	\$74,783

St. Joseph, Missouri

TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities

Alternative 2C - Separate Facilities

Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd), Screens and Storm King at West Property (61 mgd)

Operation & Maintenance Cost

34 mgd Screens at North Property

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year		
Screens	2.5	365	32.78	29,914	Labor rate =	\$32.78
Pumps	0.3	365	32.78	2,991		
Screenings Disposal	1.0	365	32.78	11,966		
Total Labor Costs/Year				\$44,871		
Disposal Cost	Tons/Day	Days/ Year	\$/Ton	Yearly Cost		
Screenings (plant flow)	2.23	365	30	24,432		
Total Disposal Costs/Year				\$24,432		
Total Tons/Year				814		
Average Tons/Day				2.2		
Base hauling on every other day trip and no weekends						
Distance to Landfill (miles)				8.0		
Hauling Cost (no labor)/Year	Cost/Trip	Trips/Year				
	58	183		\$10,585		
Total Hauling and Disposal/Year				\$35,017		

Notes:

1. Hourly rate (including bennefits) from Craig Rippey May 28, 2009
2. Landfill Disposal fee \$30/ton from Don Gilpin

Major Maintenance Costs 1.0%

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Screening Equipment	\$5,472,880	1%	\$54,729

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day	Days/ Year	kWhr
Screens	2.00	1	2	2.7	24	64	365	23,498
Screen Washer and Compactor	8.00	1	8	10.7	3	32	365	11,749
		Total hp	10		Total kWhr	97	kWhr/Year	35,247

Power Consumption and Cost

kWhr/yr	35246.8
Power Cost (\$/kWhr)	0.10
Power Cost/Year (\$)	\$3,525

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$)	\$10,079
Total Odor Control Cost (excludes power)/Year (\$)	\$49,186

34 mgd Headcell in Existing Grit Basins

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year
Headcell	2.5	365	32.78	29,914
Pumps	0.3	365	32.78	2,991
Grit Disposal	1.0	365	32.78	11,966
Total Labor Costs/year				\$44,871

Disposal Cost	Tons/Day	Days/ Year	\$/Ton	Yearly Cost
Grit (plant flow)				
Total Disposal Costs/Year	1.16	365	30	12,738
Total Disposal Costs/Year				\$12,738
Total Tons/Year				425
Average Tons/Day				1.2
Base hauling on every other day trip and no weekends				
Distance to Landfill (miles)				8.0
Hauling Cost (no labor)/Year	Cost/Trip	Trips/Year		
	58	183		\$10,585
Total Hauling and Disposal/Year				\$23,323

Notes:

1. Hourly rate (including bennefits) from Craig Rippey May 28, 2009
2. Landfill Disposal fee \$30/ton per Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Grit Equipment	\$1,190,000	1%	\$11,900

St. Joseph, Missouri

TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities

Alternative 2C - Separate Facilities

Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd), Screens and Storm King at West Property (61 mgd)

Operation & Maintenance Cost

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day	Days/ Year	kWhr
Headcell Grit Pump	10.00	1	10	13.4	24	322	365	117,489
Grit Snail	0.33	1	0	0.4	24	11	365	3,877
		Total hp	10		Total kWhr	333	kWhr/Year	121,366

Power Consumption and Cost

	kWhr/Year
Power Cost (\$/kWhr)	121366.4
Power Cost/Year (\$)	0.10
	\$12,137

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$) **\$10,079**

Total Odor Control Cost (excludes power)/Year (\$) **\$28,018**

61 mgd Storm King at West Property

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year
Screens	2.5	50	32.78	4,098
Headcell	2.5	50	32.78	4,098
Pumps	0.3	50	32.78	410
Screenings & Grit Disposal	1.0	50	32.78	1,639
Screen & Grit Cleanup	2.0	50	32.78	3,278
Total Labor Costs/Year				\$13,523

Disposal Cost	Tons/ Year	\$/Ton	Yearly Cost
Screenings (wet weather)	244	30	7,324
Grit (wet weather)	127	30	3,818
Total Disposal Costs/Year			\$11,142
Total Tons/Year			371
Average Tons/Day			1.0
Base hauling on every other day trip and no weekends			
Distance to Landfill (miles)			
			8.0
	Cost/Trip	Trips/Year	
	58	50	
Hauling Cost (no labor)/Year			\$2,900
Total Hauling and Disposal/Year			\$14,042

Notes:

- Hourly rate (including benefits) from Craig Rippey May 28, 2009
- Landfill Disposal fee \$30/ton per Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

Screening & Grit Equipment	Cost	%	Cost/Year
	\$3,262,280	1%	\$32,623

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day	Days/ Year	kWhr
Screens	2.00	1	2	2.7	12	32	50	1,609
Screen Washer and Compactor	8.00	1	8	10.7	1.5	16	50	805
Storm King Grit Pump	15.00	1	15	20.1	1.5	30	50	1,509
Grit King Grit Pump	5.00	1	5	6.7	12	80	50	4,024
Grit Snail	0.33	1	0	0.4	12	5	50	266
		Total hp	30		Total kWhr	164	kWhr/Year	8,212

Power Consumption and Cost

	kWhr/Year
Power Cost (\$/kWhr)	8212.2
Power Cost/Year (\$)	0.10
	\$821

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$) **\$14,651**

Total Odor Control Cost (excludes power)/Year (\$) **\$71,835**

St. Joseph, Missouri

TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities

Alternative 3A-1 - Separate Facilities

Vortex near Exist Grit Basin (34 mgd), Vortex at North Property (61 mgd), Screens at North Property (88 mgd)

Operation & Maintenance Cost

88 mgd Screens & 61 mgd Vortex at North Property

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year		
Screens	2.5	365	32.78	29,914	Labor rate =	\$32.78
PISTA	2.5	50	32.78	4,098		
Pumps	0.3	365	32.78	2,991		
Screenings & Grit Disposal	1.0	365	32.78	11,966		
Screen & Grit Cleanup	2.0	50	32.78	3,278		
Total Labor Costs/Year				\$76,178		

Disposal Cost	Tons/Day	Days/ Year	\$/Ton	Yearly Cost
Screenings (plant)	2.23	365	30	24,432
		Tons/Year		
Screenings (wet weather)		244	30	7,324
Grit (wet weather)		127	30	3,818
Total Disposal Costs/Year				\$35,574
Total Tons/Year				1,186
Average Tons/Day				3.2
Base hauling on every other day trip and no weekends				
Distance to Landfill (miles)				8.0
	Cost/Trip	Trips/Year		
Hauling Cost (no labor)/Year	58	183		\$10,585
Total Hauling and Disposal/Year				\$46,159

Notes:

1. Hourly rate (including benefits) from Craig Rippey May 28, 2009
2. Landfill Disposal fee \$30/ton per Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Screening & Grit Equipment	\$4,870,614	1%	\$48,706

