

7.0 WATER QUALITY MODELLING

7.1 MODEL PARAMETERS

Model Parameters The soil properties for the pervious areas of the catchment were taken from Council's *Engineering Design Guide for Development*, or in lieu of this, the recommended default values published in the *MUSIC User Guide* (version 3).

Table 7.1 - MUSIC Soil Parameters

Soil Properties:	Default Value
Impervious threshold (mm)	1.0
Soil storage capacity (mm)	125
Initial storage (% of capacity)	80
Field capacity (mm)	80
Infiltration coefficient 'a'	200
Infiltration coefficient 'b'	1.0
Initial groundwater depth (mm)	0
Daily recharge rate (%)	1.0
Daily baseflow rate (%)	0.1
Daily deep seepage rate (%)	0.0

7.2 MUSIC CATCHMENTS

In order to measure the required pollutant removal rates against a "base line" a model was created based on the proposed development layout and grading without water quality treatment measures.

7.2.1 Base Catchment

The RAFTS model developed for detailed analysis and design of the proposed water management system divided the site into approximately 60 sub-catchments. This level of detail is required at the detailed design stage for the site hydrologic and hydraulic analyses. However, this level of detail is not necessary for water quality modelling using MUSIC because the treatment devices capture runoff from large areas and sub-division of sub-catchments smaller than the treatment catchment will not achieve improved results.

The RAFTS sub-catchments were therefore consolidated into 7 sub-catchment areas based on the proposed drainage system layout (refer Figure 6).

Catchments were separated into three components for the purposes of the MUSIC model:

- roof areas (draining to rainwater tanks for subsequent reuse)
- pervious areas (including open space)
- pavement areas (including roads, footpaths, etc.)

Roof areas based on the Master Planning documentation were obtained as an average of 300m² for new residential and 500m² for rural residential while the pervious and impervious areas were measured from the Master Plan documentation.

Impervious areas were obtained by applying the recommended percentage impervious areas from Council's *Engineering Guide for Development* (refer table 6.2). Refer to tables xx and xx for details of the MUSIC sub-catchments area breakdown.

Table 7.2 – New Dwellings per MUSIC Sub-Catchment for Re-Use Data

Sub-Catchment	"New"	"Rural"	Roof Area	Re-Use Storage
	Residential	Residential		
M1	214	-	64,200 m ²	428 m ³
M2	190	7	60,500 m ²	394 m ³
M3	-	4	2,000 m ²	8 m ³
M4	-	14	7,000 m ²	28 m ³
M5	197	-	59,100 m ²	394 m ³
M6	131	-	39,300 m ²	262 m ³
M7	151	-	45,300 m ²	302 m ³

Table 7.3 - Area Breakdown per MUSIC Sub-Catchment

Sub-Catchment	Roof Area	Impervious Area ²	Open Space Area	Pervious Area	TOTAL AREA
M1	109,650 m ²	65,400 m ²	27,400 m ²	30,950 m ²	233,400 m ²
M2	60,500 m ²	81,000 m ²	22,900 m ²	24,300 m ²	188,700 m ²
M3	2,000 m ²	6,250 m ²	0 m ²	15,250 m ²	23,500 m ²
M4	7,000 m ²	18,970 m ²	0 m ²	48,230 m ²	74,200 m ²
M5	59,100 m ²	40,100 m ²	10,900 m ²	22,200 m ²	132,300 m ²
M6	39,300 m ²	50,100 m ²	0 m ²	29,800 m ²	119,200 m ²
M7	45,300 m ²	77,500 m ²	6,000 m ²	34,900 m ²	163,700 m ²
				TOTAL	935,000 m²

7.2.2 Proposed Catchment

The proposed catchment model was identical to the base model in terms of catchment area and break-up of roof, paved and pervious areas, but included the water quality management strategies outlined below.

7.3 MANAGEMENT STRATEGIES

Storm runoff generated on the Minto Urban Renewal site can be separated into 3 streams:

- roof or rainwater runoff which can be captured and reused for toilet flushing or irrigation;
- road and pavement runoff can be treated by grassed swales or bio-retention swales; and
- pervious surfaces will have reduced runoff due to a portion of infiltration, and water "lost" to groundwater.

The proposed treatment train is as follows:

- rainwater tanks capturing roof runoff;
- bio-retention swales treating road, pavement and pervious surface runoff where permitted;
- gross pollutant traps;
- Bio-Retention "raingardens".

The possibility of using the tree bays as at source stormwater bio-retention devices has not been considered as part of this proposal. The deviation of low flows from the road gutters into these tree

² Impervious area refers to all other impervious areas contained in the sub-catchment including existing roof and existing and proposed roads, footpaths, pavements etc.

bays would enable the at source water quality treatment of the low flows. This additional treatment would further improve any water quality results obtained during this modelling. The potential for this would be assessed as part of individual evaluation of each stage depending upon site parameters including road networks and grades.

