12 Ingleside Road, Ingleside
Stormwater Investigations

November 2020

southeast
engineering+environmental

a: PO Box 96 Moruya NSW 2537
p: 02 4474 4439
e: lachlan@south-east.com.au

Document Verification

Document title: 12 Ingleside Road, Ingleside – Stormwater Investigations

Project number: 513

Prepared by: Brogan Addison and Lachlan Bain

Issue and date: Nov 2020

Issue to: Owner

Document history:

Table of Contents

1.0 BACKGROUND AND SCOPE

12 Ingleside Road Ingleside (The Site) is located just south of the Mclean Street and Ingleside Road intersection. The Site receives runoff from the upstream catchment in the form of:

- Piped flows - from a culvert under Ingleside road (which is fed by a headwall on the other side of the road opposite the Site; and
- Overland flows – as the frontage of the Site is considered to be the low point on this portion of Ingleside road

No easement or formal stormwater infrastructure currently exists to manage runoff through the Site.

Southeast Engineering + Environmental (Southeast) have been engaged by the owner of the Site to size and design an open channel to intercept and convey runoff entering the Site around the proposed dwelling. As per Council's requirements the channel must be sized for the 1% AEP + appropriate freeboard.

This stormwater investigation includes the following scope of works:

- Delineate the upstream catchment
- Estimate the 1% AEP peak flow from the upstream catchment
- Examine runoff behavior for the 1% and determine peak flow entering the Site; and
- Size and configure a channel to intercept and convey peak flow through the Site