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day	Days/ Year	kWhr
Screens	2.00	1	2	2.7	24	64	365	23,498
Screen Washer and Compactor	8.00	1	8	10.7	3	32	365	11,749
Screens	2.00	1	2	2.7	12	32	50	1,609
Screen Washer and Compactor	8.00	1	8	10.7	1.5	16	50	805
PISTA Grit Pump	10.00	1	10	13.4	12	161	50	8,047
PISTA Gear Drive	2.00	1	2	2.7	12	32	50	1,609
Grit Conveyor	0.33	1	0	0.4	12	5	50	266
		Total hp	32		Total kWhr	343	kWhr/Year	47,583

Power Consumption and Cost

kWhr/yr	47583.2
Power Cost (\$/kWhr)	0.10
Power Cost/Year (\$)	\$4,758

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$)	\$14,484
Total Odor Control Cost (excludes power)/Year (\$)	\$71,118

34 mgd Vortex near Existing Grit Basins

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year
PISTA	2.5	365	32.78	29,914
Pumps	0.3	365	32.78	2,991
Grit Disposal	1.0	365	32.78	11,966
Total Labor Costs/Year				\$44,871

St. Joseph, Missouri

TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities

Alternative 3A-1 - Separate Facilities

Vortex near Exist Grit Basin (34 mgd), Vortex at North Property (61 mgd), Screens at North Property (88 mgd)

Operation & Maintenance Cost

Disposal Cost	Tons/Day	Days/ Year	\$/Ton	Yearly Cost
Grit (plant)	1.16	365	30	12,738
Total Disposal Costs/Year				\$12,738
Total Tons/Year				425
Average Tons/Day				1.2
Base hauling on every other day trip and no weekends				
Distance to Landfill (miles)				8.0
	Cost/Trip	Trips/Year		
Hauling Cost (no labor)/Year	58	183		\$10,585
Total Hauling and Disposal/Year				\$23,323

Notes:

1. Hourly rate (including benefits) from Craig Rippey May 28, 2009
2. Landfill Disposal fee \$30/ton per Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Grit Equipment	\$504,000	1%	\$5,040

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day	Days/ Year	kWhr
PISTA Grit Pump	15.00	1	15	20.1	24	483	365	176,234
PISTA Gear Drive	2.00	1	2	2.7	24	64	365	23,498
Grit Conveyor	1.00	1	1	1.3	3.0	4	365	1,469
		Total hp	18		Total kWhr	551	kWhr/Year	201,200

Power Consumption and Cost

kWhr/Year	201200.4
Power Cost (\$/kWhr)	0.10
Power Cost/Year (\$)	\$20,120

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$)	\$4,482
Total Odor Control Cost (excludes power)/Year (\$)	\$24,510

St. Joseph, Missouri

TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities

Alternative 3A-2 - Separate Facilities

Headcell at Exist Grit Basins (34 mgd), Storm King at North Property (61 mgd), Screens at North Property (88 mgd)

Operation & Maintenance Cost

88 mgd Screens & 61 mgd Storm King at North Property

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year		
Screens	2.5	365	32.78	29,914	Labor rate =	\$32.78
Storm King	2.5	50	32.78	4,098		
Pumps	0.3	365	32.78	2,991		
Screenings & Grit Disposal	1.0	365	32.78	11,966		
Screen & Grit Cleanup	2.0	50	32.78	3,278		
Total Labor Costs/Year				\$52,247		

Disposal Cost	Tons/Day	Days/ Year	\$/Ton	Yearly Cost
Screenings (plant)	2.23	365	30	24,432
		Tons/Year		
Screenings (wet weather)		244	30	7,324
Grit (wet weather)		127	30	3,818
Total Disposal Costs/Year				\$35,574
Total Tons/Year				1,186
Average Tons/Day				3.2
Base hauling on every other day trip and no weekends				
Distance to Landfill (miles)				8.0

Hauling Cost (no labor)/Year	Cost /Trip	Trips/Year	
	58	183	\$10,585
Total Hauling and Disposal/Year			\$46,159

Notes:

1. Hourly rate (including benefits) from Craig Rippey May 28, 2009
2. Landfill Disposal fee \$30/ton per Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Screening & Grit Equipment	\$4,599,280	1%	\$45,993

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day	Days/ Year	kWhr
Screens	2.00	2	4	5.4	24	129	365	46,996
Screen Washer and Compactor	8.00	2	16	21.5	3.0	64	365	23,498
Screens	2.00	1	2	2.7	12	32	50	1,609
Screen Washer and Compactor	8.00	1	8	10.7	1.5	16	50	805
Storm King Grit Pump	15.00	1	15	20.1	12	241	50	12,071
Grit King Grit Pump	5.00	1	5	6.7	12	80	50	4,024
Grit Snail	0.33	1	0	0.4	12	5	50	266
		Total hp	50		Total kWhr	569	kWhr/Year	89,268

Power Consumption and Cost

kWhr/Year	89267.7
Power Cost (\$/kWhr)	0.10
Power Cost/Year (\$)	\$8,927

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$)	\$15,563
Total Odor Control Cost (excludes power)/Year (\$)	\$75,755

St. Joseph, Missouri

TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities

Alternative 3A-2 - Separate Facilities

Headcell at Exist Grit Basins (34 mgd), Storm King at North Property (61 mgd), Screens at North Property (88 mgd)

Operation & Maintenance Cost

34 mgd Headcell in Existing Grit Basins

Labor Costs	Hours/ Day	Days/ Year	Hourly Rate (\$/hr)	\$/Year
PISTA	2.5	365	32.78	29,914
Pumps	0.3	365	32.78	2,991
Grit Disposal	1.0	365	32.78	11,966
Total Labor Costs/Year				\$44,871

Disposal Cost	Tons/Day	Days/ Year	\$/Ton	Yearly Cost
Grit (plant)	1.16	365	30	12,738
Total Disposal Costs/Year				\$12,738
Total Tons/Year				425
Average Tons/Day				1.2
Base hauling on every other day trip and no weekends				
Distance to Landfill (miles)				8.0
	Cost/Trip	Trips/Year		
Hauling Cost (no labor)/Year	58	183		\$10,585
Total Hauling and Disposal/Year				\$23,323

Notes:

- Hourly rate (including bennefits) from Craig Rippey May 28, 2009
- Landfill Disposal fee \$30/ton per Don Gilpin

Major Maintenance Costs

1.0% of equipment costs annually (replacement parts and non plant personnel)

	Cost	%	Cost/Year
Grit Equipment	\$1,232,000	1%	\$12,320

Power	hp	Number	Total hp	kW	Run Time/ Day (hrs)	kWhr/ Day	Days/ Year	kWhr
Headcell Grit Pump	10.00	1	10	13.4	24	322	365	117,489
Grit Snail	0.33	1	0	0.4	3	1	365	485
		Total hp	10		Total kWhr	323	kWhr/Year	117,974