7.2.3 Rainwater Reuse

As outlined in the master plan documentation, re-use of rainwater is proposed for the individual dwellings on the site in accordance with the requirements of BASIX. A preliminary calculation was performed on an “average” lot and roof size for the development. These calculations demonstrate that in combination with potable water use controls the reuse proposal (2,000L rainwater tank) will satisfy the 40 % reduction in water use. The sample BASIX output report detailing the reuse proposal for the new dwellings is contained in Appendix D.

The quality of roof runoff will be influenced by atmospheric deposition. The retention and reuse of rainwater will provide a small contribution to improved water quality through reduction of nutrients. The default MUSIC inputs for the deposition rate of atmospheric pollutants are based on *Urban Stormwater Quality: A Statistical Overview*. The inclusion of rainwater reuse as part of the water quality modelling was restricted to only the proposed new dwellings and thus excluded the renovated existing DOH cottages to be retained within the estate.

The modelling for rainwater reuse for toilet flushing, laundry use and outdoor garden use was undertaken using parameters sourced from the *Water Sensitive Urban Design – Technical Guidelines for Western Sydney*. Based on an average of three occupants per dwelling the water demand for toilet flushing, laundry and outdoor use is estimated at 145L/day, 145L/day and 220L/day respectively.

The rainwater tanks will also have a permanent pool, as it is likely they will need to be topped up from time to time. In accordance with Council’s requirements that the top up should not be greater than 20% of the tank volume and must not occur until the tank is 80% empty the tanks will be designed to top up the storage to 20% capacity once the actual tank storage reached 10% capacity. To allow for this in the MUSIC model, the rainfall tank size entered into the model has been reduced by 20%.

The data input to the MUSIC model was based on:

- Total number of new households: 908
- Total Average Daily Demand: 510 L per household
- Permanent pool: 200 L per household (based on a top up starting at 10% capacity, filling the tank to 20% capacity)

Table 7.4 - MUSIC Rainwater Reuse Input

Parameter	Sub-catchment						
	M1	M2	M3	M4	M5	M6	M7
Total Dwellings	214	190	4	14	197	131	151
Rain storage (kL)	342	304	6	22	315	210	242
Daily Reuse (kL)	109.1	96.9	2.0	7.1	100.5	66.8	77.0

7.2.4 Bio-Retention Devices

Bio-Retention “raingardens” are proposed for treating runoff from sub-catchments M1 (Benham Oval), M2 (Redfern Park) and M7 (Scarborough Park). “Flow splitting” pits will direct flows up to and including the 3-month ARI runoff to the treatment facilities. Higher flows, up to and including the 100-year ARI runoff will by-pass the treatment facilities and drain to an OSD basin. A bio-retention swale has also been included for the entire length of the “swale” road in sub-catchment M2.

The following parameters were input to the MUSIC model:

Table 7.5 - Bio-Retention Swale MUSIC Parameters

Catchment	Length	Surface Area	Filter Depth	Filter Area
	m	m ²	mm	m ²
Sub-catchment M1 (Benham Oval)	-	300	1000	250
Sub-catchment M2 (Redfern Park)	-	740	1000	605
Sub-catchment M7 (Scarborough Park)	-	800	1000	680
Sub-Catchment M2 (Swale Road)	400	1200	600	240

7.2.5 Gross Pollutant Traps

In developing the MUSIC model for the Minto Urban Renewal site, it was assumed that gross pollutant traps (GPTs) would be located at the outflow from each sub-catchment. Additionally, GPTs have been located upstream of any proposed water body or bio-retention device.

MUSIC requires that transfer functions for the reduction in pollutants be entered. The pollutant reductions vary for different types of GPT, estimates were therefore applied to the average advertised removal rates of the Rocla’s “Cleansall”, the CDS Unit and Humes’ “Humeceptor”:

Table 7.6 - GPT Pollutant Reductions

Pollutant	Rocla ¹	CDS ²	Humes ³	Adopted Rate
Total Suspended Solids (mg/L)	70%	70%	87%	70%
Total Nitrogen (mg/L)	-	23%	45%	25%
Total Phosphorus (mg/L)	-	30%	30%	20%
Gross Pollutants (kg/ML)	100%	98%	-	95%

¹ *Rocla Water Quality – Cleansall Gross Pollutant Trap* (Rocla Pty. Ltd. 2002)

² *Removal of Suspended Solids and Associated Pollutants by a CDS Unit* (CRC Catchment Hydrology 1999)

³ *Humeceptor case study – Seatac, Washington USA*

(<http://www.humes.com.au/products/StormwaterQuality/humeceptor/seattle.pdf>)

Table 7.7 - MUSIC Input - GPT Pollutant Reductions

Pollutant	Input	Output
Total Suspended Solids (mg/L)	1000	300
Total Nitrogen (mg/L)	50	40
Total Phosphorus (mg/L)	5	4.0
Gross Pollutants (kg/ML)	15	0.75

In accordance with statutory requirements, the GPTs will need to treat the maximum flow rate from their upstream catchments for all flows up to and including the 3-month ARI storm event. The following flow rates have been extracted from the RAFTS model.

