APPENDIX B

Dissolved Oxygen Injection System Cost Estimates
(Prepared by Kennedy/Jenks Consultants)

2 June 2014

Technical Memorandum

To: Amy Bain, P.E.

From: Milt Larsen, PE; Janet Snedecor, PE

Subject: Dissolved Oxygen Addition to Mint Farm Supply
K/J 0997003.01/J/9025

Confluence Engineering Group's (Confluence) pipe rig study has determined that increasing the dissolved oxygen in the treated water supply helps to stabilize the corrosion scale on the pipe walls of unlined cast iron and galvanized steel pipe. Confluence determined that a dissolved oxygen concentrations of 3 to 4 mg/l and 9 to 10 mg/l helped stabilize the iron scale. However, a loss of chlorine residual occurred at the higher dissolved oxygen concentration.

Options for increasing the dissolved oxygen in the water include:

- Purchasing liquid oxygen (LOX), vaporizing it into a gaseous phase and injecting it into the treated water;
- Generating LOX on site with a pressure swing adsorption (PSA) unit (molecular sieve) and injecting it into the treated water;
- Pumping the treated water through an aerator such as a packed tower aerator.

The first two alternatives can be used to inject the oxygen into the treated water under pressure or in an open contact basin. Injecting oxygen into the pipeline under pressure is preferred since it would not be necessary to destage the well pumps, break head, and add a post filtration pump station.

The third alternative, packed tower aeration or similar aeration unit process could be constructed either upstream of the filter or post filtration. If installed prior to the filters it could reduce the chlorine requirements for oxidizing the iron. However, it would not provide a benefit in oxidizing the manganese or ammonia which has the more significant chlorine demand. Packed tower aeration would require destaging the well pumps, breaking head, and construction of a new pump station. Given these additional costs this alternative was not evaluated further.

LOX is a cryogenic, oxidizing fluid that is stored in an insulated, double wall pressure tank. LOX is supplied by vendors including Praxair, Linde, and Air Liquide. They provide LOX to a number of paper mills in the area. Praxair's LOX production facility is in Fife, WA. Praxair and Linde indicated that over 90 percent of their customers rent the LOX storage tanks and vaporizers. Cost estimates were prepared for two LOX alternatives: rental of a 3,000 liter microbulk tank and evaporator and rental of a 1,500 gallon bulk LOX tank and evaporator. Based on an average LOX requirement of 300 lb. per day, Praxair indicated that they would refill the

microbulk tank twice a month. The cost of LOX is determined based on the distance from the LOX production facility, amount of LOX used and the grade of LOX. The delivered cost of food grade LOX from Praxair is $1.07 per 100 cubic feet (CCF) as gas for the microbulk system and $0.72 per 100 CCF for the bulk system. Monthly rental costs for the LOX tank, evaporator, and telemetry is $425 and $550 for the microbulk and bulk systems, respectively.

Our conceptual opinion of probable construction costs for the three alternatives are:

- Microbulk LOX rental: $263,000 (range $184,000 to $395,000)
- Bulk LOX rental: $302,000 (range $211,000 to $453,000)
- PSA oxygen generation: $1,236,000 (range $826,000 to $1,854,000)

Annual Costs

Microbulk

LOX purchase	$19,000
Equipment rental	$5,000
O&M	$5,000
Annual cost	$29,000

Bulk

LOX purchase	$13,000
Equipment rental	$7,000
O&M	$6,000
Annual cost	$26,000

PSA

Power	$5,000
O&M	$14,000
Annual cost	$19,000

Enclosure(s) (3)
Microbulk LOX Opinion of Probable Cost
Bulk LOX Opinion of Probable Cost
PSA Oxygen Generation Opinion of Probable Cost

ENGINEER'S ESTIMATE OF CONCEPTUAL COST

KENNEDY/JENKS CONSULTANTS

Project: Longview MFRWTP - Dissolved Oxygen Injection

Building, Area: MFRWTP Site - Micorbulk LOX

Prepared By: JLH/MDL
Date Prepared: 05/28/14
K/J Proj. No. 0997003*01/J/9025

Current at ENR
Escalated to ENR

Estimate Type:
- [x] Conceptual
- [ ] Preliminary (w/o plans)
- [ ] Design Development @
- [ ] Construction
- [ ] Change Order
- % Complete