Power Consumption and Cost

kWhr/Year	117973.9
Power Cost (\$/kWhr)	0.10
Power Cost/Year (\$)	\$11,797

Odor Control Cost (from Gayle VanDurme)

Total Odor Control Power Cost/Year (\$) **\$10,079**

Total Odor Control Cost (excludes power)/Year (\$) **\$28,018**

Appendix C

Opinion of Probable Net Present Worth Breakdown

St. Joseph, Missouri
TM-CSO-12/TM-VW-3 - Screening and Grit Removal Facilities
Alternative 1C-1 - Combined 88 mgd Vortex - North Property

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost (\$)	2009 Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024	
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20					
					1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689					
Flow Meter Vaults	2,009																													
Structure	2,009	50	\$846,969	\$846,969	\$846,969	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$1,966,502			
Equipment	2,009	20	\$105,000	\$105,000	\$105,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$406,317			
Screening and Grit Facilities	2,009																													
Structure	2,009	50	\$5,013,888	\$5,013,888	\$5,013,888	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$11,641,298			
Equipment	2,009	20	\$2,534,700	\$2,534,700	\$2,534,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$9,808,489			
Odor Control Equipment	2,009	20	\$470,000	\$470,000	\$470,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$1,818,752			
In-Plant Influent Pump Station Modifications	2,009	20	\$126,000	\$126,000	\$126,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$487,580			
Electrical, Instrumentation, and Controls	2,009	20	\$2,887,000	\$2,887,000	\$2,887,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$11,171,779			
Special Sitework	2,009	50	\$2,450,600	\$2,450,600	\$2,450,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$5,689,829			
Land Acquisition	2,009	10,000	\$0	\$0																										
	2,009																													
Sitework	2,009	50	\$1,443,000	\$1,443,000	\$1,443,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
General Requirements	2,009		\$1,905,000	\$1,905,000	\$1,905,000																									
Flood Protection/Fill (placeholder)	2,009		\$111,111	\$111,111	\$111,111																									
Site Remediation (placeholder)	2,009		\$0	\$0	\$0																									
Contingency	2,009		\$4,473,000	\$4,473,000	\$4,473,000																									
Construction Subtotal			\$22,366,268	\$22,366,268	\$22,366,268										\$0										\$23,690,000					
Engineering, Legal, and Administration	20%	2,009	\$4,473,000	\$4,473,000	\$4,473,254																									
Interest During Construction (yrs)		0																												
Opinion of Probable Project Cost			\$26,840,000	\$26,840,000	\$26,840,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$23,690,000		\$42,990,546			
Factored Totals					\$26,840,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$8,929,000	\$35,769,000	\$16,202,684	\$19,566,316	\$1,600,000	

O&M Elements	2009 Annual Cost (\$)	2009 Year Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
			Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20		
			1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689		
Power Costs (excluding odor control)	\$24,673	\$24,700	\$24,700	\$25,935	\$27,232	\$28,593	\$30,023	\$31,524	\$33,100	\$34,755	\$36,493	\$38,318	\$40,234	\$42,245	\$44,358	\$46,576	\$48,904	\$51,350	\$53,917	\$56,613	\$59,443	\$62,416	\$65,536		
Labor Costs	\$74,785	\$74,800	\$74,800	\$78,540	\$82,467	\$86,590	\$90,920	\$95,466	\$100,239	\$105,251	\$110,514	\$116,039	\$121,841	\$127,933	\$134,330	\$141,047	\$148,099	\$155,504	\$163,279	\$171,443	\$180,015	\$189,016	\$198,467		
Screenings & Grit Hauling and Disposal Costs	\$58,897	\$58,900	\$58,900	\$61,845	\$64,937	\$68,184	\$71,593	\$75,173	\$78,932	\$82,878	\$87,022	\$91,373	\$95,942	\$100,739	\$105,776	\$111,065	\$116,618	\$122,449	\$128,571	\$135,000	\$141,750	\$148,837	\$156,279		
Equipment Maintenance	\$25,347	\$25,300	\$25,300	\$26,565	\$27,893	\$29,288	\$30,752	\$32,290	\$33,904	\$35,600	\$37,380	\$39,249	\$41,211	\$43,272	\$45,435	\$47,707	\$50,092	\$52,597	\$55,227	\$57,988	\$60,887	\$63,932	\$67,128		
Odor Control (excluding power)	\$74,169	\$74,200	\$74,200	\$77,910	\$81,806	\$85,896	\$90,191	\$94,700	\$99,435	\$104,407	\$109,627	\$115,109	\$120,864	\$126,907	\$133,253	\$139,915	\$146,911	\$154,256	\$161,969	\$170,068	\$178,571	\$187,500	\$196,875		
Odor Control Power	\$15,194	\$15,200	\$15,200	\$15,960	\$16,758	\$17,596	\$18,476	\$19,399	\$20,369	\$21,388	\$22,457	\$23,580	\$24,759	\$25,997	\$27,297	\$28,662	\$30,095	\$31,600	\$33,180	\$34,839	\$36,581	\$38,410	\$40,330		
Opinion of Probable O&M Cost	\$273,065		\$273,100	\$286,755	\$301,093	\$316,147	\$331,955	\$348,552	\$365,980	\$384,279	\$403,493	\$423,668	\$444,851	\$467,094	\$490,448	\$514,971	\$540,719	\$567,755	\$596,143	\$625,950	\$657,248	\$690,110	\$724,616		
Factored Totals			\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$273,100	\$5,736,000	\$460,271

Economic Analysis Criteria:

Baseline for costs = May-09
ENR Building Cost Index = 4.773
Interest Rate = 5.00%
Capital Escalation Rate = 7.00%
O&M Escalation Rate = 5.00%

Net Present Worth = \$25,302,316

\$19,566,316
\$5,736,000
\$25,302,316

St. Joseph, Missouri
TM-CSO-12/TM-WW-3 - Screening and Grit Removal Facilities
Alternative 1C-2 - Combined 88 mgd Headcell - North Property

