

**88 STREET TRUNK SEWER
PRELIMINARY DESIGN REPORT**

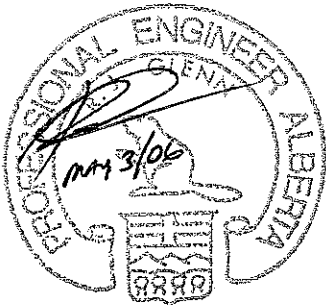
**Prepared for:
Aquatera Utilities Inc.**

MAY 2006


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1.0 INTRODUCTION

Focus was retained by Aquatera in January of 2005 to complete the preliminary design and cost estimate on the 88 Street Trunk Sewer. The trunk sewer extends from the existing sanitary trunk in Country Side South north past 132 Avenue. The trunk sewer servicing area is defined in the Waste Water Master Plan completed by ISL dated January 2005. This is illustrated in Figure 1.1. A small area of commercial and residential located north of 68 Avenue and West of 92 Street was later added to the servicing area and is included in this design.

For the purpose of this report and preliminary design, the trunk has been broken into two sections, the section North of 100 Avenue and the section South of 100 Avenue. For the area North of 100 Avenue, it is anticipated that the trunk will be constructed within the proposed developments to take advantage of the installation in servicing the lands. As a result, the final alignment and design of this section of trunk will require a greater degree of planning and design before the final trunk alignment and grades can be set.

For the area South of 100 Avenue, relatively flat topography requires the line to be extended in a straight line along the east boundary of the City. This is necessary in order to provide the maximum depth of cover through the low areas. As a result, there is a greater degree of certainty that the final design will not vary significantly from the alignments and grades in the preliminary design.

There is significant development pressure in the southern portion of the Trunk Basin. The current servicing philosophy for the area is to provide lift stations and storage at each development, pumping into the existing 92 Street Trunk Sewer during off-peak hours. The Master Plan estimated that the off-peak capacity available in this trunk is limited. Construction of this section of the trunk would allow for development of all adjacent lands within the service area, alleviate surcharging in the Crystal Heights sub-trunk, and free up some capacity in the existing 92 Street trunk. The excess capacity created in the 92 Street trunk could then be used to service some of the lands to the east of 92 Street, which are currently within the service area of the 88 Street trunk. If necessary, interim connections from lands to the north of 104 Avenue, east of 88 Street, could be made to the Crystal Lake sub-Trunk.

2.0 SYSTEM MODELLING

The Master Plan includes a preliminary assessment based on an XPSWMM hydraulic model. This model includes flows based on dry weather (land use) and wet weather (inflow and infiltration). The wet weather component of the flow has been calibrated to match the measured flows determined through a flow monitoring program. This model was provided to Focus by Aquatera.

The model was provided for Focus to complete this preliminary design. The model sections representing the extension of the 88 Street Trunk Sewer were revised to better reflect the proposed alignment and existing ground elevations. It is in the scope of our work to verify the contributing areas and the design flows for each basin within the Trunk. The calibrated wet weather flow contributions were adopted from the 2005 Wastewater Master Plan.

The model provided by Aquatera was updated to reflect the actual ground elevations. Elevations are based on actual site surveys completed by Focus for the south section. We were not able to get permission to access the land located in the SW of 19-71-5-6 or the north half of NW of 18-71-5-6 in time for the site surveys. The existing ground contours from the City of Grande Prairie (2002) were used to fill in the gap in this area. This was deemed reasonable as the tie to the survey was good and the ground is relatively flat in the area. For the North Section of the trunk, actual survey data was used for the Crystal Landing and Woodgrove areas. For the remaining lands the existing ground contours from the City of Grande Prairie (2002) were used.

The proposed pipe profile within the model was also updated to reflect the preliminary design in greater detail. This includes the pipe sizes, slopes and inverts. Focus also increased the number of dry weather flow inflow nodes within the model to better reflect the current development information and refined survey data.

2.1 Dry Weather Flow Generation

The dry weather flows have been estimated based on proposed land uses. The Land uses were derived from existing Area Structure Plans and Outline Plans provided by the City of Grande Prairie. Where Outline Plans existed, they were used.

During the preparation of the Master Plan, ISL provided the City of Grande Prairie with an analysis of existing developments within the City to determine the population densities being achieved. This result of this analysis is provided in Appendix A. Using this analysis, Focus determined that the appropriate population densities for the single family areas be based on 40 people per gross ha. The gross ha is the total land area less other uses, which includes arterial roads and 10% for Municipal Reserve. For the purposes of this trunk, no allowances were made for Environmental Reserve areas. The following table summarizes the basis for the dry weather flow calculations.

**TABLE 2.1
FLOW GENERATION**

LAND USE	POPULATION DENSITY	FLOW GENERATION	FLOW GENERATION
	(people / ha)	(l/p/day)	(cu.m/ha/day)
Single Family	40	275	
Multi Family	118.4	275	
*Mobile Home Park	50	275	
Schools			20
Commercial – Local			20
Commercial – Arterial			26
Industrial – Light			10

* Used for Mobile Home Parks located South of 100 Avenue within the County and T&E.

The inflows used in the XPSWWM model are based on a unit hydrograph calculation. This hydrograph was derived as part of the Waste Water Master Planning process. The unit hydrographs for the various land uses within each basin are added to create the inflow hydrograph. These hydrographs have been calculated with an Excel spreadsheet for 4 days of flow and then copied into the model at each inflow node. The calculation spreadsheet with the inflow hydrographs for each node is included on the CD and hard copy in Appendix B of this report. Each hydrograph is an inflow into the model.

2.2 Land Uses

The proposed land uses for the lands within the trunk drainage basin were derived from existing Area Structure Plans and Outline Plans approved by the City of Grande Prairie. For the Signature Falls area, approved plans were not yet available. In order to facilitate this design, the land owner made the overall concept plan available. Table 2.2 below summarizes the land uses for each quarter section (or portion of) within the basin. This information is also provided graphically on Figures 2.1 and 2.2.

