

Grading Rubric

Grammar and spelling (including no contractions) – 20%	
Overall effective communication – well organized, salient reporting; effective use of tables/graphs/figures; consistent tense and person-perspective; proper referencing (if used) – 20%	
Efficient use of words – 10%	
Overall layout – use of page numbers; no widow/orphans; consistent spacing; consistent paragraph justification – 10%	
Clear, concise, brief, effective Introduction that includes a Purpose and Objectives – 15%	
Clear, concise, effective discussion on results and recommendations – 25%	
TOTAL (out of 100)	

Technical Memo Writing Guidance (take 1):

1. Use logical headings –do not make them wordy
 2. Write as if you are writing to your client, not as if you are writing to your professor as a class report
 3. Brevity is good
 4. But include sufficient technical information such that if another engineer was reviewing your memo she/he would be able to complete a technical review
 5. If you choose to include equations (which would be okay), just make sure you define all terms and present the equations clearly
 6. Summarize the critical and salient conclusions from your analyses – not the mundane technical elements
 7. Conclude your memo with recommendations – be concise, do not ramble
 8. NO CONTRACTIONS!!!!!!!!!! This represents sloppy writing.
 9. Do not abbreviate measurement units such as inches, feet, meters.....it is okay to abbreviate some, such as cm and mg, since as abbreviations they are not words.....but 'in' is a word, so it can be confusing.
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Tech memo writing guidance (take 2):

A memo would typically have headings such as:

Introduction – typically discusses the larger project and introduces the topic that will be presented in the memo. Paint a picture of your project in the reader's head.

Purpose – typically discusses the general purpose of the memo and the overall project.....one sentence is sufficient. Be concise and brief.

Objectives – typically specifies in a numerical format the objectives of the design analyses that will be presented and discussed in the memo

- Write the memo as if you are submitting your preliminary design to your client, rather than simply submitting a report to me.
- Briefly summarize your design criteria – such as flow rates, pollutant loads, etc
- A significant benefit of MathCAD is that you can more clearly define parameters and equations. Please incorporate these types of clarifications – it is useful in grading, but more importantly to you in the future should you need/want to use them again.
- Always provide one hand calculation for each critical analysis to validate your electronic equations.

Analyses and Recommendations

Tech memo writing guidance (take 3):

Technical writing should:

- i. Explain assumptions
- ii. Describe pertinent 'conditions' related to your project and contents of the memo
- iii. Explain/clarify/support results

Use tables to present data – avoid embedding narrative.

Use bullets rather than embedding certain narrative items within a paragraph via commas or semicolons.

Context, context, context!

Brevity, brevity, brevity!

iv. **TECHNICAL MEMORANDUM**

PROJECT: Fairview Street Well/Clay Street Well/Clay Street Booster Pump Station

DATE:

TO:

FROM: Erik R. Coats, Ph.D., P.E.

RE: Flow Meter Analysis

Background, Purpose and Authorization

The City of Colfax measures total water production from its three ground water well sources at the following locations: _____

Water production from each source is currently monitored using propeller-style flow meters, with flow signals transmitted to the City's supervisory control and data acquisition (SCADA) system.

Based on a recent water audit performed by City staff, it has been concluded that the flow meters may be under-recording actual water production volumes. The purpose of this analysis is to evaluate and present recommendations specifically related to improving water production flow meter accuracy. This analysis has been prepared based on our discussions during my on-site facilities site assessment.

Existing Facilities Description

Following is a brief description of each water production facility specifically relative to the flow meters.

Fairview Well - Water production from the Fairview well, which produces approximately 600 gallons per minute (gpm) at a constant rate, is measured utilizing a 10-inch diameter Water Specialties propeller-style flow meter. The flow meter is flange-connected on the upstream end to a control valve, and flange-connected to a vertical (downward) bend on the downstream end.

Clay Street Well -

Clay Street Booster Pump Station -

Flow Meter Upgrade Alternatives Analysis

In general, propeller-style flow meters over time will experience reduced accuracy due to normal wear, and thus will register lower flows. Another concern, specific to Colfax, is the potential accumulation of iron bacteria or build-up of inorganic material on the flow tube and/or flow meter rotating assembly, which would also cause the flow meters to register lower flows. Another local water provider has experienced this type of problem.

Whether one or more of the flow meters is out of calibration and reading too low is unknown. However, it is my understanding that these flow meters have not been inspected or re-calibrated for many years (in some cases, possibly never).