Table 7.8 - GPT Treatable Flow Rates

GPT	3-Month ARI Flow
M1 (Benham Oval)	2.60 m ³ /s
M2 (Redfern Park)	1.76 m ³ /s
M5 (Scarborough Park)	1.69 m ³ /s
M6 (Rose Park – South)	2.10 m ³ /s
M7 (Rose Park – North)	1.49 m ³ /s

7.4 RESULTS

7.6.1 Base Model

In accordance with the industry standards and assessment processes the base water quality MUSIC model for the site was developed assuming that no water quality treatment measures would be installed. This model provides the basis for pollutant generation from the site and the measure for pollutant removal under "treated" conditions. The layout of this model is shown on Diagram 7.1.

The results of the analysis are shown in Table 7.10.

7.6.2 Proposed Model

The "treated" site conditions model was developed incorporating the water quality treatment train as described above. Diagram 7.2 shows the layout of the model in MUSIC.

The results of the model are summarised in Table 7.10 below, and show that including a treatment train as described above, the water quality improvement objectives set out in Council's *Engineering Design Guide for Development* are achieved.

Diagram 7.2 – MUSIC Model for “Treated” Development Site

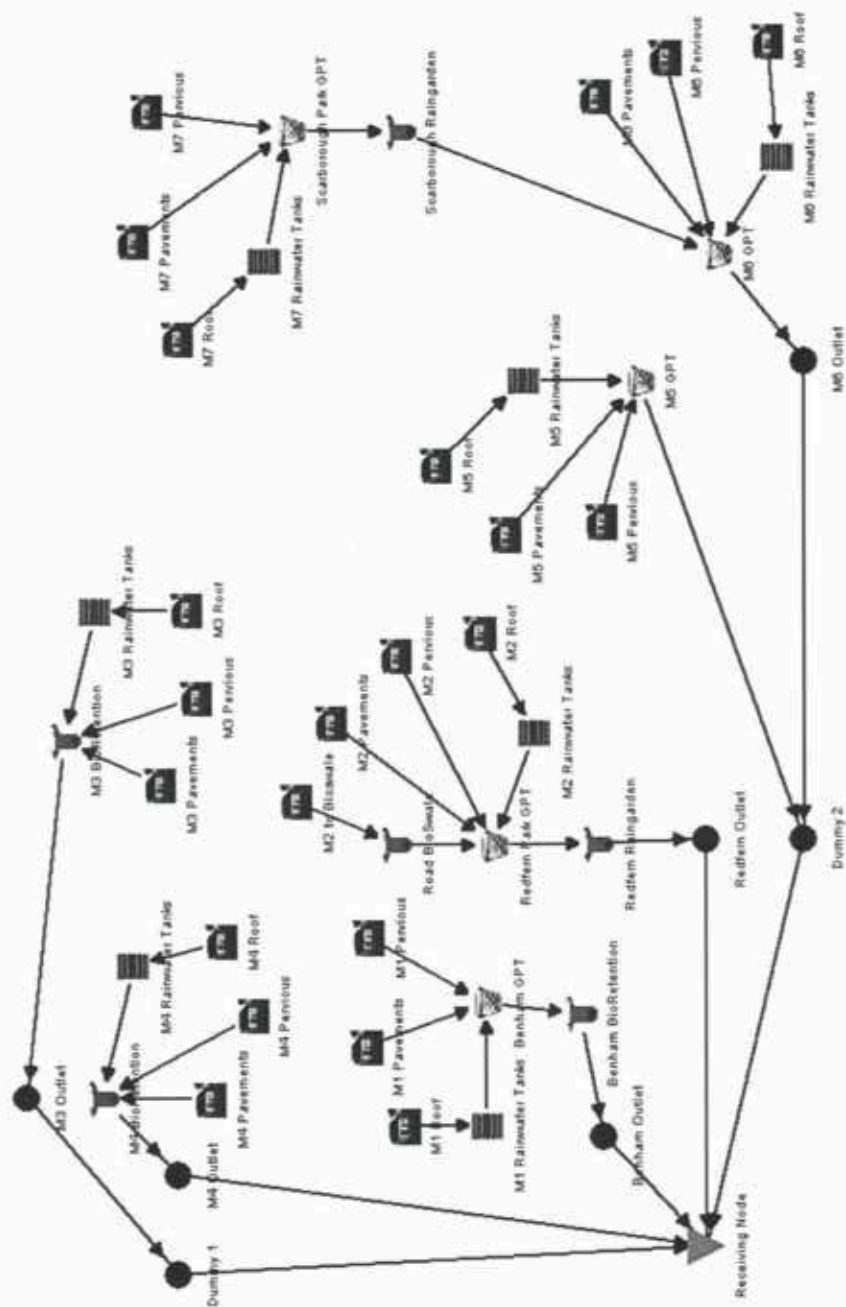


Table 7.10 – MUSIC Model Results Summary

	Flow (ML/yr)	TTSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GPs (kg/yr)
UNTREATED					
M1	150	16,200	86.8	279	3,640
M2	50.2	1,740	41.3	44.1	1,330
M3	1.77	61.5	1.46	1.56	47.1
M4	6.21	215	5.1	5.45	165
M5	93.4	9,280	57	162	2,340
M6	197	20,500	117	354	4,890
M7	112	11,800	66.4	204	2,790
TOTAL	610.58	59796.5	375.06	1050.11	15202.1
TREATED					
M1	132	1,890	21.7	152	0
M2	36.2	1,040	24.4	32.9	0
M3	1.46	44.1	1.04	1.32	0
M4	5.13	155	3.63	4.64	0
M5	78.5	2,560	31.1	120	46.6
M6	170	2,660	42	171	44.8
M7	95.2	679	14.7	84.6	0
TOTAL	518.49	9028.1	138.57	566.46	91.4
REDUCTIONS					
M1	12.0%	88.3%	75.0%	45.5%	100.0%
M2	27.9%	40.2%	40.9%	25.4%	100.0%
M3	17.5%	28.3%	28.8%	15.4%	100.0%
M4	17.4%	27.9%	28.8%	14.9%	100.0%
M5	16.0%	72.4%	45.4%	25.9%	98.0%
M6	13.7%	87.0%	64.1%	51.7%	99.1%
M7	15.0%	94.2%	77.9%	58.5%	100.0%
TOTALS	13.4%	86.8%	66.4%	46.8%	99.4%

Table 7.11 – MUSIC Model Results vs Objectives

