Oxford Falls Retirement Resort

Lots 1110, 1111, 1113 & 1336 in DP752038,
Lot 20 in DP842523 & Lot 80 in DP846099
Oxford Falls Rd, Frenchs Forest

Stormwater Concept Plan
Major Project – 05-0113
Seniors Living Resort, Oxford Falls
Proposed Concept Plan

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For
Tiffany Developments

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1.0 Introduction

This firm has been engaged by Tiffany Developments to develop a stormwater drainage concept plan for the proposed Seniors Living Resort, Oxford Falls located on the subject properties with respect to impacts on stormwater drainage regimes in the locality. The proposed development concept is detailed on plans which have been prepared by Urbis (hereinafter referred to as "the Urbis plans"). This report has been prepared based on a review of the Urbis plans and previous stormwater concept plans prepared by this firm with respect to this site. This report considers the management of minor and major stormwater flows through the site only and has been prepared to complement the Water Quality Management Concept report prepared by SEEC.

The Urbis plans detail a proposed retirement resort to be developed on the subject site. The extent of the current proposal is similar to previous proposals with the exception that the current proposal no longer includes the land within Lot 1108 DP752038. The proposed development concept is for the erection of a number of tower blocks joined by a podium level concourse set at approximately RL85. Access to the site will be provided via an internal road system connecting to Oxford Falls Rd in the vicinity of the current tennis academy administration building and on the unformed section of Barnes Rd. It is proposed that an alternative access point will be provided to the existing formation in Barnes Rd to the west of the site. This alternative route will be used for emergency access only.

The impacts of the current proposal described in the Urbis plans have been assessed as being similar to that resulting from previous proposals on the site. The development of the site has been found to not result in any increase in flood flows in the stormwater systems in the area and so the proposal is considered to be consistent with the Director General's requirements for MP05_0113 with respect to Drainage and Flooding.

2.0 Description of the Site

The site, which is currently known as Lots 1110, 1111, 1113 & 1336 in DP752038, Lot 20 in DP842523 & Lot 80 in DP846099 Oxford Falls Rd, Frenchs Forest is located in a valley in the Shire of Warringah bounded by Warringah Rd in the south, the Wakehurst Parkway in the west and Brooker Ave in the east. The valley collects the stormwater runoff from approximately 110 hectares of catchment. While the western portion of this catchment is generally in a natural state, the eastern and southern areas of the catchment have been developed for residential and industrial uses, which in the whole have tended to be uncontrolled with respect to stormwater drainage. That is, the development has been allowed to proceed without the consideration of the increase in stormwater flows and velocities which will occur as a result of that development. The result of this has been that the site now receives substantially more stormwater in a given storm event than would have naturally been discharged from the upstream catchments.

The site is traversed by a watercourse which has been substantially altered from natural conditions over the past 50 years. This watercourse which parallels Oxford Falls Road has been denoted as the "the Middle Creek Tributary" for the purposes of

this study. Warringa Council have prepared a policy document titled "Warringah Creek Management Study 2004" (WCMS) which nominates this main creek as being significant with associated riparian and no development zones. The Middle Creek Tributary originates in a gully draining the intersection of Oxford Falls Road with Iris Street located to the south of the site.

The WCMS also nominates two minor tributaries of the main creek within the site as being of significance. One of these tributaries located immediately south of the tennis courts in the Tennis Academy (hereinafter referred to as Drainage Line 1) and the second is located immediately to the south of the section of Barnes Rd intersecting with Oxfords Falls Road (Drainage Line 2). The property immediately south of the intersection of Barnes Rd and Oxford Falls Rd is not part of the site. As such, no works are proposed at this time in the Middle Creek Tributary parallel to Oxford Falls Rd south of Barnes Rd.

Drainage Line 1 in its current form is little more than an engineered drain. The original alignment of this creek can not be ascertained due to the construction of the tennis courts on the site. The upper reaches of this creek have been destroyed by the construction of a water quality pond which is currently under the care and control of Warringah Council (Lot 21 in DP842523 & Lot 29 in DP829321. The lower reach of Drainage Line 1 has been formed into a grassed trapezoidal channel protected by a 6m wide easement to drain water.