Figure 1.1: Site locality

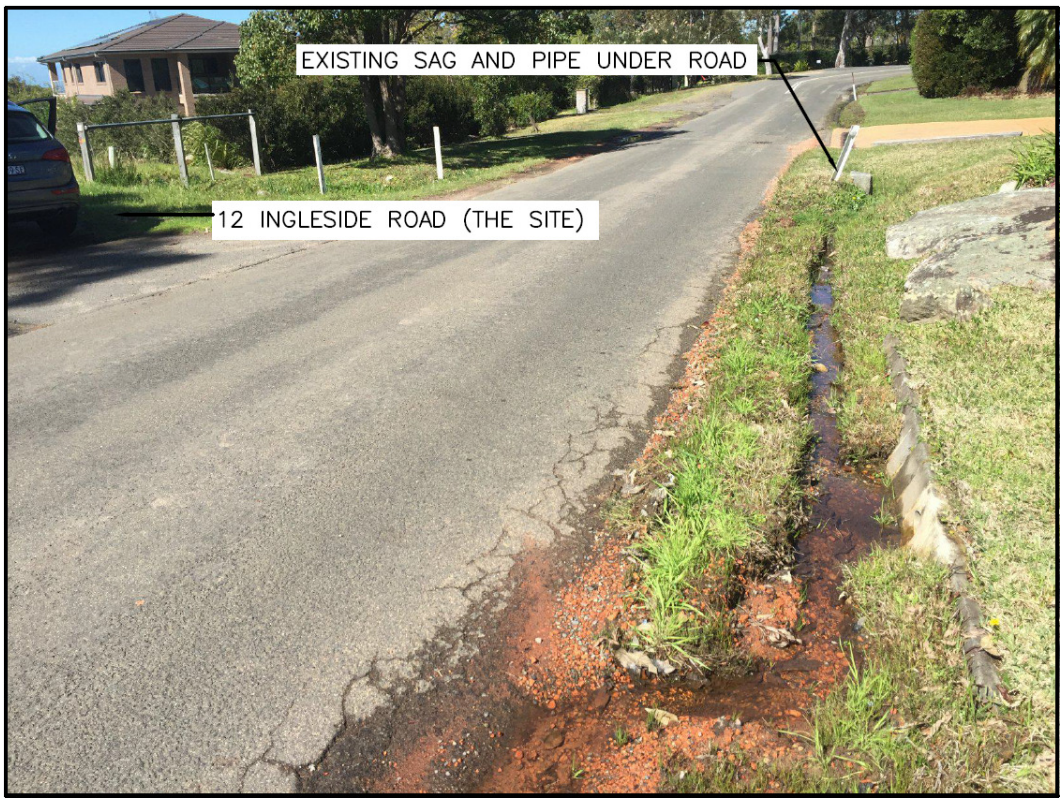


Figure 1.2: Ingleside Road – Site located on LHS

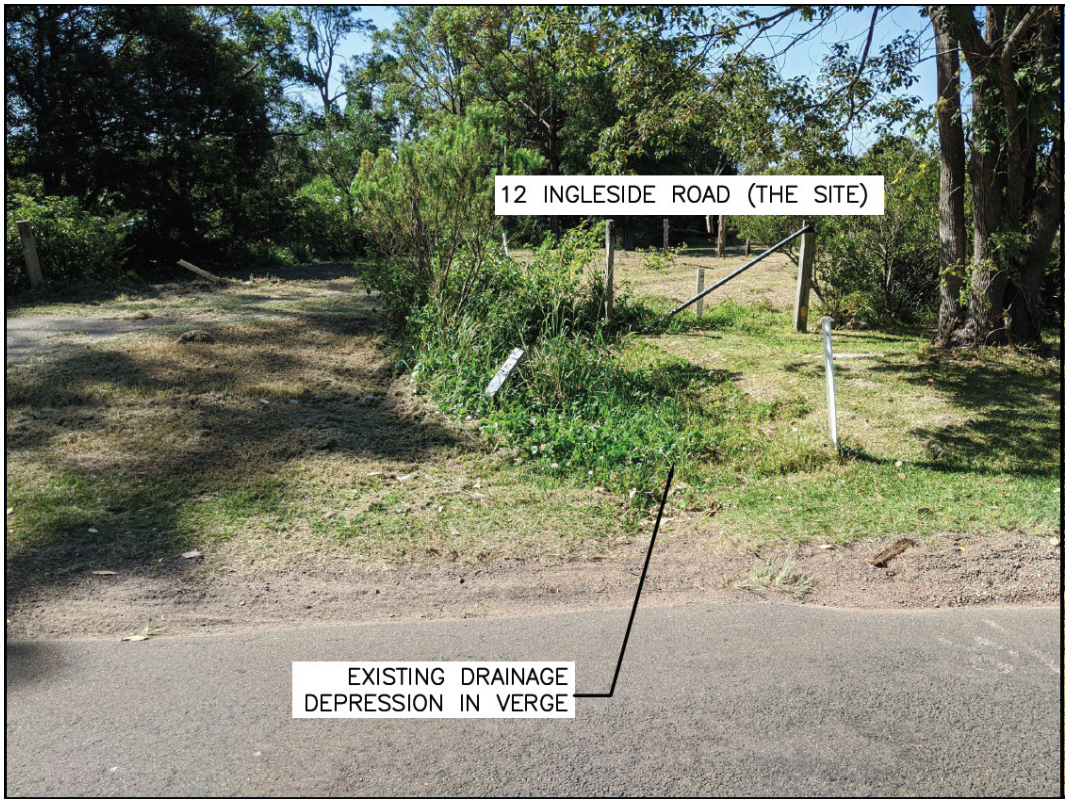


Figure 1.3: Looking at Site from Ingleside Road

2.0 HYDROLOGY

2.1. Catchment Delineation

The upstream catchment of **3.9 Ha** was determined using 1m LIDAR contours.

Refer Appendix A for catchment plan.

2.2. Peak Flow

The 1% AEP peak flows was estimated using DRAINS Hydrologic and Hydraulic Urban Catchment modelling. ARR2016 procedures were used to set up the hydrological model.

The following parameters were adopted*:*

- Major storm: 1% AEP
- Fraction Impervious Area derived from catchment land zoning – average 70% impervious
- Soil Type - Normal (3.0)
- Paved (Impervious) Area Depression Storage - 1mm
- Supplementary Area Depression Storage - 1mm
- Grassed (Pervious) Area Depression Storage - 5mm
- Antecedent Moisture Condition – 3.0

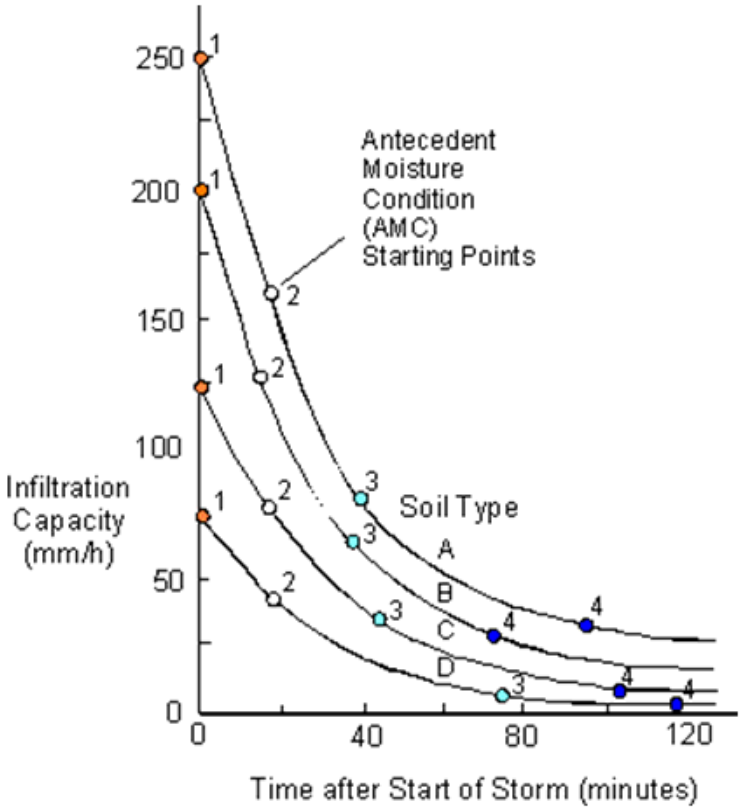


Figure 2.1: Soil moisture behaviour used in DRAINS model (DRAINS Manual, 2017)

The 1% AEP critical duration was assessed as the 10 minute storm with a peak flows of **2.3m^3/s**. The hydrograph from this event was used in the hydraulic model.

3.0 MODELLING HYDRAULIC BEHAVIOUR

3.1. Method Summary

The hydraulic modelling software HEC RAS 2D was used to model flow behaviour along Ingleside Road and determine the peak flow entering the Site. The model uses either the Saint Venant equations or Diffusion Wave equations to calculate hydraulic behaviour over a surface. This can be combined with 1D aspects of the HEC RAS model to analyse behaviour of in stream structures and terrain where the flow direction is predominantly in one direction.

In this case the Saint Venant equations have been used to ensure that momentum changes associated with abrupt terrain changes are incorporated.

3.2. Modelling assumptions

3.2.1. Terrain

Surface terrain is a 1m DEM extracted from the Elevation and Depth – Foundation Spatial Data website; https://elevation.fsdf.org.au/

A model resolution of 2.5m x 2.5m was generated over the Study area with breakline to existing road (Mclean street) to encourage flow directions to match reality – i.e. down the road table drain. Refer to Appendix B for plan showing terrain and assumed model grid.

3.2.2. Manning's roughness

A Manning's roughness value of 0.06 was applied across the Study area representing the mostly vegetated catchment and current land use.