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost (\$)	2009 Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024	
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20					
Flow Meter Vaults	2,009				1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689					
Structure	2,009	50	\$846,969	\$846,969	\$846,969	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		\$1,966,502			
Equipment	2,009	20	\$105,000	\$105,000	\$105,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$406,317	\$406,317			
Screening and Grit Facilities	2,009																													
Structure	2,009	50	\$4,576,000	\$4,576,000	\$4,576,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$10,624,606			
Equipment	2,009	20	\$3,213,700	\$3,213,700	\$3,213,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$12,436,005	\$12,436,005			
Odor Control Equipment	2,009	20	\$470,000	\$470,000	\$470,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$1,818,752	\$1,818,752			
In-Plant Influent Pump Station Modifications	2,009	20	\$126,000	\$126,000	\$126,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$487,580	\$487,580			
Electrical, Instrumentation, and Controls	2,009	20	\$2,947,000	\$2,947,000	\$2,947,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$11,403,960	\$11,403,960			
Special Sitework	2,009	50	\$2,450,600	\$2,450,600	\$2,450,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$5,689,829			
Land Acquisition	2,009	10,000	\$0	\$0																										
	2,009																													
Sitework	2,009	50	\$1,474,000	\$1,474,000	\$1,474,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
General Requirements	2,009		\$1,945,000	\$1,945,000	\$1,945,000																									
Flood Protection/Fill (placeholder)	2,009		\$111,111	\$111,111	\$111,111																									
Site Remediation (placeholder)	2,009		\$0	\$0	\$0																									
Contingency	2,009		\$4,566,000	\$4,566,000	\$4,566,000																									
Construction Subtotal			\$22,831,380	\$22,831,380	\$22,831,380										\$0										\$26,550,000					
Engineering, Legal, and Administration	20%	2,009		\$4,566,000	\$4,566,000																									
Interest During Construction (yrs)		0																												
Opinion of Probable Project Cost			\$27,400,000	\$27,400,000	\$27,400,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$26,550,000	\$44,833,550			
Factored Totals					\$27,400,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$10,006,000	\$37,406,000	\$16,897,294	\$20,508,706	\$1,600,000

O&M Elements	2009 Annual Cost (\$)	2009 Year Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
			Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20		
			1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689		
Power Costs (excluding odor control)	\$21,536	\$21,500	\$21,500	\$22,576	\$23,704	\$24,889	\$26,133	\$27,440	\$28,812	\$30,253	\$31,765	\$33,354	\$35,021	\$36,772	\$38,611	\$40,541	\$42,569	\$44,697	\$46,932	\$49,278	\$51,742	\$54,329	\$57,046		
Labor Costs	\$74,785	\$74,800	\$74,800	\$78,540	\$82,467	\$86,590	\$90,920	\$95,466	\$100,239	\$105,251	\$110,514	\$116,039	\$121,841	\$127,933	\$134,330	\$141,047	\$148,099	\$155,504	\$163,279	\$171,443	\$180,015	\$189,016	\$198,467		
Screenings & Grit Hauling and Disposal Costs	\$58,897	\$58,900	\$58,900	\$61,845	\$64,937	\$68,184	\$71,593	\$75,173	\$78,932	\$82,878	\$87,022	\$91,373	\$95,942	\$100,739	\$105,776	\$111,065	\$116,618	\$122,449	\$128,571	\$135,000	\$141,750	\$148,837	\$156,279		
Equipment Maintenance	\$32,137	\$32,100	\$32,100	\$33,705	\$35,390	\$37,160	\$39,018	\$40,969	\$43,017	\$45,168	\$47,426	\$49,798	\$52,288	\$54,902	\$57,647	\$60,529	\$63,556	\$66,734	\$70,070	\$73,574	\$77,252	\$81,115	\$85,171		
Odor Control (excluding power)	\$74,783	\$74,800	\$74,800	\$78,540	\$82,467	\$86,590	\$90,920	\$95,466	\$100,239	\$105,251	\$110,514	\$116,039	\$121,841	\$127,933	\$134,330	\$141,047	\$148,099	\$155,504	\$163,279	\$171,443	\$180,015	\$189,016	\$198,467		
Odor Control Power	\$15,337	\$15,300	\$15,300	\$16,065	\$16,868	\$17,712	\$18,597	\$19,527	\$20,503	\$21,529	\$22,605	\$23,735	\$24,922	\$26,168	\$27,477	\$28,850	\$30,293	\$31,808	\$33,398	\$35,068	\$36,821	\$38,662	\$40,595		
Opinion of Probable O&M Cost	\$277,475		\$277,400	\$291,270	\$305,834	\$321,125	\$337,181	\$354,041	\$371,743	\$390,330	\$409,846	\$430,338	\$451,855	\$474,448	\$498,171	\$523,079	\$549,233	\$576,695	\$605,529	\$635,806	\$667,596	\$700,976	\$736,025		
Factored Totals			\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$277,400	\$5,826,000	\$467,493

Net Present Worth = \$26,334,706

\$20,508,706
\$5,826,000
\$26,334,706

Economic Analysis Criteria:

Baseline for costs = May-09
ENR Building Cost Index = 4,773
Interest Rate = 5.00%
Capital Escalation Rate = 7.00%
O&M Escalation Rate = 5.00%

St. Joseph, Missouri
TM-CSO-12/TM-VVW-3 - Screening and Grit Removal Facilities
Alternative 2C - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Screens at North Property (34 mgd), Screens and Storm King at West Property (61 mgd)

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost (\$)	2009 Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024	
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20					
					1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689					
Flow Meter Vaults	2,009																													
Structure, Valves, and Piping	2,009	50	\$891,302	\$891,302	\$891,302																				-	\$2,069,435				
Equipment	2,009	20	\$105,000	\$105,000	\$105,000																				\$406,317	\$406,317				
61 mgd West Screening and Grit Facilities	2,009																													
Structure, Valves, and Piping	2,009	50	\$3,682,000	\$3,682,000	\$3,682,000																				-	\$8,548,907				
Equipment	2,009	20	\$3,262,280	\$3,262,280	\$3,262,280																				\$12,623,994	\$12,623,994				
Odor Control Equipment	2,009	20	\$470,000	\$470,000	\$470,000																				\$1,818,752	\$1,818,752				
Flow Splitter Box	2,009																													
Structure, Valves, and Piping	2,009	50	\$141,280	\$141,280	\$141,280																				-	\$328,025				
34 mgd North Screening Facilities	2,009																													
Structure, Valves, and Piping	2,009	50	\$1,722,000	\$1,722,000	\$1,722,000																				-	\$3,998,158				
Equipment	2,009	20	\$1,020,600	\$1,020,600	\$1,020,600																				\$3,949,400	\$3,949,400				
Odor Control Equipment	2,009	20	\$286,482	\$286,482	\$286,482	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$1,108,595	\$1,108,595				
34 mgd Existing Grit Basin Modifications	2,009																													
Structure, Valves, and Piping	2,009	50	\$873,030	\$873,030	\$873,030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$2,027,010			
34 mgd Existing Grit Basin Modifications	2,009																													
Equipment	2,009	20	\$1,190,000	\$1,190,000	\$1,190,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$4,604,925	\$4,604,925				
Odor Control Equipment	2,009	20	\$184,614	\$184,614	\$184,614																					\$714,398	\$714,398			
In-Plant Influent Pump Station Modifications	2,009	20	\$126,000	\$126,000	\$126,000																					\$487,580	\$487,580			
Special Sitework	2,009	50	\$2,394,800	\$2,394,800	\$2,394,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$5,560,272			
Electrical, Instrumentation, and Controls	2,009	20	\$4,087,000	\$4,087,000	\$4,087,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$15,815,400	\$15,815,400				
Land Acquisition	2,009	10,000	\$53,200	\$53,200	\$53,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$205,455			
Sitework	2,009	50	\$2,044,000	\$2,044,000	\$2,044,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
General Requirements	2,009		\$2,698,000	\$2,698,000	\$2,698,000																									
Flood Protection/Fill (placeholder)	2,009		\$185,185	\$185,185	\$185,185																									
Site Remediation (placeholder)	2,009		\$1,296,296	\$1,296,296	\$1,296,296																									
Contingency	2,009		\$6,665,000	\$6,665,000	\$6,665,000																									
Construction Subtotal			\$33,378,069	\$33,378,069	\$33,378,069										\$0										\$41,530,000					
Engineering, Legal, and Administration	20%	2,009		\$6,675,000	\$6,675,000																									
Interest During Construction (yrs)		0																												
Opinion of Probable Project Cost			\$40,050,000	\$40,050,000	\$40,050,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$41,530,000	\$64,266,624				
Factored Totals					\$40,050,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$15,652,000	\$55,702,000	\$24,221,415	\$31,480,585	\$2,500,000