Drainage Line 2 has also been substantially altered over time in an attempt to minimise the flooding impacts which have resulted from uncontrolled development on the escarpment above the valley. It is understood that Warringah Council are desirous of having this drainage line retained but due to the significant changes which have occurred to the alignment of the drainage line in the past, it is understood that Council is not concerned with retaining a particular alignment for the creek. The current form of the drainage line does not have sufficient capacity to convey the design 100 year flood. It is therefore proposed to enlarge the cross-section of Drainage Line 2 to control runoff through the site. Given the lack of works proposed to be carried out in the main creek south of Barnes Rd, Drainage Line 2 has been modelled as an extension to the Middle Creek Tributary.

3.0 Current Flood Flows

The site collects significant flows off the surrounding catchments as depicted in the enclosed catchment plan (Drg No 03508E3 sheet 2 of 2). The catchments depicted on the catchment plan have been determined off digital contours and aerial photography and confirmed on site. To establish the effect of past developments in the upstream catchments, an analysis of the catchment in its "natural state" prior to the development has been undertaken. The assumed "natural" Catchments are depicted in Drg No. 03508E3 sheet 1 of 2.

Peak flows off the natural state catchments have been determined using the Rational method as recommended in Australian Rainfall & Runoff. The calculations for these flows is provided in Appendix A. In summary, the peak flow of stormwater off the upstream catchments in the pre-developed state would have been as follows:-

5 year ARI natural catchment flow = 13.44 cumecs
100 year ARI natural catchment flow = 33.52 cumecs

The effect of development of the various catchments has been to increase the velocity and volume of stormwater runoff which is received by the site. The stormwater flows off the developed catchments (refer Appendix B for calculations) has been determined as follows:-

5 Year ARI developed catchment flow = 30.64cumecs
100 Year ARI developed catchment flow = 56.54 cumecs

Based on the above figures, the development of the upper catchments has resulted in a 228% increase in flows in the 5 year ARI event and 169% increase in the 100 year ARI event. These increases are significant and have been the cause for concern on the part of the owners of the site for some time.

In order to effectively control the runoff from the upper catchments, an analysis of the existing flow paths has been undertaken. The form of the existing roads is such that the flows off catchments 1,2 & 4 are directed to Iris Street and then into Myra St. Myra St does not have sufficient capacity (refer Appendix C) to convey the full 100 year flow and a portion of the flow overflows to the gully to the east of Myra St as indicated on the catchment plan. When Myra St flows reach Barnes Rd, it is unclear how the flows will spread and it has been assumed that the flow is divided 50/50 down each arm of Barnes Road.

Flows from the southern arm of Barnes Rd will continue to be directed to the gully to the south of Barnes Rd from where they are directed to the site vis the existing topography.

Flows from the northern arm of Barnes Rd are directed into a basin, which has been constructed at the end of a driveway leading the northern end of Barnes Rd. For the purposes of this study, the impact of this basin on the flows has been ignored other than for the purpose of acting as a gross pollutant trap. The Barnes Rd flows combine with flows off catchment 14 such that 9.97 cumecs is required to pass through the development in the 5 year event (13.49 cumecs in the 100 year event).

Catchment 15 is a wholly natural catchment and the runoff from this catchment is currently directed by the natural topography away from the site.

4.0 Modelling of Design Stormwater Flows

The flows off the catchments upstream of the site have also been modelled using the XP-Rafts computer model in order to confirm the rational flows described above. This computer based hydrological model was jointly developed by SMEC and Willing and Partners and continues to be developed by Willing and Partners. The program is considered to be industry standard and has a user friendly interface capable of simulating rainfall runoff by explicitly taking into account the sub-catchment size, the slope, percentage of impervious area, soil type (loss rates), detention basins, etc.

The catchment data as described above and in Plan Ref 03508E6 was entered into an XP-Rafts model. An assessment of the % impervious was carried out for each catchment with 1.5mm and 0mm being adopted as initial and continuing (respectively) losses for impervious surfaces. For the residential areas upstream of the site the % impervious was assessed at 60%. 15mm and 2.5mm were the adopted initial and continuing loss rates for pervious surfaces within the catchment. XP-Rafts provides an option to model older catchments as "old urban". Selection of this option increases the storage in a catchment to account for delays in flows which results from the lack of formal over-land flow paths. An inspection of the catchments upstream of the site revealed that no significant flow paths had been provided for flow in excess of the road system capacity and so the "old urban" option was selected for catchments with significant percentages of residential development. The catchments located on the valley floor have not been developed and a % impervious of 10% was adopted for these catchments. Catchments located on the sides of the escarpment were observed to be generally in a natural state and a % impervious of 0% was used where no or insignificant levels of development had occurred.