	Flow (ML/yr)	TTSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GPs (kg/yr)
REDUCTIONS	13.4%	86.8%	66.4%	46.8%	99.4%
OBJECTIVES		80%	45%	45%	

8.0 CONCLUSIONS

8.1 WATER QUANTITY

A RAFTS model of the proposed Minto Urban Renewal Project was set up and run using design storms of various ARIs and durations. The model results were compared against a model of the existing catchment development.

The model included detention basins at Benham Oval, Redfern Park and Scarborough Park, having volumes of 5,000 m³, 1,900m³ and 2,200 m³ respectively. It was found that these basins were sufficient to ensure that downstream flows and flood damage risk would not increase in the 100 year ARI event as a result of the proposed development.

An assessment of flow depths and velocities in the 100-year ARI was also undertaken. It was found that a number of the minor piped drainage system links would need to be designed for an ARI greater than Council prescribed criteria (i.e. 5-year ARI) so that overland flows in a major storm meet the safety criteria.

8.2 WATER QUALITY

The water quality model set up using the MUSIC software provides an indication of the pollutant removal rates expected when applying a treatment train of measures. However, the model is limited to concept analysis, and the detailed size and removal rates for the different treatment components should be developed at the detailed design stage of the project.

According to the results of the MUSIC analysis, a treatment train consisting of rainwater reuse, bio-retention facilities (including swales and "raingardens") and GPTs will provide adequate treatment from the proposed development of the Minto Urban Renewal site to exceed the statutory water quality objectives.

9.0 REFERENCES

Commonwealth Bureau of Meteorology (2003). *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method*.

Duncan, H.P. (1999), *Urban Stormwater Quality: A Statistical Overview, Report 99/3*, Cooperative Research Centre for Catchment Hydrology, February 1999.

Hyder Consulting (2003). *Minto Renewal — Stormwater Drainage Concept Study*, Report No. NT01DDFA., prepared for the Housing Financial Investment Group.