Based on my site inspection, facility evaluations, and discussions with flow meter equipment representatives, I have developed the following alternative approaches for upgrading flow metering capabilities:

Alternative No. 1 - Service/Repair Existing Flow Meters: Under this alternative, each existing flow meter would be removed and serviced by a contractor certified to perform such work. The scope of work would generally

include removal of the flow meter head and shipment to the service center where the meter rotating assembly would be inspected, a calibration check would be performed, the metering mechanism would be repaired and/or replaced as necessary, and the meter would be re-calibrated. The cost to service each flow meter would range from \$1,000 to \$2,000, and each flow meter would be out of service for at least a few weeks. The cost variation is attributed to the different meter manufacturers. Concurrently, the City would need to remove and clean the inside of each flow tube.

Alternative No. 2 - Flow Meter Replacement: Under this alternative, each flow meter would be replaced with 6-inch diameter electromagnetic flow meter. This type of flow meter offers high accuracy coupled with a non-intrusive operating mechanism. The non-intrusive feature effectively eliminates the concern of material build-up impacting flow meter accuracy. Moreover, this type of flow meter does not experience reduced accuracy over time, in contrast with the existing propeller meters.

Recommendations

While each flow meter could be visually inspected for material accumulation on the rotating mechanism, such an inspection would not yield any information on flow meter calibration problems. The cost difference between servicing existing meters and full replacement with an electromagnetic flow meter is potentially negligible. Moreover, the cost of repair depends on the identified problem(s), and any such problem(s) would likely recur. Therefore, my recommendation is to replace all existing meters with the electromagnetic flow meter alternative.

TECHNICAL MEMORANDUM

PROJECT: City of Colville, WA
Hewescraft Utility Extension Project

DATE: March 15, 2006

TO: John DeLeo, P.E.
DeLeo & Associates, Inc.

FROM: Erik R. Coats, Ph.D., P.E.

RE: 10% Design Submittal – Sanitary Sewer Pumping System
Updated and Revised

Introduction, Purpose and Objectives

DeLeo & Associates, Inc. (DAI) is currently designing a water and sanitary sewer service upgrade and extension project for the City of Colville, Washington. The project is located in northwest Colville. The purpose of this technical memorandum is to present the 10% design for the sanitary sewer pumping system associated with this project.

A portion of the designated area is currently serviced by two sanitary sewer pump stations (the Payless Lift Station (aka LS#3) and the WalMart Lift Station). LS#3 discharges into the WalMart LS. As part of this project, a new pump station (referred to as LS#5) will be constructed. Further, LS#3 will either be abandoned (with flow directed via gravity to LS#5) or upgraded to accommodate the increased flow from LS#5.

The objectives of this submittal are to summarize the design elements below, specifically for the options of constructing a new LS#5 and upgrading LS#3 versus constructing a new LS#5 and abandoning LS#3.

1. Updated sanitary sewer flow estimates.
2. Preliminary recommendations on pump capacities.
3. Preliminary recommendations on the force main sizes.
4. Preliminary recommendations on the wet well sizes.

Furthermore, the alternatives will consider ultimate service area build-out needs and also more near-term upgrade alternatives to accommodate a reduced level of growth. In addition, this memorandum will discuss potential impacts to the existing WalMart LS.

Sanitary Sewer Flow Estimates

The total develop-able service area for the proposed utility extension project is estimated at 460 acres, and the subject area is zoned for commercial, industrial, and residential development. A portion of the area is currently developed, although not all of the developed area is provided with City sanitary sewer service. The land south of Buena Vista Drive is provided with sanitary sewer service, and wastewater is collected in a gravity sanitary sewer system that drains to LS#3 and the WalMart LS. However, the land north of Buena Vista Drive is currently unsewered.

The City is still considering the alternatives for either i) upgrading LS#3 and constructing a smaller LS#5 or ii) abandoning LS#3 and diverting all flow to a larger LS#5. Therefore, for the purpose of this 10% design, sanitary sewer drainage basins that would discharge separately to existing LS#3 and proposed LS#5 have been delineated.