Previous inquiries with Council revealed that there are no records of flooding in the vicinity of the site. Given the lack of recorded flow data, it was not possible to calibrate the model results against such records. The results of the modelling were compared to the flow rates estimated using the rational method as described in Australian Rainfall and Runoff and those documented in work-as-executed drawings for Barnes Rd (Drg No 3CY-562.3 prepared by Lovegrove Oxley Associates Pty Ltd dated 12-7-94) obtained from Warringah Council and were found to be comparable. The resultant flow rates are therefore considered to be a reasonable assessment of the design flow rates through the site.

For each recurrence interval, various storm durations were modelled. The 90 minute duration storm found to consistently produce the largest peak flows and so this event was adopted as the design storm event.

The model for the site was then modified to account for the proposed development, The effects of the development on the model included an increase in the percentage impervious for Catchments 1/8 and 1/9 from 10% to 41.3% and 48.4% respectively and a change to the grade of the catchment to account for the flatter grades to be generated in the plaza areas of the site.

The results of the XP-Rafts modelling is summarised in Table 4.
The highlighted rows in Table 4 detail the before and after flows at the downstream edge of the proposed development in The Middle Creek Tributary. Reference to the table demonstrates that the development of the site actually results in a decrease in the flows in the Tributary. This can be explained by the flows off the development entering the Tributary prior to the peak flows from the upper catchments. Thus the development is not required to incorporate any storm water detention measures.

Table 4 - Oxford Falls Retirement Resort - Modelled Stormwater Flow Rates

Return Period	2yr Exist	2yr Devel	5yr Exist	5yr Devel	10yr Exist	10yr Devel	20yr Exist	20yr Devel	50yr Exist	50yr Devel	100yr Exist	100yr Devel
Catchment	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)
catch3/1	0.179	0.179	0.279	0.279	0.317	0.317	0.361	0.361	0.397	0.397	0.448	0.448
catch1/1	1.769	1.769	2.467	2.467	2.837	2.837	3.251	3.251	3.597	3.597	4.067	4.067
catch1/2	4.125	4.125	5.773	5.773	6.606	6.606	7.593	7.593	8.387	8.387	9.517	9.517
catch1/3	6.141	6.141	8.663	8.663	9.929	9.929	11.405	11.405	12.640	12.640	14.405	14.405
junctA	5.011	5.011	7.533	7.533	8.799	8.799	10.275	10.275	11.510	11.510	13.275	13.275
catch2/1	7.735	7.735	11.449	11.449	13.001	13.001	13.683	13.683	14.336	14.336	15.222	15.222
junctB	5.493	5.493	5.510	5.510	5.490	5.490	5.478	5.478	5.502	5.502	5.604	5.604
catch2/2	5.882	5.882	5.917	5.917	5.869	5.869	5.916	5.916	5.972	5.972	6.101	6.101
catch4/1	0.259	0.259	0.364	0.364	0.415	0.415	0.473	0.473	0.519	0.519	0.583	0.583
catch2/3	5.265	5.265	5.653	5.653	5.872	5.872	6.109	6.109	6.321	6.321	6.581	6.581
catch5/1	1.624	1.624	1.837	1.837	1.963	1.963	2.204	2.204	2.408	2.408	2.643	2.643
catch2/4	6.925	6.925	7.756	7.756	8.114	8.114	8.783	8.783	9.264	9.264	9.834	9.834
catch1/4	3.179	3.179	4.276	4.276	4.752	4.752	5.233	5.233	5.643	5.643	6.278	6.278
catch1/5	5.995	5.995	11.115	11.115	13.671	13.671	16.626	16.626	19.205	19.205	22.786	22.786
catch6/1	0.346	0.346	0.592	0.592	0.780	0.780	1.005	1.005	1.249	1.249	1.485	1.485
catch8/1	1.707	1.707	2.833	2.833	3.508	3.508	4.446	4.446	5.493	5.493	6.555	6.555
catch1/7	7.757	7.757	14.348	14.348	17.896	17.896	22.285	22.285	26.030	26.030	30.907	30.907
catch9/1	0.235	0.235	0.387	0.387	0.515	0.515	0.651	0.651	0.773	0.773	0.908	0.908
catch1/8	14.305	14.014	22.791	22.252	27.417	26.744	32.993	32.192	37.651	36.778	43.453	42.802
catch10/1	1.179	1.179	1.964	1.964	2.474	2.474	3.104	3.104	3.787	3.787	4.474	4.474
catch1/9	15.001	14.552	24.497	23.630	29.899	28.833	36.113	34.866	41.646	40.295	48.483	47.171