**TABLE 2.2
LAND USES**

Legal Description	Planning Source	Land Use Areas (gross ha)					
		Single Family	Multi-Family	Mobile Home Park*	School	Commercial	Industrial
SE 1-72-6-6	NE ASP					6.6	56.4
SW 6-72-5-6	NE ASP					3.2	56.4
SE 6-72-5-6	NE ASP					3.2	59.7
NE 31-7-5-6	NE ASP	41.7	3.2		9.7		
NW 32-7-5-6	NE ASP	51.5	3.2				
SE 31-7-5-6	NE ASP	48.7	1.1		4.4		
SW 32-7-5-6	NE ASP	53.1	1.1				
NE 30-7-5-6	Woodgrove Outline Plan/ NE ASP	44.5	2.3		4.5	6.3	
SE 30-7-5-6	Crystal Landing / T&E	32.0	4.7	23.4			
NW 19-71-5-6	Meadowview ASP	25.7	2.3		4.5		
NE 19-71-5-6	Meadowview ASP			52.6			
SW 19-71-5-6	Meadowview ASP	27.9			4.5		
SE 19-71-5-6	Meadowview ASP	45.1					
NW 18-71-5-6	SE ASP	49.8	1.3		6		
NE 18-71-5-6	SE ASP	56.3	2.2				
SW 18-71-5-6	SE ASP	49.4	4.6		3.1		
SE 18-71-5-6	SE ASP	47.0			2.9	3.8	
NE, SE, SW 7-71-5-6 **	SE ASP	120.0			12.0	5.2	

* Mobile Home Park density is 50 people per ha.

** Country Side South has been subtracted from ASP Areas. Lots were counted for Country Side South with estimate for infill area.

Gross area presented is the total area less MR, Arterial widening and storm water management areas.

2.3 Wet Weather Flows

The model provided to Focus from Aquaterra included the wet weather flow hydrographs calibrated during the preparation of the Waste Water Master Plan. The wet weather flows were not changed or altered in modeling this trunk. The Model includes a 2 year, 5 year, 10 year and 25 year 4 hour Huff Distribution and a 25 year 24 hour Huff Distribution.

Limited surcharging occurred in the system for the 25 year 4 hour event, however it was determined in all cases that the 25 year 24 hour event is the critical event for the preliminary design. As a result, the data and analysis presented in this report is based on the 25 year 24 hour event.

2.4 System Analysis

System modeling was used to derive design flows and determine pipe sizes and slopes. A number of different scenarios were considered in the trunk sizing and alignment that differ from that proposed in the Master Plan. The resulting piping system is illustrated on Figure 2.3.

South Section

- The Master Plan indicated that it did not appear to be of any advantage to increase the pipe size from 900 to 1050 in the lower reaches of the proposed trunk. The scenario was modeled with 900 and with 1050 for the reach between model nodes E9 to ET30. The results of this analysis are presented in Table 2.3. A comparison of the two sets of results shows that increasing to 1050 reduced the duration of surcharging in two nodes by approximately 2 hours. However, the depth of the EGL only decreased by 56mm and no significant positive effects are realized downstream of the oversizing. Thus, it was determined that there is no significant benefit to the oversizing and a 900mm diameter pipe is presented in the design.
- The Master Plan indicated a 750mm trunk from 100 Avenue south to the southern boundary of section 19-71-5-6, model node E5. The system was modeled a number of times with the 750mm section starting at node E3, E4, E5 and E6. The results of this analysis are presented in Table 2.4. In all cases, the results were compared with the base case where the 750 started at node E3. Changing to 750 at node E4 has no upstream effects and slightly reduces the surcharge times downstream. Similarly, making the change at node E5 has no significant effect upstream or downstream. Making the change at node E6 however, results in an increase in surcharging upstream by 90minutes and approximately 350mm in depth. As a result, the change from 900 to 750 has remained as per the Master Plan at model node E5.

North Section

- The alignment of the trunk as presented in the Master Plan has been changed to be located in the future 116 Avenue and 84 Street Arterial road right-of-ways from the Woodgrove property north to 132 Avenue. This has the effect of reducing the overall

depth of the trunk and provides a central location to the lands being serviced by the trunk.

The XPSWWM model and the final servicing scenario data file are included on the CD in Appendix C. The node results for the model are included in Appendix D.