O&M Elements	2009 Annual Cost (\$)	2009 Year Cost (\$)	2009 Year 0	2010 Year 1	2011 Year 2	2012 Year 3	2013 Year 4	2014 Year 5	2015 Year 6	2016 Year 7	2017 Year 8	2018 Year 9	2019 Year 10	2020 Year 11	2021 Year 12	2022 Year 13	2023 Year 14	2024 Year 15	2025 Year 16	2026 Year 17	2027 Year 18	2028 Year 19	2029 Year 20	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
			1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689		
61 mgd West Screen & Grit Facilities																									
Power Costs (excluding odor control)	\$821	\$800	\$800	\$840	\$882	\$926	\$972	\$1,021	\$1,072	\$1,126	\$1,182	\$1,241	\$1,303	\$1,368	\$1,437	\$1,509	\$1,584	\$1,663	\$1,746	\$1,834	\$1,925	\$2,022	\$2,123		
Labor Costs	\$13,523	\$13,500	\$13,500	\$14,175	\$14,884	\$15,628	\$16,409	\$17,230	\$18,091	\$18,996	\$19,946	\$20,943	\$21,990	\$23,090	\$24,244	\$25,456	\$26,729	\$28,066	\$29,469	\$30,942	\$32,489	\$34,114	\$35,820		
Screenings & Grit Hauling and Disposal Costs	\$14,042	\$14,000	\$14,000	\$14,700	\$15,435	\$16,207	\$17,017	\$17,868	\$18,761	\$19,699	\$20,684	\$21,719	\$22,805	\$23,945	\$25,142	\$26,399	\$27,719	\$29,105	\$30,560	\$32,088	\$33,693	\$35,377	\$37,146		
Equipment Maintenance	\$32,623	\$32,600	\$32,600	\$34,230	\$35,942	\$37,739	\$39,626	\$41,607	\$43,687	\$45,871	\$48,165	\$50,573	\$53,102	\$55,757	\$58,545	\$61,472	\$64,546	\$67,773	\$71,162	\$74,720	\$78,456	\$82,379	\$86,498		
Odor Control (excluding power)	\$49,186	\$49,200	\$49,200	\$51,660	\$54,243	\$56,955	\$59,803	\$62,793	\$65,933	\$69,229	\$72,691	\$76,325	\$80,142	\$84,149	\$88,356	\$92,774	\$97,413	\$102,283	\$107,397	\$112,767	\$118,406	\$124,326	\$130,542		
Odor Control Power	\$10,079	\$10,100	\$10,100	\$10,605	\$11,135	\$11,692	\$12,277	\$12,890	\$13,535	\$14,212	\$14,922	\$15,668	\$16,452	\$17,274	\$18,138	\$19,045	\$19,997	\$20,997	\$22,047	\$23,149	\$24,307	\$25,522	\$26,798		
34 mgd North Screen Facilities																									
Power Costs (excluding odor control)	\$3,525	\$3,500	\$3,500	\$3,700	\$3,900	\$4,100	\$4,300	\$4,500	\$4,700	\$4,900	\$5,100	\$5,400	\$5,700	\$6,000	\$6,300	\$6,600	\$6,900	\$7,200	\$7,600	\$8,000	\$8,400	\$8,800	\$9,200		
Labor Costs	\$44,871	\$44,900	\$44,900	\$47,100	\$49,500	\$52,000	\$54,600	\$57,300	\$60,200	\$63,200	\$66,400	\$69,700	\$73,200	\$76,900	\$80,700	\$84,700	\$88,900	\$93,300	\$98,000	\$102,900	\$108,000	\$113,400	\$119,100		
Screenings Hauling and Disposal Costs	\$35,017	\$35,000	\$35,000	\$36,800	\$38,600	\$40,500	\$42,500	\$44,600	\$46,800	\$49,100	\$51,600	\$54,200	\$56,900	\$59,700	\$62,700	\$65,800	\$69,100	\$72,600	\$76,200	\$80,000	\$84,000	\$88,200	\$92,600		
Equipment Maintenance	\$54,729	\$54,700	\$54,700	\$57,400	\$60,300	\$63,300	\$66,500	\$69,800	\$73,300	\$77,000	\$80,900	\$84,900	\$89,100	\$93,600	\$98,300	\$103,200	\$108,400	\$113,800	\$119,500	\$125,500	\$131,800	\$138,400	\$145,300		
Odor Control (excluding power)	\$28,018	\$28,000	\$28,000	\$29,400	\$30,870	\$32,414	\$34,034	\$35,736	\$37,523	\$39,399	\$41,369	\$43,437	\$45,609	\$47,890	\$50,284	\$52,798	\$55,438	\$58,210	\$61,120	\$64,177	\$67,385	\$70,755	\$74,292		
Odor Control Power	\$10,079	\$10,100	\$10,100	\$10,600	\$11,100	\$11,700	\$12,300	\$12,900	\$13,500	\$14,200	\$14,900	\$15,600	\$16,400	\$17,200	\$18,100	\$19,000	\$20,000	\$21,000	\$22,100	\$23,200	\$24,400	\$25,600	\$26,900		
34 mgd Grit Facilities at Existing Grit Basins																									
Power Costs (excluding odor control)	\$12,137	\$12,100	\$12,100	\$12,700	\$13,300	\$14,000	\$14,700	\$15,400	\$16,200	\$17,000	\$17,900	\$18,800	\$19,700	\$20,700	\$21,700	\$22,800	\$23,900	\$25,100	\$26,400	\$27,700	\$29,100	\$30,600	\$32,100		
Labor Costs	\$44,871	\$44,900	\$44,900	\$47,100	\$49,500	\$52,000	\$54,600	\$57,300	\$60,200	\$63,200	\$66,400	\$69,700	\$73,200	\$76,900	\$80,700	\$84,700	\$88,900	\$93,300	\$98,000	\$102,900	\$108,000	\$113,400	\$119,100		
Grit Hauling and Disposal Costs	\$23,323	\$23,300	\$23,300	\$24,500	\$25,700	\$27,000	\$28,400	\$29,800	\$31,300	\$32,900	\$34,500	\$36,200	\$38,000	\$39,900	\$41,900	\$44,000	\$46,200	\$48,500	\$50,900	\$53,400	\$56,100	\$58,900	\$61,800		
Equipment Maintenance	\$11,900	\$11,900	\$11,900	\$12,500	\$13,100	\$13,800	\$14,500	\$15,200	\$16,000	\$16,800	\$17,600	\$18,500	\$19,400	\$20,400	\$21,400	\$22,500	\$23,600	\$24,800	\$26,000	\$27,300	\$28,700	\$30,100	\$31,600		
Odor Control (excluding power)	\$71,835	\$71,800	\$71,800	\$75,390	\$79,160	\$83,117	\$87,273	\$91,637	\$96,219	\$101,030	\$106,081	\$111,385	\$116,955	\$122,802	\$128,942	\$135,390	\$142,159	\$149,267	\$156,730	\$164,567	\$172,795	\$181,435	\$190,507		
Odor Control Power	\$14,651	\$14,700	\$14,700	\$15,400	\$16,200	\$17,000	\$17,900	\$18,800	\$19,700	\$20,700	\$21,700	\$22,800	\$23,900	\$25,100	\$26,400	\$27,700	\$29,100	\$30,600	\$32,100	\$33,700	\$35,400	\$37,200	\$39,100		
Opinion of Probable O&M Cost	\$475,229		\$475,100	\$498,800	\$523,750	\$550,078	\$577,711	\$606,382	\$636,721	\$668,562	\$702,044	\$737,092	\$773,857	\$812,675	\$853,288	\$895,843	\$940,585	\$987,564	\$1,037,032	\$1,088,844	\$1,143,356	\$1,200,529	\$1,260,525		
Factored Totals			\$475,100	\$475,048	\$475,057	\$475,178	\$475,285	\$475,116	\$475,131	\$475,135	\$475,168	\$475,136	\$475,081	\$475,154	\$475,143	\$475,085	\$475,059	\$475,035	\$475,076	\$475,059	\$475,088	\$475,090	\$475,079	\$9,978,000	\$800,661