5.0 Description of Proposed Stormwater Management Concepts

The proposed drainage scheme to manage stormwater off and through the proposed development is described in the drawings by JMD Development Consultants Ref 03508E7 issue D dated 27-10-08.

On the upstream (western) side of the development catch drains will be constructed to train the overland flows off the upstream catchments to The Middle Creek Tributary and Drainage Line 1.

Stormwater flows off the proposed plaza areas in and around the buildings and internal road systems will be treated as described in the SEEC report and then piped to discharge into the Middle Creek Tributary and Drainage Lines 1 & 2. The number of drainage outlets will be limited to approximately three with proposed outlets being located at the junction of Drainage Line 2 and the Middle Creek Tributary, the Barnes Road reserve and at the junction of Drainage Line 1 and The Middle Creek Tributary.

From the previous development proposals, it is understood that the shoulder of Oxford Falls Rd will be required to be constructed to an appropriate standard as a condition of the consent for this development. Such works will require the installation of a piped drainage system along the road shoulder. This piped system would be collected and discharged to the Middle Creek Tributary at the current Barnes Rd intersection and at the existing channel adjacent to the tennis academy building.

The design of Drainage Line 1 has been undertaken with a view to providing a riparian corridor appropriate to the current standard of the existing drainage corridor. The current drainage corridor is an engineered trapezoidal grassed channel with a small concrete lined invert. It is proposed that this channel be improved by constructing a vegetated drainage depression of variable width about 13m wide which will incorporate water treatment structures to treat the flows to a standard at least equivalent to that provided by the current Council structure. The vertical alignment of Drainage Line 1 has been kept at a maximum grade of 1% to retard flow velocities with the change in height across the site being accommodated in a series of rock lined drop structures of varying hight. These drops will be a feature of the site providing gentle cascading waterfalls. Small ponds could be incorporated into the design of Drainage Line 1 at the downstream side of these cascade structures to increase the aesthetic qualities of the development.

A previous study of this site determined the extent of stormwater flows in the design 1% annual exceedence probability (AEP) storm event under current conditions. This task involved the creation of a hydraulic model of the existing site using the HEC-RAS program. The flows as described above were entered into a model of the site derived from the available site survey and the resulting flood extents are depicted by blue shading in the appended plan Ref 03508E7 sheet 1.

Drg ref 03508E7 sheet 1 shows that the 1% AEP flows are substantially contained within the current form of the Middle Creek Tributary through the site. The only significant modifications to the Tributary are required immediately downstream of the Barnes Rd crossing and immediately downstream of Drainage Line 1. In these locations, it is proposed that the flows will be diverted away from the proposed development area by the construction of rock retaining walls. The existing and post-development flood levels along the Tributary are indicated on the plan Ref 03508E7 Sheet 2 of 2 which clearly shows that the proposed development will not significantly impact on the flood levels through the site downstream of Barnes Rd.

The flows from the gully adjacent to the southern arm of Barnes Rd are currently collected by a dam structure as depicted in Drg Ref 03508E7 Sheet 1. From this dam, the stormwater flows follow a constructed drainage channel around the western side of Lot 1125 Oxford Falls Rd (triangular shaped property between Lots 1336 and 1113). When the volume of water flowing from the gully exceeds the capacity of this drainage channel, the water spills out of the channel and follows the contour of the land down to the Middle Creek Tributary.