3.2.3. Boundary conditions

The upstream boundary condition used a flow hydrograph with a 1 minute time step extracted from DRAINS. Hydrographs for the 1% AEP used in the model are shown in Figure 3.1.

The inflow boundary was positioned at the lower end of the catchment to confine entry flows towards the Site. The boundary condition locations can be found in Appendix B.

The downstream boundary condition was located downstream past the Site, and assumed a 2% friction slope for water surface calculations at the boundary. This a conservative estimate of the steeper terrain behind the Site.

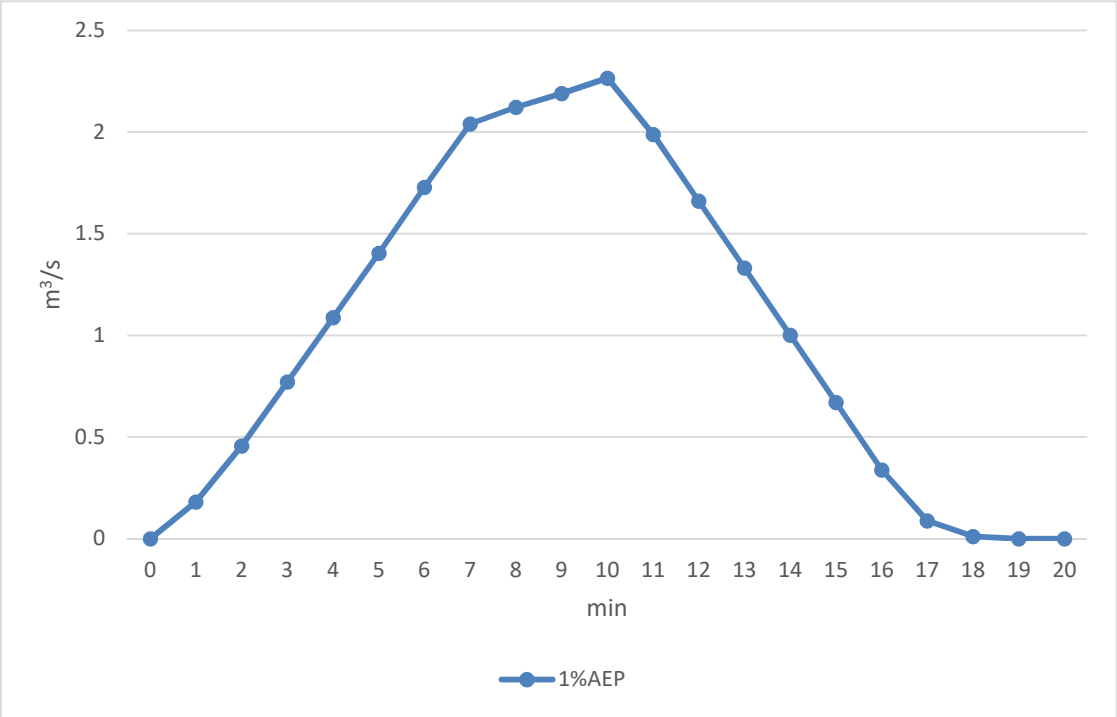


Figure 3.1: Inflow hydrograph

3.3. Results

The hydraulic model indicates that the 1% AEP peak flow crosses over Ingleside road, and spreads out near the McLean Street and Ingleside Road intersection entering 10, 12 (the Site) and 14 Ingleside Road . A portion of runoff is shown to head north up Ingleside Road. A profile line was drawn along the front boundary of the Site to determine the peak flow of approximately **1.3 m^3/s** entering at this location. Refer Figure 3.2.

Further interrogation of the model showed that the majority of flow enters the property to the north of the property driveway (**~0.9 m^3/s**), whilst **~0.4 m^3/s** will enter on the southern side of the property driveway.