LS#5 Sanitary Sewer Drainage Basin. The LS#5 service area covers approximately 70.4 acres, of which 66.4 acres is zoned for commercial development and 4 acres is zoned for residential development. Typical commercial

developments would include restaurants, hotels, laundromats, and miscellaneous retail stores. Much of the land is currently undeveloped, and thus forecasting the sanitary sewer flows that would be contributed to LS#5 is difficult. Depending on the type of commercial development, sanitary sewer flows could vary significantly. For example, a hotel would be expected to contribute upwards of 30,000 to 35,000 gpd/acre, while a retail store would contribute in the range of 200 to 300 gpd/acre. However, a typical average contribution for a commercially-zoned area would be 1,000 gpd/acre to 1,400 gpd/acre. Considering that this is a relatively large undeveloped area, and that the Colville area is not a major tourist destination that would demand multiple hotel or similar high water demand commercial developments, it is anticipated that sanitary sewer flows would approach the “typical” ranges. Utilizing these latter estimates, and assuming the small residentially-zoned land would be developed more in a multi-family manner (2,000 gpd/ac, peaking factor=3), the estimated build-out average daily flow contributing to LS#5 would be 50 to 70 gallons per minute. The estimated build-out peak daily flow would be 156 to 210 gpm (assumes a peaking factor of approximately 3).

For near-term planning purposes, an estimate was developed for sanitary sewer flow that would be generated by the current development within the subject drainage basin. The City provided occupancy data for the existing facilities, and flows were estimated based on typical per capita contributions for the type of development. Table 1 summarizes these analyses.

Table 1
LS#5 Drainage Basin – Current Sanitary Sewer Flow Estimates

Facility	Total People	Avg.Per Person Flow, gpcd	Peaking Factor	Flow, gpd	
				Average	Peak
Hewescraft	175	20	3	3,500	10,500
Lawson Trucking	4	20	1.5	80	120
Red Barn	3	20	3	60	180
Terry's Storage	2	10	1.5	20	30
Border Patrol Bldg	30	20	3	600	1,800
Apartments (6)	18	150	3	2,700	8,100
SFRs (2)	6	150	3	900	2,700
TOTAL (gpd):				7,860	23,430
TOTAL (gpm):				5.5	16.3

LS#3 Sanitary Sewer Drainage Basin. The LS#3 service area covers approximately 316.8 acres, of which 116.8 acres is zoned for industrial development, 74.4 acres is zoned for commercial development, 27.6 acres is zoned for multi-family residential development, and 98 acres is zoned for single family residential development. Similar to the LS#5 basin, much of the land is currently undeveloped, and thus forecasting the sanitary sewer flows that would be contributed to LS#3 is difficult. The following assumptions were made to determine the average and peak flows: commercial zone (1,000 gpd/ac, peaking factor (PF) = 3); industrial zone (1,250 gpd/ac, PF=2); multi-family residential (2,000 gpd/ac, PF=3); and single family residential (3 houses/ac, 3 people/house, average dry weather flow=130 gallons per person per day, PF=3). The estimated average and peak daily flow would be 271 gpm and 712 gpm, respectively. These flow rates do not include any contribution from the LS#5 basin.

For near-term planning purposes, current flow contributions were also analyzed. The average flow currently discharged to LS#3 has been previously estimated at 36,000 gallons per day (gpd); the WalMart LS is estimated to currently discharge an average of 120,000 gpd, including the contribution from LS#3.

Pump and Force Main Analysis

New Lift Station #5. LS#5 will utilize submersible sewage pumps, and two pumps will be installed inside a concrete wet well. Two pumps will be provided for redundancy and reliability, although the system will only rely on one

pump to discharge the peak influent flows. LS#5 would be located at station 54+80. Alternatives with and without LS#3, coupled with capacity needs for both short- and long-term development scenarios, are discussed below. Table 2 summarizes the alternatives.

New LS#5 with a LS#3. Under this alternative, the LS#5 force main would discharge into existing manhole A-108 located at Buena Vista Drive (approximately station 39+40), yielding a total force main length of approximately 1,540 feet. To accommodate service area build-out, based on a preliminary pump selection evaluation each pump would deliver approximately 200 to 250 gpm at approximately 70 feet total dynamic head, and each pump would require a 10 to 12 horsepower motor. A 4-inch diameter force main would be installed to convey the pumped flow to the downstream gravity sanitary sewer system. At this flow rate, the resulting force main velocity will be approximately 5.1 to 6.4 feet per second, which is within the acceptable range of 3 to 8 feet per second.

For the shorter-term development scenario, each pump would deliver approximately 90 to 100 gpm at approximately 23 feet total dynamic head, and would require a 2 horsepower motor. A 4-inch diameter force main would be installed to convey the pumped flow to the downstream gravity sanitary sewer system. This flow rate was selected based on maintaining a minimum velocity in the 4-inch diameter force main; for a sanitary sewer pumping system, the minimum pipe diameter should be 4 inches such that a 3-inch solid can readily be discharged. The resulting force main velocity would be approximately 2.6 feet per second. Although this scenario would not provide for service area build-out, the pump capacity would nonetheless provide for significant growth.