TABLE 2.3

Model Results

Comparison of 900 vs 1050 for the bottom of the system

25 Year 24 Hour Event

Model Node	With 1050mm Diameter from E9 to ET30					With 900mm Diameter from E9 to ET30					Comparison	
	Max Water Level	Pipe Invert	Ground Elevation	Depth EGL	Surcharge Duration (min)	Max Water Level	Pipe Invert	Ground Elevation	Depth EGL	Surcharge Duration (min)	Surcharge Duration (min)	Depth (m)
300099	669.814	669.61	680.8	10.966	0	669.814	669.61	680.8	10.966	0	0	0
300098	669.73	669.537	680.7	10.948	0	669.73	669.537	680.7	10.948	0	0	0
300097	669.583	669.394	680.4	10.792	0	669.583	669.394	680.4	10.792	0	0	0
300096	669.48	669.323	679.9	10.388	0	669.48	669.323	679.9	10.388	0	0	0
300095	669.277	669.082	678.8	9.492	0	669.277	669.082	678.8	9.492	0	0	0
300094	669.176	668.981	677.4	8.2	0	669.176	668.981	677.4	8.2	0	0	0
300093	668.941	668.745	677.3	8.335	0	668.941	668.745	677.3	8.335	0	0	0
300092	668.7	668.508	679.4	10.676	0	668.7	668.508	679.4	10.676	0	0	0
300091	668.649	668.46	680.4	11.726	0	668.649	668.46	680.4	11.726	0	0	0
300090	668.498	668.313	681.2	12.676	0	668.498	668.313	681.2	12.676	0	0	0
300089	668.273	668.072	680	11.702	0	668.273	668.072	680	11.702	0	0	0
300088	668.025	667.892	678.9	10.842	0	668.025	667.892	678.9	10.842	0	0	0
300070	667.762	667.594	678	10.189	0	667.762	667.594	678	10.189	0	0	0
300069	667.444	667.302	677	9.412	0	667.444	667.302	677	9.412	0	0	0
300068	666.411	666.224	676.7	10.162	0	666.411	666.224	676.7	10.162	0	0	0
300067	664.5	664.4	674.1	9.441	0	664.5	664.4	674.1	9.441	0	0	0
300066	661.533	661.364	671.3	9.546	0	661.533	661.364	671.3	9.546	0	0	0
300065	660.462	660.188	667	6.476	0	660.462	660.188	667	6.476	0	0	0
300064	660.193	659.924	666.2	5.971	0	660.193	659.924	666.2	5.971	0	0	0
300063	659.913	659.648	666.8	6.85	0	659.913	659.648	666.8	6.85	0	0	0
300062	659.62	659.36	666.8	7.141	0	659.62	659.36	666.8	7.141	0	0	0
300061	659.365	659.072	666.1	6.699	0	659.365	659.072	666.1	6.699	0	0	0
300060	655.867	654.815	665	5.945	0	655.867	654.815	665	5.945	0	0	0
EN0	678.041	677.898	684.4	6.359	0	678.041	677.898	684.4	6.359	0	0	0
EN1	671.885	671.731	675.9	3.923	0	671.885	671.731	675.9	3.923	0	0	0
EN1A	666.868	666.65	672	5.009	0	666.868	666.65	672	5.009	0	0	0
EN2	665.692	665.37	671.5	5.769	0	665.692	665.37	671.5	5.769	0	0	0
EN3	665.122	664.48	669.5	4.354	84	665.122	664.48	669.5	4.354	83.761	0	0
EN4	664.576	663.67	669.7	5.102	273	664.576	663.67	669.7	5.102	273.215	0	0
EN5	663.195	662.8	667.4	4.138	0	663.195	662.8	667.4	4.138	0	0	0
EN6	662.338	661	666.7	4.31	0	662.338	661	666.7	4.31	0	0	0
EN7	658.996	658.64	664.67	5.573	0	658.996	658.64	664.67	5.573	0	0	0
EN8	656.891	656.5	664.7	7.698	0	656.891	656.5	664.7	7.698	0	0	0
EN9	655.092	654.793	662.01	6.711	0	655.092	654.793	662.01	6.711	0	0	0
EN9A	653.341	652.976	658.35	4.726	0	653.341	652.976	658.35	4.726	0	0	0
EN9B	652.776	652.347	657.97	5.052	0	652.776	652.347	657.97	5.052	0	0	0
EN10	652.526	651.965	655.32	2.729	0	652.526	651.965	655.32	2.729	0	0	0
EN11	652.052	651.544	654.53	2.423	0	652.052	651.544	654.53	2.423	0	0	0
E1	651.337	650.7	656.26	3.524	0	651.337	650.7	656.26	3.524	0	0	0
E2	650.727	650	656.27	5.491	0	650.727	650	656.27	5.491	0	0	0
E3	650.034	649.5	655.38	5.27	0	650.034	649.5	655.38	5.27	0	0	0
E4	649.537	648.9	653.5	3.907	0	649.537	648.9	653.5	3.907	0	0	0
E5	649.295	648.4	654.39	5.062	0	649.295	648.4	654.39	5.062	0	0	0
E6	649.108	647.9	653.5	4.369	141	649.108	647.9	653.5	4.369	141.259	0	0
E7	648.022	647.3	651.94	3.755	0	648.053	647.3	651.94	3.755	0	0	0
ETA	647.962	647.2	651.31	3.308	0	648	647.2	651.31	3.274	0	0	-0.034
E8	647.777	646.9	653.7	5.899	0	647.829	646.9	653.7	5.84	0	0	-0.049
E9	647.558	646.5	651.92	4.336	0	647.615	646.5	651.92	4.279	157.111	157	-0.056
ET30	647.519	646.4	651.8	4.265	47	647.525	646.4	651.8	4.249	216.399	170	-0.016
ET29	647.336	646.3	651.72	4.325	295	647.341	646.3	651.72	4.32	296.353	-1	-0.005
ET28	647.166	646.29	651.65	4.428	222	647.169	646.29	651.65	4.424	221.033	1	-0.004
ET27	647.005	646.17	650.9	3.84	133	647.009	646.17	650.9	3.836	129.167	3	-0.004
400031	646.853	646.04	650.82	3.911	58	646.858	646.04	650.82	3.906	66.778	-9	-0.005
400030	646.677	645.92	649.7	2.966	0	646.68	645.92	649.7	2.963	0	0	-0.003
400029	646.499	645.78	649.23	2.67	0	646.503	645.78	649.23	2.667	0	0	-0.003
400028	646.328	645.61	648.73	2.338	0	646.331	645.61	648.73	2.335	0	0	-0.003
400027	646.146	645.45	649.86	3.639	0	646.149	645.45	649.86	3.637	0	0	-0.002
400026	646.005	645.26	648	1.922	0	646.008	645.26	648	1.919	0	0	-0.003
400025	645.843	645.12	648	2.087	0	645.844	645.12	648	2.086	0	0	-0.001
400024	645.809	645.077	648	2.12	0	645.81	645.077	648	2.119	0	0	-0.001
400023	645.766	644.908	649	3.194	0	645.767	644.908	649	3.194	0	0	0
400022	645.718	644.87	649	3.247	0	645.719	644.87	649	3.247	0	0	0
400021	645.597	644.84	649	3.355	0	645.598	644.84	649	3.355	0	0	0
400020	645.462	644.76	648	2.485	0	645.463	644.76	648	2.484	0	0	-0.001
400019	645.398	644.67	648	2.547	0	645.399	644.67	648	2.546	0	0	-0.001
400018	645.374	644.66	648.2	2.772	0	645.374	644.66	648.2	2.771	0	0	-0.001
1981	645.137	644.37	648.53	3.354	0	645.138	644.37	648.53	3.354	0	0	0
400008	644.948	644.09	648.34	3.36	0	644.949	644.09	648.34	3.359	0	0	-0.001
400007	644.937	644.08	648	3.021	0	644.938	644.08	648	3.02	0	0	-0.001
400006	644.824	643.98	650	5.134	0	644.825	643.98	650	5.133	0	0	-0.001
400005	644.744	643.92	649	4.213	0	644.745	643.92	649	4.213	0	0	0
400004	644.633	643.84	648	3.322	0	644.634	643.84	648	3.322	0	0	0
400003	644.514	643.75	648	3.436	0	644.514	643.75	648	3.436	0	0	0
400002	644.448	643.7	648	3.499	0	644.448	643.7	648	3.499	0	0	0
400001	644.283	643.6	649	4.659	0	644.283	643.6	649	4.659	0	0	0
400000	643.518	642.99	648.45	4.421	0	643.518	642.99	648.45	4.42	0	0	-0.001
100010	643.416	642.83	645	1.528	0	643.416	642.83	645	1.528	0	0	0
100009	642.659	642.38	647	4.245	0	642.659	642.38	647	4.245	0	0	0
OUTFALL	641.277	641	643	1.388	0	641.277	641	643	1.388	0	0	0