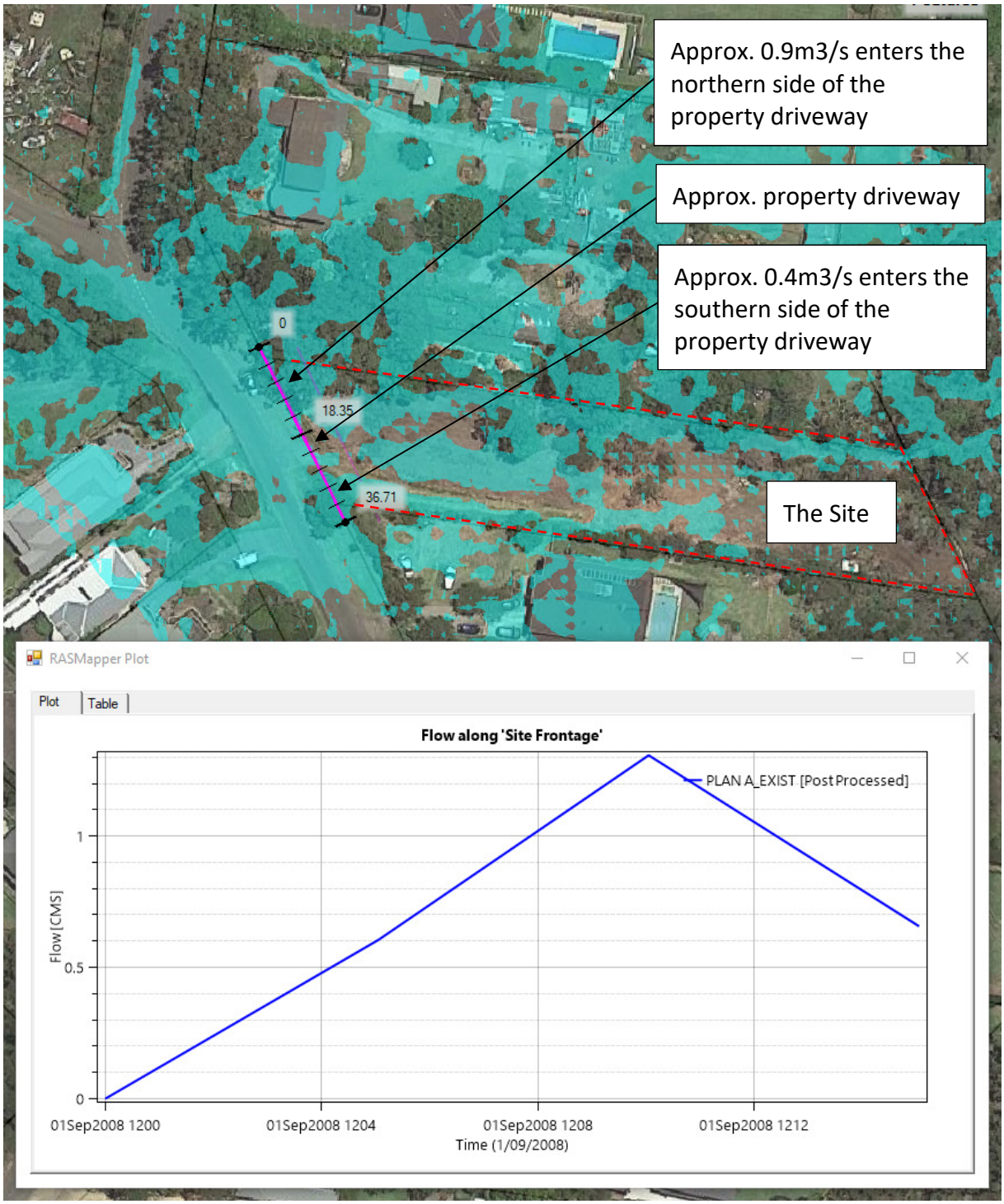


Figure 3.2: Runoff behaviour for 1% AEP and flow profile at Site frontage (~1.3 m^3/s)

4.0 OPEN CHANNEL SIZING & CONFIGURATION

4.1. Method Summary

The 2D hydraulic modelling indicates that flows are likely to enter the Site at various points along the property frontage. Therefore an open channel located across the upper portion of the Site is proposed to ensure all overland flows entering the Site can be captured.

The profile (width and depth) of the open channel was estimated using a manning's channel calculation and the longitudinal grade modified to match the detailed survey of the Site using Civil Site Design. The alignment and cross sections were extracted to a 1D HEC-RAS model and peak flow rates adopted from the 2D HEC-RAS hydraulic assessment to ensure that the proposed channel has capacity. This included 0.4m^3/s entering the top of the channel (south of the driveway) and an additional 0.9m^3/s entering just north of the driveway.

A copy of the 1D HEC-RAS model summary is included in Appendix C.

4.2. Modelling assumptions

1D HEC-RAS model assumptions included

- The dimension of the channel as 1.5m wide, 0.5m deep and grades 5-7%
- Mannings roughness = 0.035 (channel lined with sandstone blockwork)
- Downstream boundary conditions 1% friction slope for water surface

4.3. Results

The proposed channel can convey the 1% AEP peak flow and has sufficient freeboard (500mm) to the proposed dwellings finished floor levels.

Refer detailed plans - *12 INGLESIDE RD_UPSTREAM FLOW MGMT + ON SITE WASTEWATER MGMT + SEDIMENT CONTROL MGMT_20201106* included in the DA submission

APPENDIX A

DATE: Nov 2020

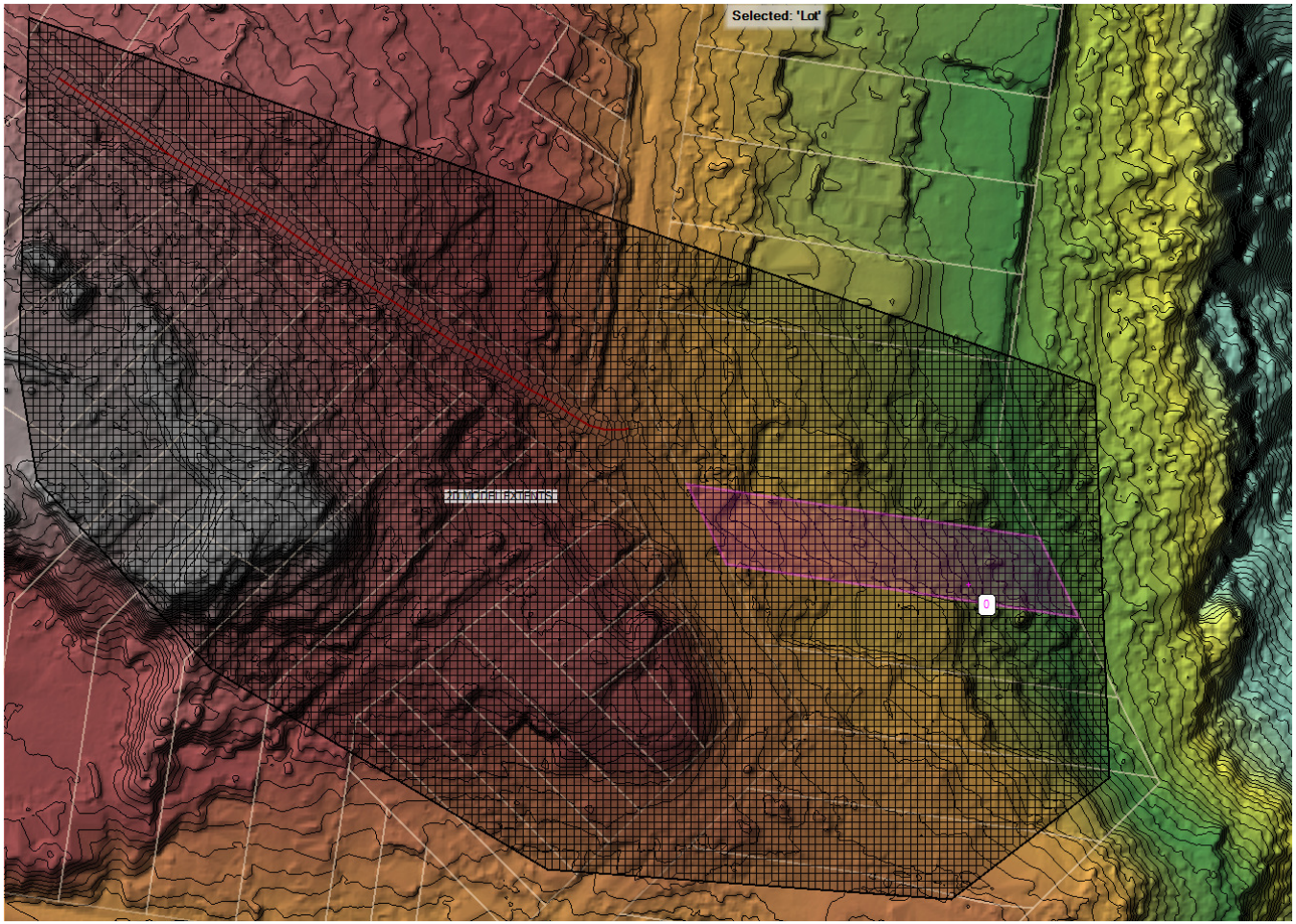
12 Ingleside Road, Ingleside - Upstream Catchment Plan