New LS#5 without a LS#3. Under this alternative LS#5 would need to provide capacity for the entire LS#5 and LS#3 service area. The LS#5 force main would discharge into existing manhole A-101 located near 8th Avenue (approximately station 12+00), yielding a total force main length of approximately 4,530 feet. For both short- and long-term growth needs, a single 8-inch diameter force main would be installed to convey the pumped flow to the downstream sanitary sewer system. To accommodate service area build-out, based on a preliminary pump selection evaluation each pump would deliver approximately 900 to 1,000 gpm at approximately 120 feet total dynamic head, and each pump would require a 45 horsepower motor. At this flow rate, the resulting force main velocity will be approximately 5.8 to 6.4 feet per second, which is within the acceptable range of 3 to 8 feet per second.

For the short-term development scenario, the target minimum flow rate would be approximately 500 gpm, which is derived from a minimum 3 feet per second velocity in the force main; provides for significant basin development. Based on a preliminary pump selection evaluation each pump would deliver approximately 475 to 550 gpm at approximately 53 feet total dynamic head, and would require a 12 horsepower motor (note: for a 6-inch diameter force main, the motor size would be larger than 50 HP to deliver this target flow rate).

Upgraded Lift Station #3. As noted, based on run-time data the average daily influent flow to this pump station is estimated at 25 gpm. Assuming a peaking factor of 3, the estimated peak influent flow is 75 gpm. Although the current capacity of LS#3 is not known, estimates on individual pump capacity can be made based on the motor size. The pump motor size is 7.5 HP. The existing 4-inch diameter force main has a total length of approximately 1,850 feet, with an estimated static elevation of approximately 20 feet between the pump station and discharge manhole. Assuming pump efficiency at 50% to 60% (reasonable for pumps of this size), the individual pump capacity would be 175 to 225 gpm. These conclusions are consistent with previous DAI analyses.

Alternatives for modifying LS#3 to accommodate growth in the LS#5 and LS#3 service area are discussed below. Table 2 summarizes the alternatives.

No Upgrade Necessary. The estimated current LS#3 single pump capacity appears to be adequate to discharge the estimated current peak influent flow plus the short-term capacity alternative for LS#5, which will discharge into this pump station. Thus, for the scenario of providing only shorter-term capacity for LS#5, no upgrade to existing LS#3 would be required. However, under this alternative very little additional capacity would be provided for growth specifically in the current LS#3 service area.

Furthermore, and perhaps most critically, actual LS#3 pump capacity has not been field verified; such an evaluation would need to be completed should the City want to consider this scenario in further detail.

Upgrade Pumps Only. The maximum capacity of the existing force main is approximately 325 gpm, assuming a velocity of 8 feet per second. Theoretically the pump size could thus be increased to provide for growth in the subject basins. However, through a preliminary screening of pump alternatives it was determined that the required pressure to deliver 325 gpm in a 4-inch diameter force main could not be accommodated with a submersible sewage-handling pump. Therefore, the alternative of upgrading the existing pumps to provide increased capacity is not feasible.

Upgrade Pumps and Force Main. To accommodate service area build-out, including inflow from LS#5, the minimum single pump capacity would need to be approximately 960 gpm. An 8-inch diameter force main would be required at this flow rate; thus, approximately 1,850 feet of new force main would be constructed (discharging into MH A-101 located near 8th Avenue). Based on a preliminary pump selection evaluation, each pump would deliver approximately 1,000 to 1,200 gpm at 65 feet total dynamic head, and each pump would require a 35 horsepower motor. At this pumping rate, the resulting force main velocity would be 6.4 to 7.5 feet per second. Two pumps would be provided for redundancy and reliability. The upgrade would require new pumps/motors, a new guide rail system in the wet well, modifications to the force main at the wet well, replacement of the pump station control panel, and an electrical service upgrade. Accommodations for emergency backup power would also need to be provided.

For the shorter-term growth scenario, to maintain consistency in these evaluations (e.g., with the LS#5 evaluations) a target pump capacity of 500 gpm was selected. Either a 6-inch or an 8-inch diameter force main would be required at this flow rate; the total force main length would be approximately 1,850 feet. For these evaluations, an 8-inch diameter pipe was selected. Based on a preliminary pump selection evaluation, each pump would deliver approximately 550 gpm at approximately 28 feet total dynamic head. Each pump would require a 10 horsepower motor. At this pumping rate the resulting force main velocity would be approximately 3.5 feet per second. The upgrade would require new pumps/motors, a new guide rail system in the wet well, modifications to the force main at the wet well, replacement of the pump station control panel, and an electrical service upgrade. Accommodations for emergency backup power would also need to be provided.