3.0 PRELIMINARY DESIGN

The trunk sewer was sized using the results of the SWWM Model. The standards used in the design are as per Aquatera and City of Grande Prairie standards. The minimum slopes in the standards are:

Minimum Slopes:

- 300mm 0.22%
- 375mm 0.15%
- 450mm 0.12%
- 525mm 0.10%
- 600mm 0.10%
- 675mm 0.10%
- 750mm 0.10%
- 900mm 0.10%

At manholes a drop across the manholes of 30mm was provided. There is an exception to this in that the section from the existing trunk at 68 Avenue to the crossing of Woody Creek has been designed with the pipe slope through the manhole. This provides the maximum depth of cover at the Woody Creek Crossing. There is some consideration underway to lowering the Creek through this section and the extra cover could be critical if this should happen. Where pipe sizes change, the obverts of the incoming and outgoing pipes have been matched.

A minimum cover of 2.75m has been provided. Where this cover is not possible, insulation will have to be provided. Cellular concrete insulation may be appropriate for these areas.

In general, the pipes have been sized to carry the 25 year 24 hour wet weather flow event with no surcharging. There are a number of nodes that will experience surcharging during this event as presented in the previous section.

The preliminary design plan profiles for the trunk sewer are included as attachment to this report. A summary table for the design is included in Table 3.1. This table shows the model node, design manhole, ground elevations, inverts, diameters lengths and grades.

**TABLE 3.1
TRUNK DESIGN**

MODEL NODE	MANHOLE	CHAINAGE	RIM	DNS INVERT	DIAMETER	LENGTH	SLOPE	DROP	UPS INVERT	COVER
	ET30	+877.06	651.72						646.456	N/A
	ET31	+972.95	651.79	646.552	900	95.89	0.100%	0.000	646.552	4.3
E9	ET32	1+019.57	652.40	646.599	900	46.82	0.100%	0.000	646.599	4.9
	ET33	1+076.37	653.00	646.655	900	56.8	0.100%	0.000	646.655	5.4
	ET34	1+184.21	653.00	646.763	900	107.84	0.100%	0.000	646.763	5.3
	ET35	1+284.09	653.00	646.863	900	99.88	0.100%	0.000	646.863	5.2
E8	ET36	1+404.42	653.00	646.983	900	120.33	0.100%	0.000	646.983	5.1
	ET37	1+523.72	653.00	647.103	900	119.3	0.100%	0.000	647.103	5.0
	ET38	1+600.31	653.00	647.179	900	76.59	0.100%	0.000	647.179	4.9
	ET39	1+642.17	653.00	647.221	900	41.86	0.100%	0.000	647.221	4.9
E7A	ET40	1+742.17	652.40	647.321	900	100	0.100%	0.000	647.321	4.2
E7	ET41	1+787.85	651.94	647.367	900	45.68	0.100%	0.030	647.397	3.7
	ET100	1+937.85	652.00	647.547	900	150	0.100%	0.030	647.577	3.6
	ET101	2+087.85	652.78	647.727	900	150	0.100%	0.030	647.757	4.2
	ET102	2+159.14	652.62	647.828	900	71.29	0.100%	0.030	647.858	3.9
E6	ET103	2+232.32	653.50	647.931	900	73.182	0.100%	0.030	647.961	4.7
	ET104	2+382.32	653.25	648.111	900	150	0.100%	0.030	648.141	4.2
	ET105	2+532.32	653.55	648.291	900	150	0.100%	0.030	648.321	4.4
E5	ET106	2+625.7	654.50	648.415	900	93.381	0.100%	0.150	648.565	5.3
	ET107	2+775.7	654.39	648.715	750	150	0.100%	0.030	648.745	4.9
	ET108	2+925.7	653.19	648.895	750	150	0.100%	0.030	648.925	3.5
E4	ET109	3+075.7	653.03	649.075	750	150	0.100%	0.030	649.105	3.2
	ET110	3+225.7	653.50	649.255	750	150	0.100%	0.030	649.285	3.5
	ET111	3+375.7	653.50	649.435	750	150	0.100%	0.030	649.465	3.3
E3	ET112	3+425.7	653.50	649.515	750	50	0.100%	0.030	649.545	3.2
	ET113	3+525.7	653.56	649.645	750	100	0.100%	0.030	649.675	3.2
	ET114	3+675.7	654.51	649.825	750	150	0.100%	0.030	649.855	3.9
E2	ET115	3+765.48	655.38	649.944	750	89.78	0.100%	0.030	649.974	4.7