N

0 25 50 75 100 125 150 175 200 m

southeast
engineering+environmental

APPENDIX B



2D FLOW AREA

INFLOW BOUNDARY

APPENDIX C

HEC-RAS HEC-RAS 5.0.7 March 2019
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X        X
X     X  X        X    X      X   X    X    X        X
X     X  XXXXXX    XXXX       X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Ingleside
Project File : Ingleside.prj
Run Date and Time: 5/11/2020 4:53:15 PM

Project in SI units

PLAN DATA

Plan Title: PLAN A_1.5 CHANNEL
Plan File : C:\Users\BroganSE\Dropbox\Current\513_12 Ingleside Road SW and WW\Design Calc's & Models\HEC\Ingleside.p02

Geometry Title: 1.5m CHANNEL
Geometry File : C:\Users\BroganSE\Dropbox\Current\513_12 Ingleside Road SW and WW\Design Calc's & Models\HEC\Ingleside.g01

Flow Title : 1%AEP
Flow File : C:\Users\BroganSE\Dropbox\Current\513_12 Ingleside Road SW and WW\Design Calc's & Models\HEC\Ingleside.f01

Plan Summary Information:

Number of:	Cross Sections	= 24	Multiple Openings	=	0
	Culverts	= 0	Inline Structures	=	0
	Bridges	= 0	Lateral Structures	=	0

Computational Information

Water surface calculation tolerance	= 0.003
Critical depth calculation tolerance	= 0.003
Maximum number of iterations	= 20
Maximum difference tolerance	= 0.1
Flow tolerance factor	= 0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method: Average Conveyance
    Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: 1%AEP
Flow File : C:\Users\BroganSE\Dropbox\Current\513_12 Ingleside Road SW and WW\Design Calc's & Models\HEC\Ingleside.f01

Flow Data (m3/s)

River	Reach	RS	PF 1
HEC-CHANNEL CL	Br-1	114.151	.4
HEC-CHANNEL CL	Br-1	100.000	1.3

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
HEC-CHANNEL CL	Br-1	PF 1	Normal S = 0.01	Normal S = 0.01

GEOMETRY DATA

Geometry Title: 1.5m CHANNEL
Geometry File : C:\Users\BroganSE\Dropbox\Current\513_12 Ingleside Road SW and WW\Design Calc's & Models\HEC\Ingleside.g01

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 114.151

INPUT
Description:
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-2.429	108.939	-1.35	108.4	-1	108.4	-.85	108.4	-.75	107.9
0	107.9	.75	107.9	.85	108.4				

```
Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -2.429    .035      -1    .035       0    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       0            4.151   4.151   4.151             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 110.000

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -2.373 108.704  -2.022 108.528  -1.577 108.306  -1.394 108.214   -1.35 108.192
      -1 108.192   -.935 108.192    -.85 108.193   -.833 108.108    -.75 107.693
   -.127 107.692     .75 107.692    .833 108.108     .85 108.192       1 108.192
    1.35 108.192   1.562 108.086   1.684 108.147

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -2.373    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1              5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 105.000

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -2.307 108.421  -1.532 108.033  -1.441 107.988  -1.359 107.947   -1.35 107.942
  -1.265 107.942      -1 107.943    -.85 107.943   -.833 107.858    -.75 107.443
   -.127 107.442     .75 107.442    .767 107.527     .85 107.942       1 107.942
    1.35 107.942   1.388 107.923   1.432 107.902

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -2.307    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1              5       5       5             .1       .3
```

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 100.000

INPUT
Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-2.24	108.138	-2.026	108.031	-1.984	108.009	-1.367	107.701	-1.35	107.693
-1	107.692	-.935	107.692	-.85	107.693	-.833	107.608	-.75	107.193
-.127	107.192	.75	107.192	.767	107.277	.85	107.693	1	107.693
1.265	107.692	1.35	107.693	1.358	107.689	1.499	107.618		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-2.24	.035	-1	.035	1	.035

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-1	1	1.403	1.403	1.403	.1	.3