St. Joseph, Missouri
TM-CSO-12/TM-VV-3 - Screening and Grit Removal Facilities
Alternative 3A-1 - Separate Facilities
Vortex near Exist Grit Basins (34 mgd), Vortex at North Property (61 mgd), Screens at North Property (88 mgd)

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost (\$)	2009 Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024	
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20					
Flow Meter Vaults	2,009				1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689					
Structure, Valves, and Piping	2,009	50	\$846,969	\$846,969	\$846,969																					-	\$1,966,502			
Equipment	2,009	20	\$105,000	\$105,000	\$105,000																					\$406,317	\$406,317			
88 & 61 mgd North Screen and Grit Facilities	2,009																									-				
Structure, Valves, and Piping	2,009	50	\$4,366,614	\$4,366,614	\$4,366,614																					-	\$10,138,451			
Equipment	2,009	20	\$2,226,700	\$2,226,700	\$2,226,700																					\$8,616,626	\$8,616,626			
Odor Control Equipment	2,009	20	\$470,000	\$470,000	\$470,000																					\$1,818,752	\$1,818,752			
Flow Splitter Box	2,009																									-				
Structure, Valves, and Piping	2,009	50	\$65,000	\$65,000	\$65,000																					-	\$150,918			
34 mgd Grit Near Existing Grit Basin	2,009																									-				
Structure, Valves, and Piping	2,009	50	\$1,888,044	\$1,888,044	\$1,888,044	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$4,383,680			
Equipment	2,009	20	\$504,000	\$504,000	\$504,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$1,950,321	\$1,950,321			
Odor Control Equipment	2,009	20	\$160,594	\$160,594	\$160,594																					\$621,448	\$621,448			
In-Plant Influent Pump Station Modifications	2,009	20	\$126,000	\$126,000	\$126,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$487,580	\$487,580			
Special Sitework	2,009	50	\$2,419,400	\$2,419,400	\$2,419,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$5,617,389			
Electrical, Instrumentation, and Controls	2,009	20	\$3,295,000	\$3,295,000	\$3,295,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$12,750,610	\$12,750,610			
Land Acquisition	2,009	10,000	\$0	\$0	\$0																					-				
Sitework	2,009	50	\$1,647,000	\$1,647,000	\$1,647,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
General Requirements	2,009		\$2,174,000	\$2,174,000	\$2,174,000																									
Flood Protection/Fill (placeholder)	2,009		\$111,111	\$111,111	\$111,111																									
Site Remediation (placeholder)	2,009		\$0	\$0	\$0																									
Contingency	2,009		\$5,101,000	\$5,101,000	\$5,101,000																									
Construction Subtotal			\$25,506,432	\$25,506,432	\$25,506,432										\$0											\$26,650,000				
Engineering, Legal, and Administration 20%	2,009		\$5,101,000	\$5,101,000	\$5,101,286																									
Interest During Construction (yrs)		0																												
Opinion of Probable Project Cost			\$30,610,000	\$30,610,000	\$30,610,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$26,650,000		\$48,908,593		
Factored Totals					\$30,610,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$10,044,000	\$40,654,000	\$18,433,134	\$22,220,866	\$1,800,000