The nature of the existing Barnes Rd crossing of the Middle Creek Tributary is such that the stormwater flows dam up behind the crossing which results in the flooding of Lot 1125 as shown on Drg 03508E7 Sheet 1.

The current development proposal provides for the construction of a new drainage line denoted as Drainage Line 2 on Drg 03508E7 Sheet 2. This drainage line proposes to divert the flows discharging from the dam in the Barnes Rd gully along the southern boundary of the site directly to the Middle Creek Tributary. This work will simplify the drainage paths across this portion of the site without adversely affecting the Lot 1125 property (as shown by existing and post-development flood levels).

The extent of flood flows in the 1% AEP storm post-development is depicted by green shading in Drg Ref 03508E7 Sheet 2. All proposed development floor levels are at least 0.5m above the post-development flood levels as depicted on the plans.

6.0 Conclusion

This report has considered the impacts of the proposed Seniors Living Resort development on the storm water flows traversing the subject site. The proposed development layout is similar to previous layouts considered on this site in that it will not adversely impact on the stormwater flows in the area.

The storm water assessments conducted on this site have determined that the peak flows for the design 1% AEP flood will be contained within the existing form of the Middle Creek Tributary with only minor creek training works required to divert the flows around the proposed development. Various works as described in the attached plans Ref 03508E7 sheet 2 will be required the control stormwater flows through the site. The storm water investigations on this site have demonstrated that the proposed development layout described in the Urbis plans will in fact result in a small decrease in flows from the Middle Creek Tributary thereby improving the grossly distorted hydrological regime in the area which has resulted from uncontrolled development of

the upstream catchments. The proposed development is therefore considered to be consistent with the outcomes required by the Director General's Requirements outlined for this project with respect to stormwater quantity measures.

The proposed development will require the relocation of the Council owned stormwater facility located adjacent to the site together with the current outlet channel for the facility. Preliminary assessment of the site reveals that an alternative structure which will achieve equivalent outcomes can be provided within the site. This assessment has also confirmed that the proposed development layout will provide for all habitable floor levels in the proposed development to achieve at least 0.5m freeboard to the design flood levels through the site.

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Appendix A
Calculation of Natural Catchment Peak Flows

Assuming natural catchment prior to development.

Catchment R1

Area	= 68.88 ha.	
t'c	= 0.76A^0.38	
	= 39.6 minutes say 40 minutes	
I(5yr)	= 67.7mm/hr	
I(100yr)	= 117.6mm/hr	
C10	= 0.7	(AR&R Vol 2)
FF(5yr)	= 0.88	(AR&R Vol 1 book 4)
FF(100yr)	=1.26	(AR&R Vol 1 book 4)

Q =FFY.C10.I.A/360

Q(5yr) = 0.88x0.7x67.7x68.88/360
= 7.98 cumecs

Q(100yr) = 1.26x0.7x117.6x68.88/360
= 19.85 cumecs

Catchment R2

Area	= 17.8 ha.	
t'c	= 0.76A^0.38	
	= 23.7 minutes say 24 minutes	
I(5yr)	= 87.5mm/hr	
I(100yr)	= 149.5mm/hr	
C10	= 0.7	(AR&R Vol 2)
FF(5yr)	= 0.88	(AR&R Vol 1 book 4)
FF(100yr)	=1.26	(AR&R Vol 1 book 4)

Q =FFY.C10.I.A/360

Q(5yr) = 0.88x0.7x87.5x17.8/360
= 2.67 cumecs

Q(100yr) = 1.26x0.7x149.5x17.8/360
= 6.85 cumecs

Catchment R3

Area	= 18.61 ha.	
t'c	= 0.76A^0.38	
	= 24 minutes	
I(5yr)	= 87.5mm/hr	
I(100yr)	= 149.5mm/hr	
C10	= 0.7	(AR&R Vol 2)
FF(5yr)	= 0.88	(AR&R Vol 1 book 4)

FF(100yr) =1.26 (AR&R Vol 1 book 4)

Q =FFY.C10.I.A/360

Q(5yr) = 0.88x0.7x87.5x18.61/360
= 2.79 cumecs

Q(100yr) = 1.26x0.7x149.5x18.61/360
= 6.82 cumecs

Thus total flows to creek in natural state was as follows:-

5 year ARI	7.98+2.67+2.79	= 13.44 cumecs
100 year ARI	19.85+6.85+6.82	= 33.52 cumecs