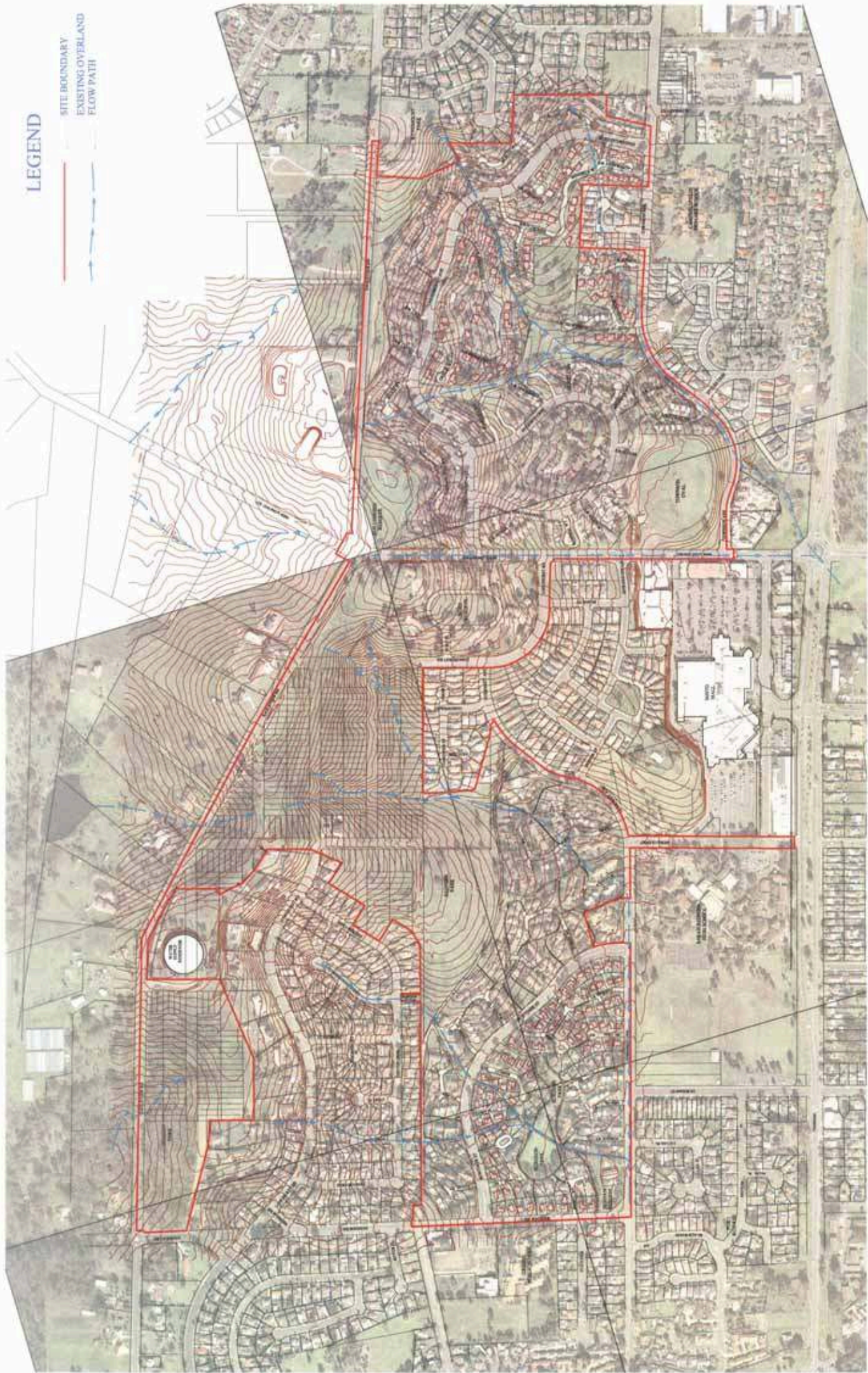
Institution of Engineers, Australia (2001). *Australian Rainfall and Runoff — A Guide to Flood Estimation, Volumes 1 & 2*, Institution of Engineers, Australia.

NSW Government (2004). *Floodplain Development Manual*.

XPSsoftware, (1996). *XP-RAFTS User Manual Version 5*.

Wang, Q.J., Chiew, F.H.S., McConachy, F.L.N., James, R., de Hoedt, G.C., & Wright, W.J. (2001). *Climatic Atlas of Australia: Evapotranspiration*. Melbourne: Bureau of Meteorology and Cooperative Research Centre for Catchment Hydrology.