**TABLE 3.1
TRUNK DESIGN**

MODEL NODE	MANHOLE	CHAINAGE	RIM	DNS INVERT	DIAMETER	LENGTH	SLOPE	DROP	UPS INVERT	COVER
					750	150	0.100%			
	ET116	3+915.48	655.86	650.124	750	150	0.100%	0.030	650.154	5.0
	ET117	4+065.48	656.18	650.304	750	150	0.100%	0.030	650.334	5.1
	ET118	4+215.48	656.37	650.484	750	150	0.100%	0.030	650.514	5.1
E1	ET200	4+253.19	655.72	650.552	750	37.712	0.100%	0.240	650.792	4.4
	ET202	4+336.56	655.63	650.875	750	83.365	0.100%	0.060	650.935	4.0
	ET203	4+429.99	654.41	651.029	750	93.437	0.100%	0.060	651.089	2.6
	ET204	4+506.76	654.55	651.166	750	76.766	0.100%	0.030	651.196	2.6
EN11	ET205	4+616.76	654.53	651.306	750	110	0.100%	0.075	651.381	2.5
	ET206	4+722.25	654.97	651.486	675	105.491	0.100%	0.030	651.516	2.8
	ET207	4+814.79	655.72	651.609	675	92.543	0.100%	0.030	651.639	3.4
EN10	ET208	4+903.15	655.32	651.727	675	88.36	0.100%	0.075	651.802	3.0
	ET209	4+980.56	657.10	651.957	600	77.406	0.200%	0.030	651.987	4.5
EN9B	ET210	5+039.41	658.38	652.105	600	58.849	0.200%	0.075	652.180	5.8
EN9A	ET213	5+143.06	659.00	652.698	525	103.653	0.500%	0.060	652.758	5.8
	ET214	5+203.09	660.36	653.358	525	60.025	1.000%	0.030	653.388	6.5
EN9	ET216	5+263.52	662.70	653.993	525	60.439	1.000%	0.030	654.023	8.2
	ET217	5+363.52	663.20	655.023	525	100	1.000%	0.030	655.053	7.7
	ET218	5+455.03	664.70	655.968	525	91.504	1.000%	0.030	655.998	8.2
	ET219	5+491.26	664.80	656.360	525	36.233	1.000%	0.030	656.390	7.9
	ET220	5+531.11	664.50	656.788	525	39.853	1.000%	0.030	656.818	7.2
EN8	ET221	5+588.4	664.90	657.391	525	57.289	1.000%	0.030	657.421	7.0
	ET222	5+678.06	665.30	657.870	525	89.652	0.500%	0.030	657.900	6.9
	ET223	5+755.29	665.30	658.286	525	77.23	0.500%	0.030	658.316	6.5
	ET224	5+791.56	664.57	658.497	525	36.272	0.500%	0.030	658.527	5.5
	ET225	5+856.02	664.60	658.849	525	64.46	0.500%	0.030	658.879	5.2
	ET226	5+956.99	664.54	659.132	525	100.976	0.250%	0.030	659.162	4.9
EN7	ET227	6+050.31	664.80	659.395	525	93.321	0.250%	0.030	659.425	4.9

**TABLE 3.1
TRUNK DESIGN**

MODEL NODE	MANHOLE	CHAINAGE	RIM	DNS INVERT	DIAMETER	LENGTH	SLOPE	DROP	UPS INVERT	COVER
	ET228	6+128.61	666.00	659.621	525	78.296	0.250%	0.030	659.651	5.9
	ET229	6+155.77	666.30	659.719	525	27.161	0.250%	0.030	659.749	6.1
	ET230	6+201.4	666.00	659.863	525	45.624	0.250%	0.030	659.893	5.6
	ET231	6+251.11	665.50	660.017	525	49.715	0.250%	0.030	660.047	5.0
	ET232	6+289.49	665.50	660.143	525	38.378	0.250%	0.030	660.173	4.8
	ET233	6+344.94	665.80	660.312	525	55.454	0.250%	0.030	660.342	5.0
EN6	ET300	6+453.85	666.00	660.614	525	108.91	0.250%	0.060	660.674	4.9
	ET301	6+553.85	666.46	660.854	525	100	0.180%	0.030	660.884	5.1
	ET302	6+653.85	666.00	661.064	525	100	0.180%	0.030	661.094	4.4
	ET303	6+753.85	666.11	661.274	525	100	0.180%	0.030	661.304	4.3
EN6'	ET304	6+830.86	666.34	661.443	525	77.01	0.180%	0.060	661.503	4.4
	ET305	6+930.86	667.50	661.683	525	100	0.180%	0.030	661.713	5.3
	ET306	7+030.86	667.50	661.893	525	100	0.180%	0.030	661.923	5.1
	ET307	7+130.86	668.39	662.103	525	100	0.180%	0.030	662.133	5.8
EN5	ET308	7+230.86	666.91	662.313	525	100	0.150%	0.030	662.343	4.1
	ET309	7+330.86	666.96	662.493	525	100	0.150%	0.030	662.523	3.9
	ET310	7+430.86	669.03	662.673	525	100	0.150%	0.030	662.703	5.8
	ET311	7+530.86	669.53	662.853	525	100	0.150%	0.030	662.883	6.2
EN4	ET312	7+630.86	669.80	663.033	450	100	0.150%	0.075	663.108	6.3
	ET313	7+730.86	669.70	663.258	450	100	0.150%	0.030	663.288	6.0
	ET314	7+830.86	669.50	663.438	450	100	0.150%	0.030	663.468	5.6
	ET315	7+930.86	669.50	663.618	450	100	0.150%	0.030	663.648	5.4
EN3	ET316	8+030.86	669.50	663.798	450	100	0.150%	0.030	663.828	5.3
	ET317	8+130.86	669.50	663.978	450	100	0.150%	0.030	664.008	5.1
	ET318	8+230.86	669.50	664.158	450	100	0.150%	0.030	664.188	4.9
	ET319	8+330.86	669.92	664.338	450	100	0.150%	0.030	664.368	5.1
EN2	ET320	8+404.35	670.94	664.531	450	73.49	0.222%	0.075	664.606	6.0