Appendix B
Calculation of Developed Catchment Peak Flows

Oxford Falls Retirement Resort - Developed Flows

c10(AR&R)=	0.7	C5 Adopted for Natural =	0.616
FF100 =	1.26	C5 Adopted for Developed =	0.9
FF5 =	0.88	C5 Adopted for Fully Sealed =	1

Catch		Area	t'c rural	Length of overland flow	Slope	n*	t'c adopt	I(100 ARI)	C(100yr)	Q(100yr)	I (5yrARI)	C(5yr)	Q(5yrARI)		Totals Q(5yrARI)	Totals Q(100yr)
	1	8.123	17.6	300	3	0.011	6	252.5	1	5.697	154.5	1	3.486			
	2	8.18	17.6	280	4	0.08	12	198.5	0.9	4.059	119	0.9	2.434			
	3	9.76	18.8	380	10	0.08	12	198.5	0.9	4.843	119	0.9	2.904	sum 1,2+4	8.258	13.608
	4	6.044	15.7	230	4	0.08	8	229.4	1	3.851	139.3	1	2.339	sum 1-4	11.162	18.451
	5	4.56	14.1	150	6	0.08	8	229.4	0.9	2.615	139.3	0.9	1.588			
	6	1.72	9.7	140	7	0.08	8	229.4	0.9	0.986	139.3	0.9	0.599			
	7	1.767	9.8	140	7	0.08	8	229.4	0.9	1.013	139.3	0.9	0.615			
8A		0.3479	5.3	90	12	0.08	6	252.5	0.9	0.220	154.5	0.9	0.134			
8B		1.091	8.2	150	20	0.08	6	252.5	0.9	0.689	154.5	0.9	0.421			
8C		8.308	17.7				15	182.1	0.882	3.707	108.3	0.616	1.540			
	9	6.126	15.8	160	11	0.08	6	252.5	0.9	3.867	154.5	0.9	2.366			
	10	16.767	23.1				23	152.3	0.882	6.256	89.3	0.616	2.562			
	11	2.425	11.1	170	6	0.08	8	229.4	0.9	1.391	139.3	0.9	0.845			
	12	0.665	6.8	100	6	0.08	6	252.5	0.9	0.420	154.5	0.9	0.257			
	13	2.85	11.8	120	25	0.15	6	252.5	0.9	1.799	154.5	0.9	1.101	sum 11-13	2.202	3.610
14A		1.324	8.8	200	24	0.15	8	229.4	0.882	0.744	139.3	0.616	0.316			
14B		2.018	10.3	115	24	0.15	8	229.4	0.9	1.157	139.3	0.9	0.703			
	15	2.715	11.6	200	18	0.15	8	229.4	0.882	1.526	139.3	0.616	0.647			
16A		0.667	6.8	70	16	0.1	6	252.5	0.9	0.421	154.5	0.9	0.258			
16B		0.202	4.3	70	16	0.1	6	252.5	0.9	0.128	154.5	0.9	0.078	sum 16A,16B&8A	0.470	0.768
16C		1.121	8.3	85	5	0.08	6	252.5	0.9	0.708	154.5	0.9	0.433			
16D		0.2	4.3	21	10	0.15	6	252.5	0.882	0.124	154.5	0.616	0.053	sum 16C+16D	0.486	0.831
16E		0.651	6.7	32	10	0.15	6	252.5	0.882	0.403	154.5	0.616	0.172			
	17	3.235	12.4	165	6	0.1	8	229.4	0.882	1.818	139.3	0.77616	0.972			
	18	1.896	10.1				10	212.2	0.882	0.986	128	0.616	0.415			
	19	4.644	14.2				14	187.1	0.882	2.129	111.6	0.77616	1.117			
	20	13.385	21.2				21	158.5	0.882	5.198	93.2	0.616	2.135			
	21	2.28	10.8	150	6	0.08	8	229.4	0.9	1.308	139.3	0.9	0.794			
suma(-15)		110.3569							sumQ(-15)	56.536		sumQ(-15)	30.635			

Appendix C
Calculation of Myra St Flow Capacity