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 98.597

INPUT
Description:
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-2.221	108.058	-1.35	107.622	-1	107.622	-.85	107.622	-.75	107.122
.75	107.122	.85	107.622	1	107.622	1.35	107.622	1.567	107.514

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-2.221	.035	-1	.035	1	.035

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-1	1	5.498	3.927	2.356	.1	.3

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 94.670

INPUT
Description:
Station Elevation Data num= 10

```
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.432 107.467   -1.35 107.426      -1 107.426    -.85 107.426    -.75 106.926
    .75 106.926     .85 107.426       1 107.426    1.35 107.426   1.452 107.375

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.432    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1             4.67    4.67    4.67             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 90.000

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.519 107.277  -1.363 107.199   -1.35 107.192      -1 107.192    -.85 107.192
   -.833 107.108    -.75 106.692     .75 106.692    .767 106.777     .85 107.192
       1 107.192    1.35 107.192   1.359 107.188   1.375  107.18

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.519    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1                5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 85.000

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -1.41 106.973  -1.379 106.957   -1.35 106.942      -1 106.942    -.85 106.942
   -.833 106.858    -.75 106.442     .75 106.442    .767 106.527     .85 106.942
       1 106.942   1.352 106.942   1.576 107.054

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -1.41    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
```

```
           -1       1                5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 80.000

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.417 106.665  -1.356 106.695   -1.35 106.692      -1 106.692    -.85 106.692
   -.833 106.608    -.75 106.192     .75 106.192    .767 106.277     .85 106.692
       1 106.692    1.35 106.692   1.423 106.656   1.469 106.679

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.417    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
           -1       1                5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 75.000

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.502 106.366  -1.363 106.436   -1.35 106.442      -1 106.442    -.85 106.442
   -.833 106.358    -.75 105.942     .75 105.942    .767 106.027     .85 106.442
       1 106.442    1.35 106.442   1.365 106.435   1.513 106.361

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.502    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
           -1       1                5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 70.000

INPUT
Description:
```

```
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.493 106.121  -1.464 106.135   -1.35 106.192      -1 106.192    -.85 106.192
   -.767 105.777    -.75 105.692     .75 105.692    .833 106.108     .85 106.192
       1 106.192    1.35 106.192   1.448 106.144   1.478 106.128

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.493    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 65.000

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.383 105.926  -1.359 105.938   -1.35 105.942      -1 105.942    -.85 105.942
   -.767 105.527    -.75 105.442     .75 105.442    .833 105.858     .85 105.942
       1 105.942    1.35 105.942   1.367 105.951   1.386 105.941

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.383    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 60.000

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.401 105.716  -1.352 105.691   -1.35 105.692      -1 105.692    -.85 105.692
   -.767 105.277    -.75 105.192     .75 105.192    .833 105.608     .85 105.692
       1 105.692    1.35 105.692   1.353 105.694   1.382 105.709

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.401    .035      -1    .035       1    .035
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 55.000

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.361 105.447  -1.351 105.442      -1 105.442    -.85 105.442   -.767 105.027
    -.75 104.942     .75 104.942    .833 105.358     .85 105.442       1 105.442
    1.35 105.442   1.356 105.445   1.448 105.491

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.361    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 50.000

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.371 105.099   -1.35 105.109      -1 105.109    -.85 105.109   -.767 104.694
    -.75 104.609     .75 104.609    .833 105.025     .85 105.109       1 105.109
    1.35 105.109   1.367 105.101   1.386  105.11

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.371    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 45.000
```

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1.394	104.737	-1.354	104.757	-1.35	104.759	-1	104.759	-.85	104.759
-.767	104.344	-.75	104.259	.75	104.259	.833	104.675	.85	104.759
1	104.759	1.35	104.759	1.354	104.758	1.49	104.69		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1.394	.035	-1	.035	1	.035

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-1	1	5	5	5	.1	.3

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 40.000

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1.418	104.375	-1.358	104.405	-1.35	104.409	-1	104.409	-.85	104.409
-.767	103.994	-.75	103.909	.75	103.909	.833	104.325	.85	104.409
1	104.409	1.35	104.409	1.374	104.397	1.402	104.384		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1.418	.035	-1	.035	1	.035

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-1	1	5	5	5	.1	.3

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 35.000

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1.429	104.087	-1.362	104.053	-1.35	104.059	-1	104.059	-.85	104.059
-.767	103.644	-.75	103.559	.75	103.559	.833	103.975	.85	104.059
1	104.059	1.35	104.059	1.355	104.057	1.394	104.037		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

```
  -1.429    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 30.000

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -1.59 103.829  -1.364 103.716   -1.35 103.709      -1 103.709    -.85 103.709
   -.767 103.294    -.75 103.209     .75 103.209    .833 103.625     .85 103.709
       1 103.709    1.35 103.709   1.358 103.705    1.54 103.796

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -1.59    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
REACH: Br-1               RS: 25.000

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -1.536 103.453   -1.49  103.43   -1.35 103.359      -1 103.359    -.85 103.359
   -.767 102.944    -.75 102.859     .75 102.859    .833 103.275     .85 103.359
       1 103.359    1.35 103.359   1.387 103.378   1.718 103.544

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -1.536    .035      -1    .035       1    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
            -1       1               5       5       5             .1       .3

CROSS SECTION


RIVER: HEC-CHANNEL CL
```

REACH: Br-1 RS: 20.000

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1.433	103.051	-1.404	103.037	-1.35	103.009	-1	103.009	-.85	103.009
-.767	102.594	-.75	102.509	.75	102.509	.833	102.925	.85	103.009
1	103.009	1.35	103.009	1.582	103.125	1.65	103.159		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1.433	.035	-1	.035	1	.035