O&M Elements	2009 Annual Cost (\$)	2009 Year Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
			Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20		
			1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689		
88 mgd North Screen & 61 mgd North Grit Facilities																									
Power Costs (excluding odor control)	\$4,758	\$4,800	\$4,800	\$5,040	\$5,292	\$5,557	\$5,834	\$6,126	\$6,432	\$6,754	\$7,092	\$7,446	\$7,819	\$8,210	\$8,620	\$9,051	\$9,504	\$9,979	\$10,478	\$11,002	\$11,552	\$12,129	\$12,736		
Labor Costs	\$76,178	\$76,200	\$76,200	\$80,010	\$84,011	\$88,211	\$92,622	\$97,253	\$102,115	\$107,221	\$112,582	\$118,211	\$124,122	\$130,328	\$136,844	\$143,686	\$150,871	\$158,414	\$166,335	\$174,652	\$183,384	\$192,554	\$202,181		
Screenings & Grit Hauling and Disposal Costs	\$46,159	\$46,200	\$46,200	\$48,510	\$50,936	\$53,482	\$56,156	\$58,964	\$61,912	\$65,008	\$68,258	\$71,671	\$75,255	\$79,018	\$82,969	\$87,117	\$91,473	\$96,046	\$100,849	\$105,891	\$111,186	\$116,745	\$122,582		
Equipment Maintenance	\$48,706	\$48,700	\$48,700	\$51,135	\$53,692	\$56,376	\$59,195	\$62,155	\$65,263	\$68,526	\$71,952	\$75,550	\$79,327	\$83,294	\$87,458	\$91,831	\$96,423	\$101,244	\$106,306	\$111,621	\$117,202	\$123,062	\$129,216		
Odor Control (excluding power)	\$71,118	\$71,100	\$71,100	\$74,655	\$78,388	\$82,307	\$86,422	\$90,744	\$95,281	\$100,045	\$105,047	\$110,299	\$115,814	\$121,605	\$127,685	\$134,070	\$140,773	\$147,812	\$155,202	\$162,963	\$171,111	\$179,666	\$188,649		
Odor Control Power	\$14,484	\$14,500	\$14,500	\$15,225	\$15,986	\$16,786	\$17,625	\$18,506	\$19,431	\$20,403	\$21,423	\$22,494	\$23,619	\$24,800	\$26,040	\$27,342	\$28,709	\$30,144	\$31,652	\$33,234	\$34,896	\$36,641	\$38,473		
34 mgd Grit Facilities Near Existing Grit Basins																									
Power Costs (excluding odor control)	\$20,120	\$20,100	\$20,100	\$21,100	\$22,200	\$23,300	\$24,500	\$25,700	\$27,000	\$28,400	\$29,800	\$31,300	\$32,900	\$34,500	\$36,200	\$38,000	\$39,900	\$41,900	\$44,000	\$46,200	\$48,500	\$50,900	\$53,400		
Labor Costs	\$44,871	\$44,900	\$44,900	\$47,100	\$49,500	\$52,000	\$54,600	\$57,300	\$60,200	\$63,200	\$66,400	\$69,700	\$73,200	\$76,900	\$80,700	\$84,700	\$88,900	\$93,300	\$98,000	\$102,900	\$108,000	\$113,400	\$119,100		
Grit Hauling and Disposal Costs	\$23,323	\$23,300	\$23,300	\$24,500	\$25,700	\$27,000	\$28,400	\$29,800	\$31,300	\$32,900	\$34,500	\$36,200	\$38,000	\$39,900	\$41,900	\$44,000	\$46,200	\$48,500	\$50,900	\$53,400	\$56,100	\$58,900	\$61,800		
Equipment Maintenance	\$5,040	\$5,000	\$5,000	\$5,300	\$5,600	\$5,900	\$6,200	\$6,500	\$6,800	\$7,100	\$7,500	\$7,900	\$8,300	\$8,700	\$9,100	\$9,600	\$10,100	\$10,600	\$11,100	\$11,700	\$12,300	\$12,900	\$13,500		
Odor Control (excluding power)	\$24,510	\$24,500	\$24,500	\$25,725	\$27,011	\$28,362	\$29,780	\$31,269	\$32,832	\$34,474	\$36,198	\$38,008	\$39,908	\$41,903	\$43,998	\$46,198	\$48,508	\$50,934	\$53,480	\$56,154	\$58,962	\$61,910	\$65,006		
Odor Control Power	\$4,482	\$4,500	\$4,500	\$4,700	\$4,900	\$5,100	\$5,400	\$5,700	\$6,000	\$6,300	\$6,600	\$6,900	\$7,200	\$7,600	\$8,000	\$8,400	\$8,800	\$9,200	\$9,700	\$10,200	\$10,700	\$11,200	\$11,800		
Opinion of Probable O&M Cost	\$383,750		\$383,800	\$403,000	\$423,215	\$444,381	\$466,735	\$490,017	\$514,567	\$540,331	\$567,352	\$595,680	\$625,464	\$656,757	\$689,515	\$723,996	\$760,160	\$798,073	\$838,002	\$879,917	\$923,893	\$970,008	\$1,018,443		
Factored Totals			\$383,800	\$383,810	\$383,868	\$383,873	\$383,984	\$383,941	\$383,978	\$384,003	\$384,006	\$383,981	\$383,981	\$383,992	\$383,948	\$383,950	\$383,933	\$383,887	\$383,898	\$383,905	\$383,897	\$383,865	\$383,841	\$8,063,000	\$646,996

Net Present Worth = \$30,283,866

Economic Analysis Criteria:

Baseline for costs = May-09
ENR Building Cost Index = 4,773
Interest Rate = 5.00%
Capital Escalation Rate = 7.00%
O&M Escalation Rate = 5.00%

\$22,220,866
\$8,063,000
\$30,283,866

St. Joseph, Missouri
TM-CSO-12/TM-VV-3 - Screening and Grit Removal Facilities
Alternative 3A-2 - Separate Facilities
Headcell at Exist Grit Basins (34 mgd), Storm King at North Property (61 mgd), Screens at North Property (88 mgd)

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost (\$)	2009 Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
					Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20				
Flow Meter Vaults	2,009				1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689				
Structure, Valves, and Piping	2,009	50	\$846,969	\$846,969	\$846,969																					-	\$1,966,502		
Equipment	2,009	20	\$105,000	\$105,000	\$105,000																				\$406,317	\$406,317			
88 & 61 mgd North Screen and Grit Facilities	2,009																												
Structure, Valves, and Piping	2,009	50	\$4,450,585	\$4,450,585	\$4,450,585																					-	\$10,333,416		
Equipment	2,009	20	\$3,367,280	\$3,367,280	\$3,367,280																					\$13,030,311	\$13,030,311		
Odor Control Equipment	2,009	20	\$470,000	\$470,000	\$470,000																					\$1,818,752	\$1,818,752		
Flow Splitter Box	2,009																												
Structure, Valves, and Piping	2,009	50	\$65,000	\$65,000	\$65,000																					-	\$150,918		
34 mgd Grit in Existing Grit Basin	2,009																												
Structure, Valves, and Piping	2,009	50	\$1,261,901	\$1,261,901	\$1,261,901	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$2,929,894		
Equipment	2,009	20	\$1,232,000	\$1,232,000	\$1,232,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$4,767,451	\$4,767,451		
Odor Control Equipment	2,009	20	\$184,614	\$184,614	\$184,614																					\$714,398	\$714,398		
In-Plant Influent Pump Station Modifications	2,009	20	\$126,000	\$126,000	\$126,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$487,580	\$487,580		
Special Sitework	2,009	50	\$2,450,600	\$2,450,600	\$2,450,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$5,689,829		
Electrical, Instrumentation, and Controls	2,009	20	\$3,640,000	\$3,640,000	\$3,640,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$14,085,651	\$14,085,651		
Land Acquisition	2,009	10,000	\$0	\$0	\$0																								
Sitework	2,009	50	\$1,820,000	\$1,820,000	\$1,820,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
General Requirements	2,009		\$2,402,000	\$2,402,000	\$2,402,000																								
Flood Protection/Fill (placeholder)	2,009		\$111,111	\$111,111	\$111,111																								
Site Remediation (placeholder)	2,009		\$0	\$0	\$0																								
Contingency	2,009		\$5,633,000	\$5,633,000	\$5,633,000																								
Construction Subtotal			\$28,166,060	\$28,166,060	\$28,166,060										\$0											\$35,310,000			
Engineering, Legal, and Administration	20%	2,009	\$5,633,000	\$5,633,000	\$5,633,212																								
Interest During Construction (yrs)		0																											
Opinion of Probable Project Cost			\$33,800,000	\$33,800,000	\$33,800,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$35,310,000			
Factored Totals					\$33,800,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$13,308,000	\$47,108,000	\$21,249,413	\$25,858,587	\$2,100,000