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Labor $/Unit	Labor Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 1 - GENERAL REQUIREMENTS											
	Division 1, Mobilization, Bonds, Insurance		1	LS							10,000
		Subtotal									10,000
DIVISION ALL - SITE WORK, CONCRETE, PIPING											
	Truck Offload Pad										
		Sawcut Asphalt	44	LF			5	220			220
		Remove & Dispose Asphalt	13	SY			10	130			130
		Concrete Pad	4	CY	225	1,000	200	889			1,889
		Subtotal									
	Microbulk Tank										
		10x10x18" Slab									
		Over excavate	217	CY			15	3,250			3,250
		Load & Haul Excess Material	217	CY			25	5,417			5,417
		Dewatering	1	LS			2,000	2,000			2,000
		Place CDF	217	CY	100	21,667	25	5,417			27,083
		Anchor Bolts	8	EA	50	400	50	400			800
		Concrete Pad	6	CY	250	1,389	300	1,667			3,056
		Install 3000 liter LOX Microbulk Tank	1	LS			3,000	3,000			3,000
		Install Evaporator	1	LS			500	500			500
		Install Telemetry	1	LS	500	500	500	500			1,000
		6" DIP Carrier Water Pipeline	200	LF	19	3,800	15	3,000			6,800
		6" DIP 90° Bend	6	EA	430	2,580	113	678			3,258
		6" DIP 45° Bend	2	EA	390	780	113	226			1,006
		30 X 6 Tapping Sleeve	2	EA	4,146	8,292					8,292
		6" Tap	2	EA					1,020	2,040	2,040
		Sawcut Asphalt	70	LF			5	350			350
		Remove & Dispose Asphalt	14	SY			10	140			140
		Asphalt Patch	14	SY					75	1,050	1,050
		Trench & Backfill	200	LF			15	3,000			3,000
		2" CAV	1	EA	1,050	1,050	70	70			1,120
		Utility Vault Constructed around 30" DIP	1	LS	5,000	5,000	2,500	2,500			7,500
		Electrical	1	LS					10,000	10,000	10,000
		Instrumentation	1	LS					20,000	20,000	20,000
		Subtotals				46,458		33,353		33,090	123,000
		Contractor Markup for Sub	@	12%							4,000
		Est. Contractor OH&P	@	15%							12,000
		Subtotals									139,000
		Sales Tax	@	7.9%							11,000
		Subtotals									150,000
		Estimate Contingency	@	30%							45,000
		Subtotals									195,000
		Programming/SCADA Screens									8,000
		Design Engineering/Construction Admin	@	35%							68,000
		Budgetary Cost									**263,000**

Estimate Accuracy	
+50%	-30%

Notes:

a) Cost estimates conceptual in nature and based on a preliminary design evaluation.
b) A range of cost is provided assuming a low range equivalent to 30% less than the base cost, and a high range of 50% more than the base cost.
c) Note equipment rental and chemical not included. Equipment rental approximately $5,100/year and chemical approximately $15,000/year.

Estimated Range of Probable Cost		
+50%	Total Est.	-30%
$395,000	**$263,000**	**$184,000**

ENGINEER'S ESTIMATE OF CONCEPTUAL COST

KENNEDY/JENKS CONSULTANTS

Project: Longview MFRWTP - Dissolved Oxygen Injection

Building, Area: MFRWTP Site - Bulk LOX

Prepared By: JLH/MDL
Date Prepared: 05/28/14
K/J Proj. No. 0997003*01/J/9025

Current at ENR
Escalated to ENR

Estimate Type:
- [x] Conceptual
- [ ] Preliminary (w/o plans)
- [ ] Design Development @
- [ ] Construction
- [ ] Change Order
- % Complete

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Labor $/Unit	Labor Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 1 - GENERAL REQUIREMENTS											
	Division 1, Mobilization, Bonds, Insurance		1	LS							12,000
		Subtotal									12,000
DIVISION ALL - SITE WORK, CONCRETE, PIPING											
	Truck Offload Pad										
		Sawcut Asphalt	44	LF			5	220			220
		Remove & Dispose Asphalt	13	SY			10	130			130
		Concrete Pad	4	CY	225	1,000	200	889			1,889
	Bulk Tank										
		15x15x18" Slab									
		Overexcavate	295	CY			15	4,424			4,424
		Load & Haul Excess Material	295	CY			25	7,373			7,373
		Dewatering	1	LS			3,000	3,000			3,000
		Place CDF	295	CY	100	29,491	25	7,373			36,863
		Anchor Bolts	12	EA	50	600	50	600			1,200
		Concrete Pad	13	CY	225	2,813	200	2,500			5,313
		Install 1500 gal LOX Bulk Tank	1	LS			3,000	3,000			3,000
		Install Evaporator	1	LS			500	500			500
		Install Telemetry	1	LS	500	500	500	500			1,000
		6" DIP Carrier Water Pipeline	200	LF	19	3,800	15	3,000			6,800
		6" DIP 90° Bend	6	EA	430	2,580	113	678			3,258
		6" DIP 45° Bend	2	EA	390	780	113	226			1,006
		30 X 6 Tapping Sleeve	2	EA	4,146	8,292					8,292
		6" Tap	2	EA					1,020	2,040	2,040
		Sawcut Asphalt	70	LF			5	350			350
		Remove & Dispose Asphalt	14	SY			10	140			140
		Asphalt Patch	14	SY					75	1,050	1,050
		Trench & Backfill	200	LF			15	3,000			3,000
		2" CAV	1	EA	1,050	1,050	70	70			1,120
		Utility Vault Constructed around 30" DIP	1	LS	5,000	5,000	2,500	2,500			7,500
		Electrical	1	LS					10,000	10,000	10,000
		Instrumentation	1	LS					20,000	20,000	20,000
		Subtotals				55,905		40,472		33,090	141,000
		Contractor Markup for Sub	@	12%							4,000
		Est. Contractor OH&P	@	15%							14,000
		Subtotals									159,000
		Sales Tax	@	7.9%							13,000
		Subtotals									172,000
		Estimate Contingency	@	30%							52,000
		Subtotals									224,000
		Programming/SCADA Screens									8,000
		Design Engineering/Construction Admin	@	35%							78,000
		Budgetary Cost									**302,000**