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-1	1	5	5	5	.1 .3

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 15.000

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1.415	102.638	-1.404	102.632	-1.35	102.659	-1	102.659	-.85	102.659
-.767	102.244	-.75	102.159	.75	102.159	.833	102.575	.85	102.659
1	102.659	1.35	102.659	1.354	102.657	1.402	102.681		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1.415	.035	-1	.035	1	.035

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-1	1	5	5	5	.1 .3

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 10.000

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1.48	102.244	-1.361	102.304	-1.35	102.309	-1	102.309	-.85	102.309
-.767	101.894	-.75	101.809	.75	101.809	.833	102.225	.85	102.309
1	102.309	1.351	102.309	1.387	102.291				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1.48	.035	-1	.035	1	.035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff	Contr.	Expan.
-1	1	5	5	5	.1		.3

CROSS SECTION

RIVER: HEC-CHANNEL CL
REACH: Br-1 RS: 5.000

INPUT
Description:
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1.611	101.829	-1.374	101.947	-1.35	101.959	-1	101.959	-.85	101.959
-.767	101.544	-.75	101.459	.75	101.459	.833	101.875	.85	101.959
1	101.959	1.35	101.959	1.357	101.956	1.438	101.916	1.543	101.863

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1.611	.035	-1	.035	1	.035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff	Contr.	Expan.
-1	1	5	5	5	.1		.3

SUMMARY OF MANNING'S N VALUES

River:HEC-CHANNEL CL

Reach	River Sta.	n1	n2	n3
Br-1	114.151	.035	.035	.035
Br-1	110.000	.035	.035	.035
Br-1	105.000	.035	.035	.035
Br-1	100.000	.035	.035	.035
Br-1	98.597	.035	.035	.035
Br-1	94.670	.035	.035	.035
Br-1	90.000	.035	.035	.035
Br-1	85.000	.035	.035	.035
Br-1	80.000	.035	.035	.035
Br-1	75.000	.035	.035	.035
Br-1	70.000	.035	.035	.035
Br-1	65.000	.035	.035	.035
Br-1	60.000	.035	.035	.035
Br-1	55.000	.035	.035	.035
Br-1	50.000	.035	.035	.035
Br-1	45.000	.035	.035	.035

Br-1	40.000	.035	.035	.035
Br-1	35.000	.035	.035	.035
Br-1	30.000	.035	.035	.035
Br-1	25.000	.035	.035	.035
Br-1	20.000	.035	.035	.035
Br-1	15.000	.035	.035	.035
Br-1	10.000	.035	.035	.035
Br-1	5.000	.035	.035	.035