APPENDIX A: DRAWINGS



LEGEND

- SITE BOUNDARY
- EXISTING OVERLAND FLOW PATH

**MINTO URBAN RENEWAL
EXISTING SITE LAYOUT**

SCALE 1:65000
METRES

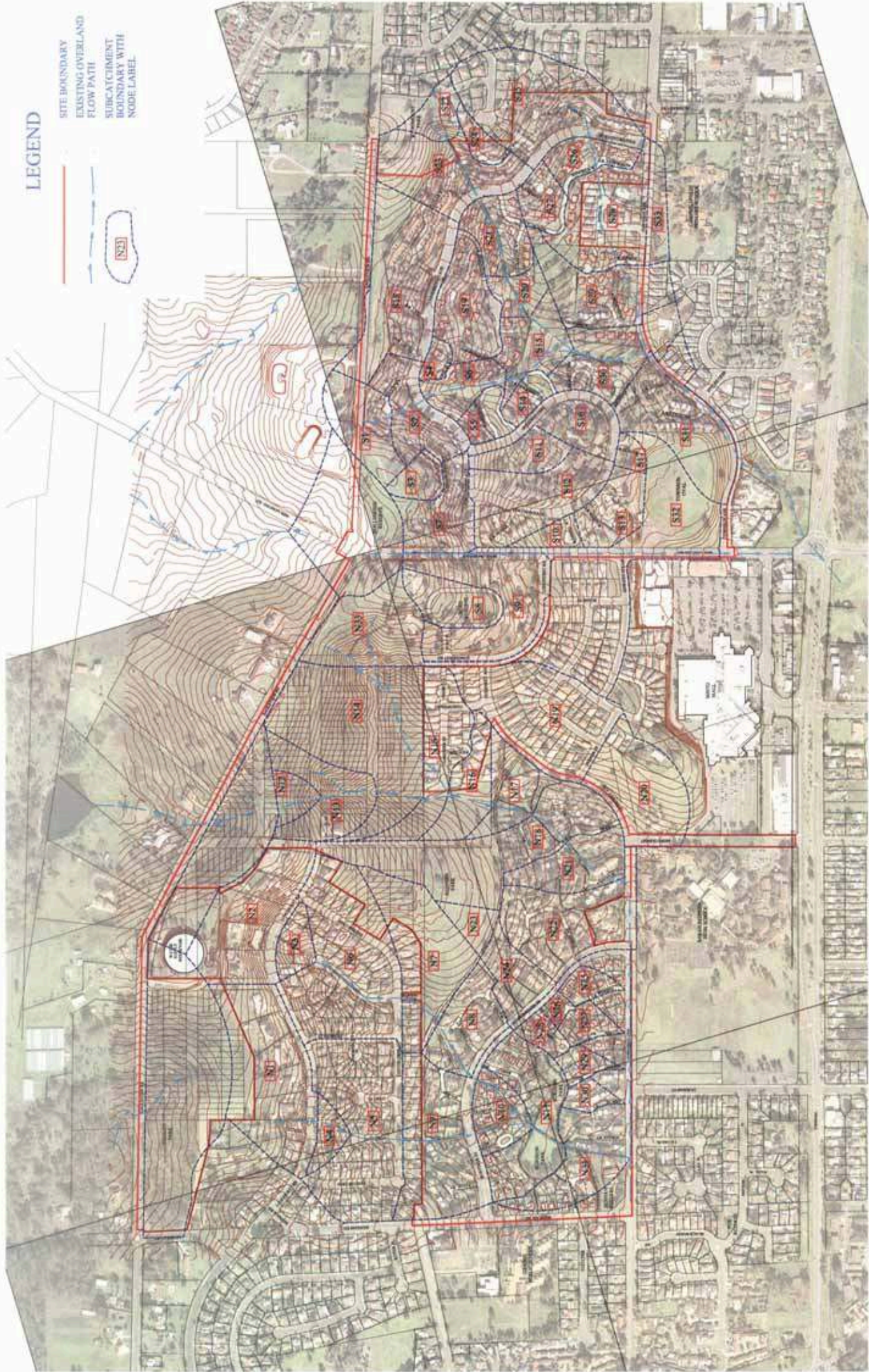
0 60 120 180 240 300 360 420 480



FIGURE 1

LEGEND

- SITE BOUNDARY
- EXISTING OVERLAND FLOW PATH
- SUBCATCHMENT BOUNDARY WITH NODE LABEL



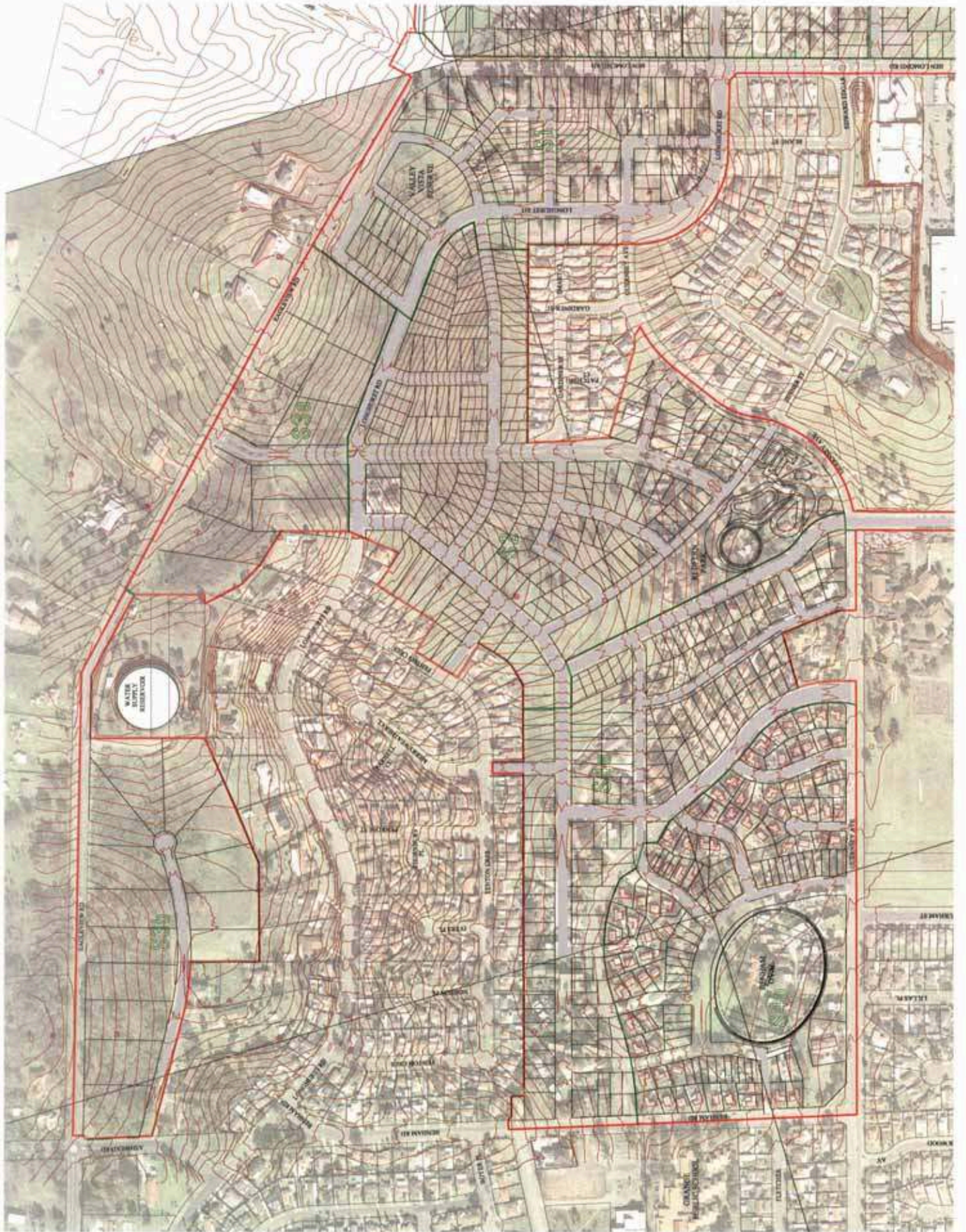
**MINTO URBAN RENEWAL
EXISTING CATCHMENT PLAN**