Estimate Accuracy	
+50%	-30%

Notes:

a) Cost estimates are purely conceptual and based on a preliminary design evaluation.
b) A range of cost is provided assuming a low range equivalent to 30% less than the base cost, and a high range of 50% more than the base cost.
c) Note equipment rental and chemical not included. Equipment rental approximately $6,600/year and chemical approximately $10,000/year.

Estimated Range of Probable Cost		
+50%	Total Est.	-30%
$453,000	**$302,000**	**$211,000**

ENGINEER'S ESTIMATE OF CONCEPTUAL COST

KENNEDY/JENKS CONSULTANTS

Project: Longview MFRWTP - Dissolved Oxygen Injection

Building, Area: MFRWTP Site - PSA SDOX

Prepared By: JLH/MDL
Date Prepared: 05/28/14
K/J Proj. No. 0997003*01/J/9025

Current at ENR
Escalated to ENR

Estimate Type: [X] Conceptual [ ] Preliminary (w/o plans) [ ] Design Development @ [ ] Construction [ ] Change Order % Complete

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Labor $/Unit	Labor Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 1 - GENERAL REQUIREMENTS											
	Division 1, Mobilization, Bonds, Insurance		1	LS							46,000
		Subtotal									46,000
DIVISION ALL - SITE WORK, CONCRETE, PIPING											
	Truck Offload Pad										
		Sawcut Asphalt	44	LF			5	220			220
		Remove & Dispose Asphalt	13	SY			10	130			130
		Concrete Pad	4	CY	225	1,000	200	889			1,889
	Oxygen Generation Facility										
		20 X 26 CMU Building	520	SF	75	39,000	75	39,000			78,000
		Overexcavate	443	CY			15	6,644			6,644
		Load & Haul Excess Material	443	CY			25	11,074			11,074
		Dewatering	1	LS			3,000	3,000			3,000
		Place CDF	443	CY	100	44,296	25	11,074			55,370
		PSA Oxygen Generator	1	LS	119,000	119,000	11,900	11,900			130,900
		Oxygen Dissolution Unit	1	LS	199,000	199,000	19,900	19,900			218,900
		Install Telemetry	1	LS	500	500	500	500			1,000
		6" DIP O2 Carrier Water Pipeline	200	LF	19	3,800	15	3,000			6,800
		6" DIP 90° Bend	6	EA	430	2,580	113	678			3,258
		6" DIP 45° Bend	2	EA	390	780	113	226			1,006
		30 X 6 Tapping Sleeve	2	EA	4,146	8,292					8,292
		6" Tapping Valve	2	EA	845	1,690	112	224			1,914
		6" Tap	2	EA					1,020	2,040	2,040
		Sawcut Asphalt	70	LF			5	350			350
		Remove & Dispose Asphalt	14	SY			10	140			140
		Asphalt Patch	14	SY					75	1,050	1,050
		Trench & Backfill	200	LF			15	3,000			3,000
		2" CAV	1	EA	1,050	1,050	70	70			1,120
		Utility Vault Constructed around 30" DIP	1	LS	5,000	5,000	2,500	2,500			7,500
		Electrical	1	LS					10,000	10,000	10,000
		Instrumentation	1	LS					20,000	20,000	20,000
		Subtotals				425,988		114,519		33,090	619,598
		Contractor Markup for Sub	@	12%							4,000
		Est. Contractor OH&P	@	15%							81,076
		Subtotals									705,000
		Sales Tax	@	7.9%							55,695
		Subtotals									760,695
		Estimate Contingency	@	30%							228,000
		Subtotals									989,000
		Programming/SCADA Screen									8,000
		Design Engineering/Construction Admin	@	25%							247,000
		Budgetary Cost									**1,236,000**

Estimate Accuracy	
+50%	-30%

Notes:

a) Cost estimates are purely conceptual and based on a preliminary design evaluation.
b) A range of cost is provided assuming a low range equivalent to 30% less than the base cost, and a high range of 50% more than the base cost.

Estimated Range of Probable Cost		
+50%	Total Est.	-30%
$1,854,000	**$1,236,000**	**$865,000**