**TABLE 3.1
TRUNK DESIGN**

MODEL NODE	MANHOLE	CHAINAGE	RIM	DNS INVERT	DIAMETER	LENGTH	SLOPE	DROP	UPS INVERT	COVER
	ET321	8+452.65	671.54	664.809	375	48.3	0.420%	0.060	664.869	6.4
	ET322	8+562.65	671.59	665.331	375	110	0.420%	0.030	665.361	5.9
	ET323	8+672.65	672.26	665.823	375	110	0.420%	0.030	665.853	6.1
	ET324	8+782.65	672.41	666.315	375	110	0.420%	0.030	666.345	5.7
EN1A	ET325	8+869.23	672.00	666.708	300	86.58	0.420%	0.075	666.783	5.0
	ET326	8+972.53	672.45	667.382	300	103.3	0.580%	0.030	667.412	4.8
	ET327	9+082.53	674.53	668.050	300	110	0.580%	0.030	668.080	6.2
	ET328	9+192.53	675.45	668.718	300	110	0.580%	0.030	668.748	6.4
EN1	ET329	9+302.53	675.99	669.386	300	110	0.580%	0.030	669.416	6.3
	ET330	9+412.53	676.15	670.054	300	110	0.580%	0.030	670.084	5.8
	ET331	9+522.53	677.19	671.459	300	110	1.250%	0.030	671.489	5.4
	ET332	9+632.53	678.51	672.864	300	110	1.250%	0.030	672.894	5.3
	ET333	9+742.53	680.67	674.269	300	110	1.250%	0.030	674.299	6.1
	ET334	9+852.53	682.30	675.674	300	110	1.250%	0.030	675.704	6.3
	ET335	9+962.53	683.44	677.079	300	110	1.250%	0.030	677.109	6.1
EN0	ET336	10+072.53	684.44	678.484	300	110	1.250%	0.030	678.514	6.0

4.0 LATERAL ANALYSIS

In order to confirm that the lands within the basin can be serviced by the proposed trunk, Focus completed a review of the lands that are low areas. The lands considered are shaded on Figure 4.1.

This review includes a preliminary layout of a lateral system for each of the land parcels and, based on existing ground, and an assessment of serviceability by gravity. The analysis is based on the laterals extending from the trunk into the parcel at an overall slope of 0.5%. A 200mm pipe would have a minimum slope of 0.40% and drops across manholes, say an average of 45mm per manhole with manholes every 90m. This results in an overall slope of 0.45%. The additional 0.05% is a contingency for curved sewers and changes in lateral alignments.

4.1 South Sections

The analysis for the south sections is presented in Table 4.1 and Figures 4.2, 4.3, 4.4 and 4.5. As previously indicated, the alignment of this section of trunk is essentially fixed and minimum grades have been used. As a result, there is no option for this section to deepen the pipes to allow the adjacent lands to drain by gravity. Table 4.1 shows the trunk manhole invert, diameter and obvert elevation, the later manhole number (as shown on the corresponding figures), obvert, ground and depth to the obvert.

Figure 4.2 shows the area serviced by MH 100. The lateral was considered first to cross the creek to service the lands to the west. As an additional creek crossing may not be desirable, it was also considered to connect to MH40 and extend north to MH100W1. This results in approximately 0.9m less cover. At the upper reaches of the area, cover is deficient and fill or pumping will be required. Alternately, some of this land may be serviceable into the 92 Street trunk.

Figure 4.3, 4.4 and 4.5 show the areas that will require fill or pumping.

4.2 North Sections

For the north section of the trunk, there is significant grade available to deepen the trunk through the Woodgrove area and service all of the lands by gravity. The analysis for the north sections are presented in Table 4.2 and Figures 4.6 and 4.7. The analysis in Table 4.2 includes results based on both the design as presented and an alternative with a deeper trunk at minimum grade. The deepening would start at MH 213 in the NE corner of the Crystal Landing area.

It is very apparent that a significant amount of fill would be required to services these lands with the design as presented. A lift station could be the more cost effective solution to servicing. With the option of deepening the trunk and increasing the pipe size for a couple of reaches, the land would become serviceable by gravity with very little fill required.

A preliminary estimate of the increased construction cost to deepen the trunk sufficiently to allow this to work is \$1,400,000.00. This does not include any design or contingency allowance. Prior to detailed design, this cost should be compared to the cost of a lift station and forcemain to determine if this should be done.