WalMart LS. One note of caution regarding the above analyses and recommendations must be made with respect to impacts to the existing WalMart LS. The estimated single-pump capacity for the WalMart LS is approximately 550 gpm. Thus, depending on the scenario implemented, the WalMart LS could be overloaded. Potential interim remedies to this situation are discussed further below under “Wet Well Analysis”.

Wet Well Analysis

The following wet well analyses will be developed under the assumption that adequate capacity will be provided for full service area build-out. Table 2 summarizes the recommendations.

Lift Station #5 with a Lift Station #3. The wet well volume for a constant speed pump station is controlled by the allowable maximum number of starts for the pump motor. For a 12 HP motor, the maximum number of starts should not exceed approximately 10 per hour; thus, for a two pump system, the cycle time for a single pump would be 3 minutes (e.g., time to fill and drain the wet well). For a constant speed pump, the minimum cycle time occurs when the influent flow is half of the pump capacity. The required wet well volume between the ‘pumps off’ and ‘lead pump on’ levels would be approximately 190 gallons. The minimum diameter wet well for this lift station would be 60 inches.

Lift Station #5 without a Lift Station #3. For a 45 HP motor, the maximum number of starts should not exceed approximately 7 per hour, thus for a two pump system, the cycle time for a single pump would be 4.3 minutes (e.g., time to fill and drain the wet well). The required wet well volume between ‘pumps off’ and ‘lead pump on’ levels would be approximately 1,200 gallons. A 96-inch diameter wet well would be installed.

Upgraded Lift Station #3. For a 35 HP motor, the maximum number of starts should not exceed approximately 8 per hour, thus for a two pump system, the cycle time for a single pump would be 3.75 minutes (e.g., time to fill and drain the wet well). The required wet well volume between ‘pumps off’ and ‘lead pump on’ levels would be approximately 1,200 gallons. For the existing 72-inch diameter wet well, an operating range of approximately 5.5 feet would be required. Insufficient information is available at this time to determine if the required operating parameters can be accomplished in the existing wet well. A new wet well may be required.

Existing WalMart LS. The existing wet well is 96 inches in diameter, thus it potentially can provide relatively significant storage volume. The storage capacity per foot of depth is 376 gallons. The existing pumps are equipped with 10 HP motors. The required wet well volume between ‘pumps off’ and ‘lead pump on’ levels would be approximately 340 gallons. Therefore, although on the basis of instantaneous capacity the WalMart LS is too small, until the service area develops such that LS#3 discharges at full capacity for extended time periods, there may be sufficient volume in the WalMart LS wet well to buffer the excess influent flow (e.g., serve as equalization) such that the current pump capacity is sufficient.

Summary and Conclusions

The preliminary design analyses presented herein provide a summary of alternatives for constructing a new LS#5 and either upgrading or eliminating LS#3, with sufficient capacity to accommodate service area build-out or a shorter-term growth scenario. Depending on the scenario selected, the existing WalMart LS may experience instantaneous capacity deficiencies. Beyond providing equalization storage in the existing WalMart LS wet well, potential additional alternatives to address this capacity issue that could be further investigated would include:

- Route the new LS#3 force main directly to a gravity sanitary sewer, thus bypassing the WalMart LS.
- Design the new LS#3 to match the capacity of the existing WalMart LS.
- Upgrade the WalMart LS to accommodate the increased peak influent flow.

As the design for this project proceeds, the following additional evaluations will need to be performed:

- Refinement and finalization of pump capacities and motor sizes. Small changes from the numbers presented herein could occur once the construction plans are finalized.
- Pump net positive suction head determination.
- Analysis of hydrogen sulfide formation in the pump station force mains and wet wells.
- Refinement and finalization of wet well sizing, both for proposed and existing wet wells.
- Wet well buoyancy analyses.

**Table 2
Summary of Pump Station Upgrade Alternatives**

	LS#5				LS#3	
	With a LS#3		Without a LS#3		Short-term Alternative	Service Area Build-out Alternative
	Short-term Alternative	Service Area Build-out Alternative	Short-term Alternative	Service Area Build-out Alternative		
Pump Capacity, gpm	100	250	550	1,000	550	1,000
Motor Horsepower	2	12	12	45	10	35
Force Main Dia, inches	4	4	8	8	8	8
Wet Well Dia, inches	60	60	96	96	72 (existing)	72 (existing)