FIGURE 2

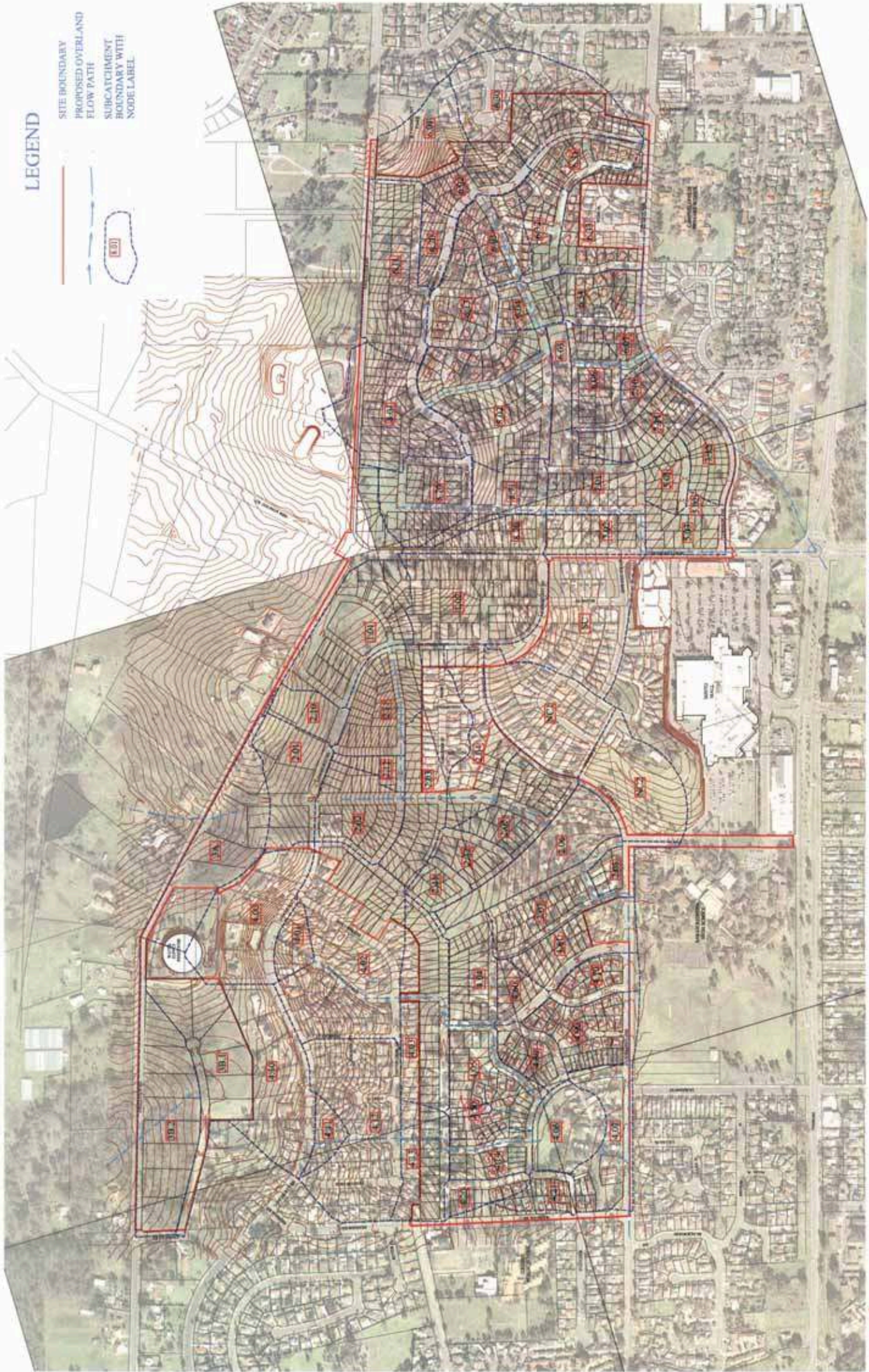


Hughes Trueman
 Consulting Engineers Planners & Managers
 100 St John St, Adelaide SA 5000
 100 St John St, Adelaide SA 5000
 T: 08 8411 2000 F: 08 8411 2001 P: 08 8411 2002 E: info@hughes-trueman.com.au