**TABLE 4.1
LATERAL ANALYSIS
SOUTH SECTIONS**

				Avg Slope	0.50%						
Trunk				Lateral			Approx. Depth to Obvert				
MH	Inv	Dia	Obv	MH	Obvert	Ground					
100	647.577	900	648.48	100W1	648.98	653	4.02				
				100W2	649.48	653.1	3.62				
				100W3	649.98	653.6	3.62				
				100W4	650.48	654.2	3.72				
				100W5	650.98	654.6	3.62				
				100W6	651.48	656	4.52				
				Alternate - no creek crossing, tie-in at MH40							
				100W1	649.84	653	3.16				
				100W2	650.34	653.1	2.76				
				100W3	650.84	653.6	2.76				
				100W4	651.34	654.2	2.86				
				100W5	651.84	654.6	2.76				
				100W6	652.34	656	3.66				
				100W2N1	650.34	652.8	2.46				
				100W2N2	650.84	653	2.16				
				100W2N3	651.17	653	1.83				
				100W4N1	651.84	654.7	2.86				
				100W4N2	652.34	655	2.66				
				100W4N3	652.84	654	1.16				
				100W4N3	653.34	653.5	0.16				
				100W6N1	652.84	655.9	3.06				
				100W6N2	653.34	656.2	2.86				
				100W6N3	653.84	655.7	1.86				
				100W6N4	654.34	654.5	0.16				
				104	648.141	900	649.04	104W1	649.54	653.7	4.16
								104W2	650.04	653.4	3.36
				106	648.565	750	649.31	106W1	649.81	653.8	3.99
106W2	650.31	653.5	3.19								
106W3	650.81	653.8	2.99								
106W4	651.31	654.6	3.29								
106W5	651.81	655	3.19								
107	648.745	750	649.49	107E1	649.99	652.7	2.71				
				107E2	650.49	653	2.51				
				107E3	650.99	653.1	2.11				
				107E4	651.49	653.7	2.21				
				107E5	651.99	654.1	2.11				
				107E6	652.49	654.2	1.71				
				107E7	652.99	653.9	0.91				
				107E8	653.19	653.7	0.51				

**TABLE 4.1
LATERAL ANALYSIS
SOUTH SECTIONS**

Trunk				Lateral			Approx. Depth to Obvert
MH	Inv	Dia	Obv	MH	Obvert	Ground	
109	649.105	750	649.85	109E1	650.35	653	2.65
				109E2	650.85	653.1	2.25
				109E3	651.35	653.3	1.95
				109E4	651.85	653.4	1.55
				109E5	652.35	654.4	2.05
				109E6	652.85	655.2	2.35
				109E7	653.35	655.3	1.95
				109E8	653.55	655.2	1.65
				109W1	650.35	653.3	2.95
				109W2	650.85	653.3	2.45
				109W3	651.35	653.6	2.25
				109W4	651.85	653.8	1.95
113	649.675	750	650.42	113E1	650.92	653.2	2.28
				113E2	651.42	653.4	1.98
				113E3	651.92	652.9	0.98
				113E4	652.42	653.4	0.98
				113E5	652.92	654.7	1.78
				113E6	653.42	655.5	2.08
				113E7	653.92	655.2	1.28
				113E8	654.12	654.8	0.68
115	649.974	750	650.72	115E1	651.22	654	2.78
				115E2	651.72	653.5	1.78
				115E3	652.22	653.7	1.48
				115E4	652.72	654.3	1.58
				115E5	653.22	654	0.78
				115E6	653.72	654.2	0.48
				115E7	654.22	654.7	0.48
				115E8	654.42	654.7	0.28
117	650.334	750	651.08	117E1	651.58	654.5	2.92
				117E2	652.08	654.7	2.62
				117E3	652.58	653.9	1.32
				117E4	653.08	653.7	0.62
				117E5	653.58	654.2	0.62
				117E6	654.08	655.3	1.22
				117E7	654.58	657.3	2.72
				117E8	654.78	657.7	2.92

**TABLE 4.2
LATERAL ANALYSIS
NORTH SECTIONS**

Trunk				Lateral			Approx. Depth to Obvert
MH	Inv	Dia	Obv	MH	Obvert	Ground	
305 As Designed	661.713	525	662.24	305E1	662.74	667.4	4.66
				305E2	663.24	667.4	4.16
				305E3	663.74	667	3.26
				305E4	664.24	666.6	2.36
				305E5	664.74	666.1	1.36
				305E6	665.24	665.8	0.56
				305E7	665.74	666.4	0.66
				305E8	665.94	666.9	0.96
	658.287 Minimum Grade	450	658.74	305E1	659.24	667.4	8.16
				305E2	659.74	667.4	7.66
				305E3	660.24	667	6.76
				305E4	660.74	666.6	5.86
				305E5	661.24	666.1	4.86
				305E6	661.74	665.8	4.06
				305E7	662.24	666.4	4.16
				305E8	662.44	666.9	4.46
307 As Designed	662.133	525	662.66	307E1	663.16	667.7	4.54
				307E2	663.66	666.6	2.94
				307E3	664.16	666.6	2.44
				307E4	664.66	667	2.34
				307E5	665.16	667	1.84
				307E6	665.66	666.8	1.14
				307E7	666.16	666.6	0.44
				307E8	666.36	666.5	0.14
	659.107 Minimum Grade	450	659.56	307E1	660.06	667.7	7.64
				307E2	660.56	666.6	6.04
				307E3	661.06	666.6	5.54
				307E4	661.56	667	5.44
				307E5	662.06	667	4.94
				307E6	662.56	666.8	4.24
				307E7	663.06	666.6	3.54
				307E8	663.26	666.5	3.24
309 As Designed	662.523	525	663.05	309E1	663.55	666.6	3.05
				309E2	664.05	666.4	2.35
				309E3	664.55	666.3	1.75
				309E4	665.05	666.2	1.15
				309E5	665.55	666.1	0.55
				309E6	666.05	666.1	0.05
				309E7	666.55	666.1	-0.45
				309E8	666.75	666.1	-0.65
	659.887 Minimum Grade	450	660.34	309E1	660.84	666.6	5.76
				309E2	661.34	666.4	5.06
				309E3	661.84	666.3	4.46
				309E4	662.34	666.2	3.86
				309E5	662.84	666.1	3.26
				309E6	663.34	666.1	2.76
				309E7	663.84	666.1	2.26
				309E8	664.04	666.1	2.06