O&M Elements	2009 Annual Cost (\$)	2009 Year Cost (\$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
			Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20		
			1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573	0.37689		
88 mgd North Screen & 61 mgd North Grit Facilities																									
Power Costs (excluding odor control)	\$8,927	\$8,900	\$8,900	\$9,345	\$9,812	\$10,303	\$10,818	\$11,359	\$11,927	\$12,523	\$13,149	\$13,807	\$14,497	\$15,222	\$15,983	\$16,782	\$17,621	\$18,502	\$19,428	\$20,399	\$21,419	\$22,490	\$23,614		
Labor Costs	\$52,247	\$52,200	\$52,200	\$54,810	\$57,561	\$60,428	\$63,449	\$66,622	\$69,953	\$73,451	\$77,123	\$80,979	\$85,028	\$89,280	\$93,744	\$98,431	\$103,352	\$108,520	\$113,946	\$119,643	\$125,626	\$131,907	\$138,502		
Screenings & Grit Hauling and Disposal Costs	\$46,159	\$46,200	\$46,200	\$48,510	\$50,936	\$53,482	\$56,156	\$58,964	\$61,912	\$65,008	\$68,258	\$71,671	\$75,255	\$79,018	\$82,969	\$87,117	\$91,473	\$96,046	\$100,849	\$105,891	\$111,186	\$116,745	\$122,582		
Equipment Maintenance	\$45,993	\$46,000	\$46,000	\$48,300	\$50,715	\$53,251	\$55,913	\$58,709	\$61,644	\$64,727	\$67,963	\$71,361	\$74,929	\$78,676	\$82,609	\$86,740	\$91,077	\$95,631	\$100,412	\$105,433	\$110,704	\$116,240	\$122,052		
Odor Control (excluding power)	\$75,755	\$75,800	\$75,800	\$79,590	\$83,570	\$87,748	\$92,135	\$96,742	\$101,579	\$106,658	\$111,991	\$117,591	\$123,470	\$129,644	\$136,126	\$142,932	\$150,079	\$157,583	\$165,462	\$173,735	\$182,422	\$191,543	\$201,120		
Odor Control Power	\$15,563	\$15,600	\$15,600	\$16,380	\$17,199	\$18,059	\$18,962	\$19,910	\$20,905	\$21,951	\$23,048	\$24,201	\$25,411	\$26,681	\$28,015	\$29,416	\$30,887	\$32,431	\$34,053	\$35,755	\$37,543	\$39,420	\$41,391		
34 mgd Grit Facilities Near Existing Grit Basins																									
Power Costs (excluding odor control)	\$11,797	\$11,800	\$11,800	\$12,400	\$13,000	\$13,700	\$14,400	\$15,100	\$15,900	\$16,700	\$17,500	\$18,400	\$19,300	\$20,300	\$21,300	\$22,400	\$23,500	\$24,700	\$25,900	\$27,200	\$28,600	\$30,000	\$31,500		
Labor Costs	\$44,871	\$44,900	\$44,900	\$47,100	\$49,500	\$52,000	\$54,600	\$57,300	\$60,200	\$63,200	\$66,400	\$69,700	\$73,200	\$76,900	\$80,700	\$84,700	\$88,900	\$93,300	\$98,000	\$102,900	\$108,000	\$113,400	\$119,100		
Grit Hauling and Disposal Costs	\$23,323	\$23,300	\$23,300	\$24,500	\$25,700	\$27,000	\$28,400	\$29,800	\$31,300	\$32,900	\$34,500	\$36,200	\$38,000	\$39,900	\$41,900	\$44,000	\$46,200	\$48,500	\$50,900	\$53,400	\$56,100	\$58,900	\$61,800		
Equipment Maintenance	\$12,320	\$12,300	\$12,300	\$12,900	\$13,500	\$14,200	\$14,900	\$15,600	\$16,400	\$17,200	\$18,100	\$19,000	\$20,000	\$21,000	\$22,100	\$23,200	\$24,400	\$25,600	\$26,900	\$28,200	\$29,600	\$31,100	\$32,700		
Odor Control (excluding power)	\$28,018	\$28,000	\$28,000	\$29,400	\$30,870	\$32,414	\$34,034	\$35,736	\$37,523	\$39,399	\$41,369	\$43,437	\$45,609	\$47,890	\$50,284	\$52,798	\$55,438	\$58,210	\$61,120	\$64,177	\$67,385	\$70,755	\$74,292		
Odor Control Power	\$10,079	\$10,100	\$10,100	\$10,600	\$11,100	\$11,700	\$12,300	\$12,900	\$13,500	\$14,200	\$14,900	\$15,600	\$16,400	\$17,200	\$18,100	\$19,000	\$20,000	\$21,000	\$22,100	\$23,200	\$24,400	\$25,600	\$26,900		
Opinion of Probable O&M Cost	\$375,052		\$375,100	\$393,835	\$413,452	\$434,284	\$456,069	\$478,742	\$502,744	\$527,916	\$554,302	\$581,947	\$611,100	\$641,710	\$673,830	\$707,517	\$742,927	\$780,024	\$819,070	\$859,933	\$902,985	\$948,099	\$995,554		
Factored Totals			\$375,100	\$375,081	\$375,013	\$375,151	\$375,209	\$375,107	\$375,155	\$375,180	\$375,173	\$375,128	\$375,162	\$375,194	\$375,214	\$375,211	\$375,229	\$375,205	\$375,225	\$375,186	\$375,209	\$375,195	\$375,214	\$7,879,000	\$632,231

Net Present Worth =	\$33,737,587	\$25,858,587 \$7,879,000 \$33,737,587
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Economic Analysis Criteria:

Baseline for costs = May-09
ENR Building Cost Index = 4,773
Interest Rate = 5.00%
Capital Escalation Rate = 7.00%
O&M Escalation Rate = 5.00%