LEGEND

- SITE BOUNDARY
- PROPOSED OVERLAND FLOW PATH
- SUBCATCHMENT BOUNDARY WITH NODE LABEL



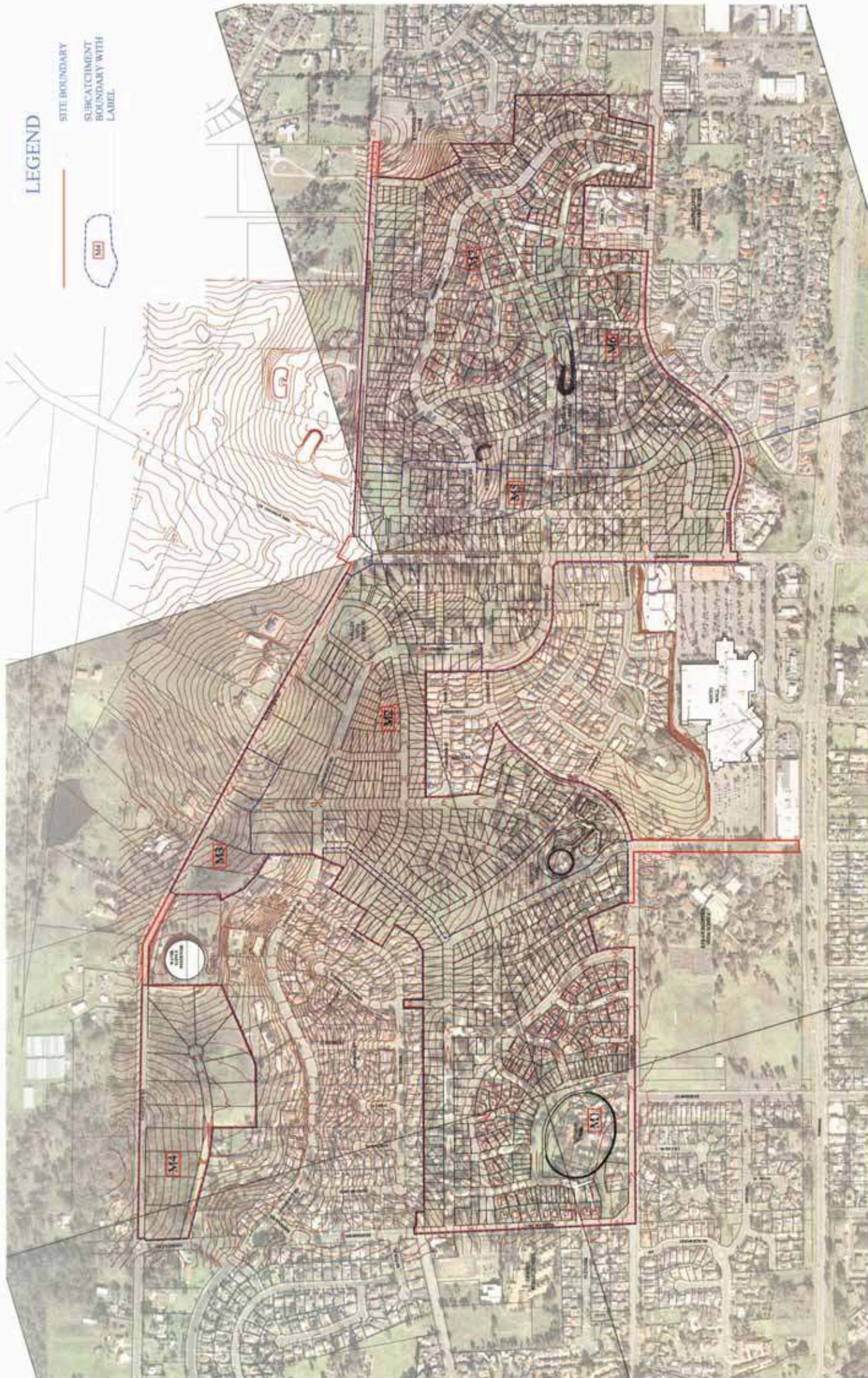
**MINTO URBAN RENEWAL
PROPOSED CATCHMENT PLAN**



FIGURE 4



100 Sturt Street, Adelaide SA 5000
 Tel: 08 8401 1000 Fax: 08 8401 1001
 www.hughes-trueman.com.au



LEGEND

- SITE BOUNDARY
- SUBCATCHMENT BOUNDARY WITH LABEL

**MINTO URBAN RENEWAL
STORMWATER QUALITY (MUSIC) CATCHMENT PLAN**



Hughes Trueman
Consulting Engineers Planners & Managers
100, 121, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

FIGURE 6