**TABLE 4.2
LATERAL ANALYSIS
NORTH SECTIONS**

Trunk				Lateral			Approx. Depth to Obvert
MH	Inv	Dia	Obv	MH	Obvert	Ground	
311	662.883 As Designed	525	663.41	311E1	663.91	669.4	5.49
				311E2	664.41	668.7	4.29
				311E3	664.91	668.1	3.19
				311E4	665.41	667.3	1.89
				311E5	665.91	667.4	1.49
				311E6	666.41	667.2	0.79
				311E7	666.91	666.8	-0.11
				311E8	667.11	666.7	-0.41
	660.627 Minimum Grade	450	661.08	311E1	661.58	669.4	7.82
				311E2	662.08	668.7	6.62
				311E3	662.58	668.1	5.52
				311E4	663.08	667.3	4.22
				311E5	663.58	667.4	3.82
				311E6	664.08	667.2	3.12
				311E7	664.58	666.8	2.22
				311E8	664.78	666.7	1.92
313	663.288 As Designed	450	663.74	313E1	664.24	669.2	4.96
				313E2	664.74	669.2	4.46
				313E3	665.24	669.1	3.86
				313E4	665.74	669.2	3.46
				313E5	666.24	669.2	2.96
				313E6	666.74	669.2	2.46
				313E7	667.24	668.8	1.56
				313E8	667.44	668.5	1.06
	661.197 Minimum Grade	450	661.65	313E1	662.15	669.2	7.05
				313E2	662.65	669.2	6.55
				313E3	663.15	669.1	5.95
				313E4	663.65	669.2	5.55
				313E5	664.15	669.2	5.05
				313E6	664.65	669.2	4.55
				313E7	665.15	668.8	3.65
				313E8	665.35	668.5	3.15
315	663.648 As Designed	450	664.10	315E1	664.60	669.6	5.00
				315E2	665.10	669.5	4.40
				315E3	665.60	669.7	4.10
				315E4	666.10	670.2	4.10
				315E5	666.60	670.2	3.60
				315E6	667.10	669.6	2.50
				315E7	667.60	668.9	1.30
				315E8	667.80	668.8	1.00
	661.587 Minimum Grade	450	662.04	315E1	662.54	669.6	7.06
				315E2	663.04	669.5	6.46
				315E3	663.54	669.7	6.16
				315E4	664.04	670.2	6.16
				315E5	664.54	670.2	5.66
				315E6	665.04	669.6	4.56
				315E7	665.54	668.9	3.36
				315E8	665.74	668.8	3.06

**TABLE 4.2
LATERAL ANALYSIS
NORTH SECTIONS**

Trunk				Lateral			Approx. Depth to Obvert
MH	Inv	Dia	Obv	MH	Obvert	Ground	
317	664.008 As Designed	450	664.46	317E1	664.96	669.3	4.34
				317E2	665.46	669.4	3.94
				317E3	665.96	669.6	3.64
				317E4	666.46	670.2	3.74
				317E5	666.96	669.9	2.94
				317E6	667.46	669.6	2.14
				317E7	667.96	669	1.04
				317E8	668.16	668.7	0.54
	661.927 Minimum Grade	450	662.38	317E1	662.88	669.3	6.42
				317E2	663.38	669.4	6.02
				317E3	663.88	669.6	5.72
				317E4	664.38	670.2	5.82
				317E5	664.88	669.9	5.02
				317E6	665.38	669.6	4.22
				317E7	665.88	669	3.12
				317E8	666.08	668.7	2.62
319	664.368 As Designed	450	664.82	319E1	665.32	670.5	5.18
				319E2	665.82	671.1	5.28
				319E3	666.32	670.9	4.58
				319E4	666.82	671.1	4.28
				319E5	667.32	670.6	3.28
				319E6	667.82	669.2	1.38
				319E7	668.32	668.2	-0.12
				319E8	668.52	667.4	-1.12
	662.227 Minimum Grade	450	662.68	319E1	663.18	670.5	7.32
				319E2	663.68	671.1	7.42
				319E3	664.18	670.9	6.72
				319E4	664.68	671.1	6.42
				319E5	665.18	670.6	5.42
				319E6	665.68	669.2	3.52
				319E7	666.18	668.2	2.02
				319E8	666.38	667.4	1.02

5.0 WOODY CREEK CROSSING

The trunk crosses Woody Creek at the NW corner of SE 18-71-5-6. Based on the preliminary design and the detailed site survey, the cover provided for this section of pipe will be 1.7m. This is short of the standard by 1.05m. Therefore, it is recommended that this section of trunk be insulated with cellular concrete insulation.

There is a proposal being considered to lower the creek in this area to provide for storm water management. Based on the information we have on this proposal, the invert of the creek could be lowered approximately 2m from 650.0 to 648 at the crossing location. The preliminary design of the trunk will not accommodate this change in grade.

In order to limit the potential for inflow in this area, consideration should be given to using HDPE fused pipe for the crossing for a seamless conduit.

6.0 CONSTRUCTION COST ESTIMATE

The construction cost estimate for the 88 Street Trunk Sewer has been prepared in sections. Figure 6.1 shows the sections used for calculating the costs. The costs for each segment include the downstream manhole in the calculation.

The resulting cost estimate for the South Sections is presented in Table 6.1 and the North Sections in Table 6.2. The quantity take-off for each section is included in Appendix E.

The estimate is based on the following assumptions:

- 2005 construction costs; inflated 20% for materials and 5% for other items.
- PVC piping
- 1500mm manholes for 900mm diameter pipe
- 1200mm manholes for 750mm diameter and smaller
- Safety platforms for manholes 6.5m or deeper
- 25% added to cover Design and Contingencies

Costs not included in the estimate:

- Land costs
- Legal costs
- Administration costs
- Allowance for poor ground conditions

The resulting estimated construction cost for the South sections is \$2,921,000.00. The area serviced by this trunk is approximately 400 ha. The resulting cost per ha is \$7,300.00.

The estimated construction cost for the North sections is \$5,120,600.00. As indicated in section 4, should the trunk depth be increased to service the low lands, the estimated cost for the North sections will increase to \$6,520,600. The area serviced by this trunk is approximately 576 ha. The resulting cost per ha is \$8,890.00 as designed and \$11,320.00 with the deepened trunk.