SUMMARY OF REACH LENGTHS

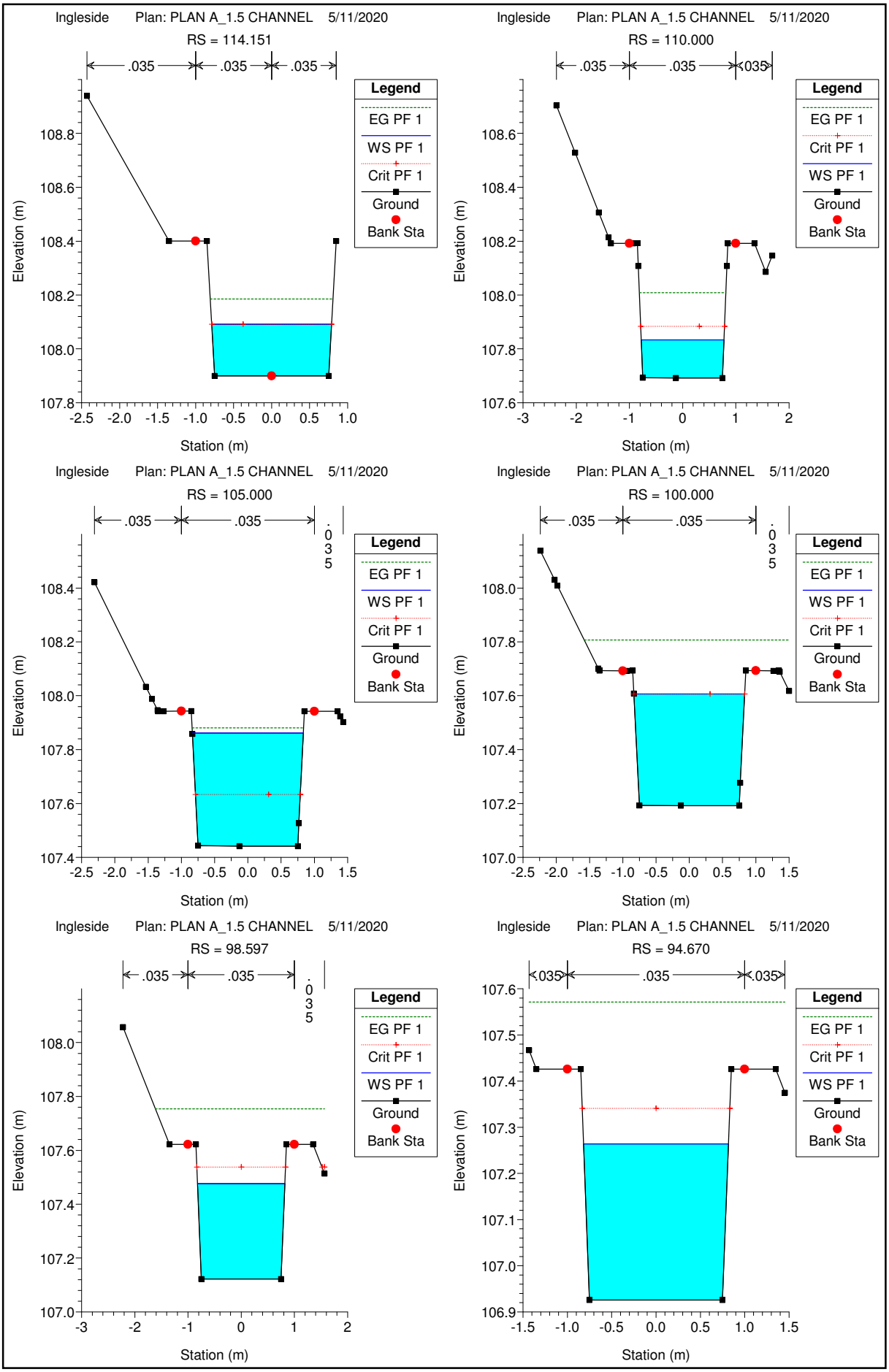
River: HEC-CHANNEL CL

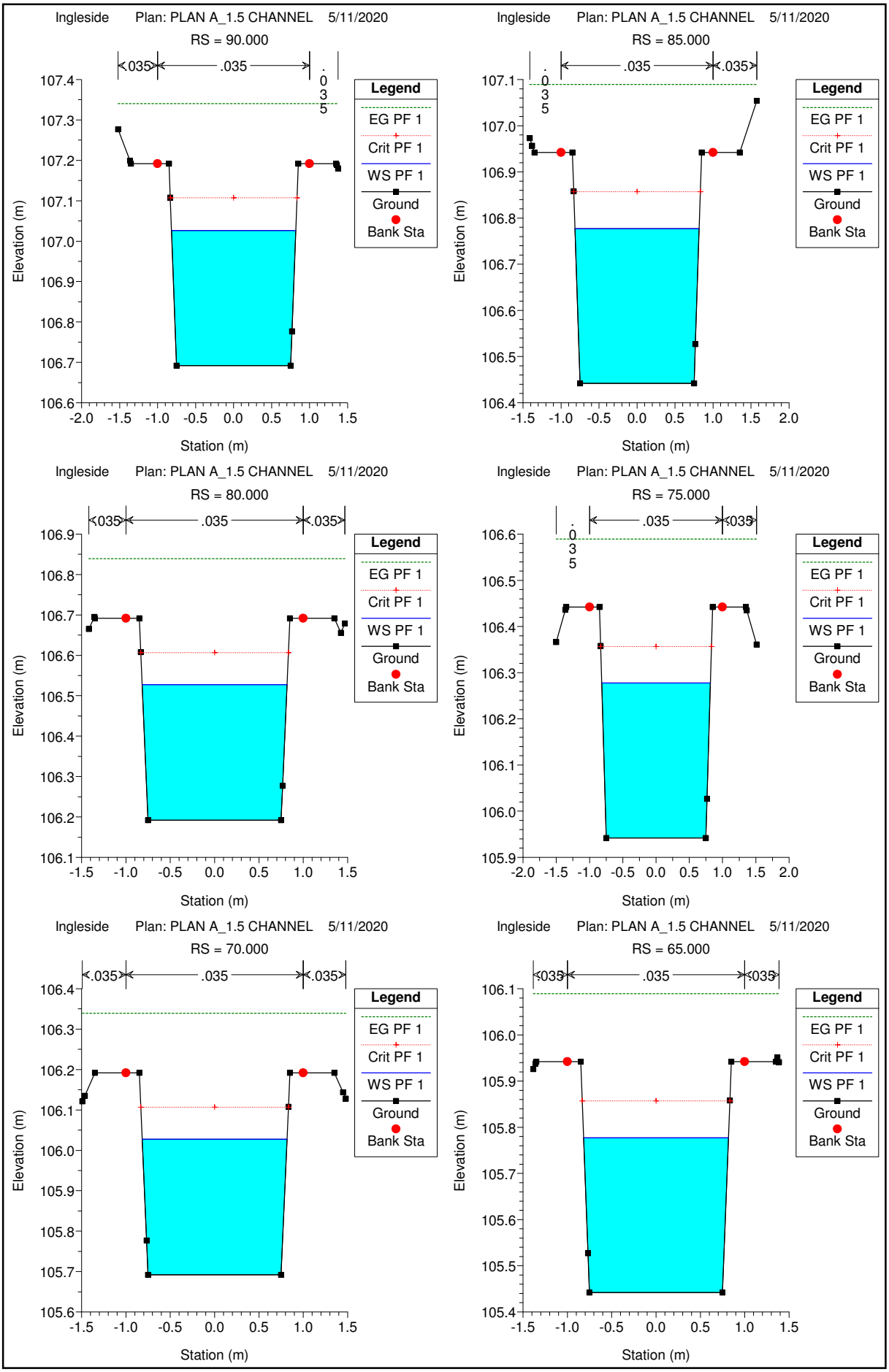
Reach	River Sta.	Left	Channel	Right
Br-1	114.151	4.151	4.151	4.151
Br-1	110.000	5	5	5
Br-1	105.000	5	5	5
Br-1	100.000	1.403	1.403	1.403
Br-1	98.597	5.498	3.927	2.356
Br-1	94.670	4.67	4.67	4.67
Br-1	90.000	5	5	5
Br-1	85.000	5	5	5
Br-1	80.000	5	5	5
Br-1	75.000	5	5	5
Br-1	70.000	5	5	5
Br-1	65.000	5	5	5
Br-1	60.000	5	5	5
Br-1	55.000	5	5	5
Br-1	50.000	5	5	5
Br-1	45.000	5	5	5
Br-1	40.000	5	5	5
Br-1	35.000	5	5	5
Br-1	30.000	5	5	5
Br-1	25.000	5	5	5
Br-1	20.000	5	5	5
Br-1	15.000	5	5	5
Br-1	10.000	5	5	5
Br-1	5.000	5	5	5

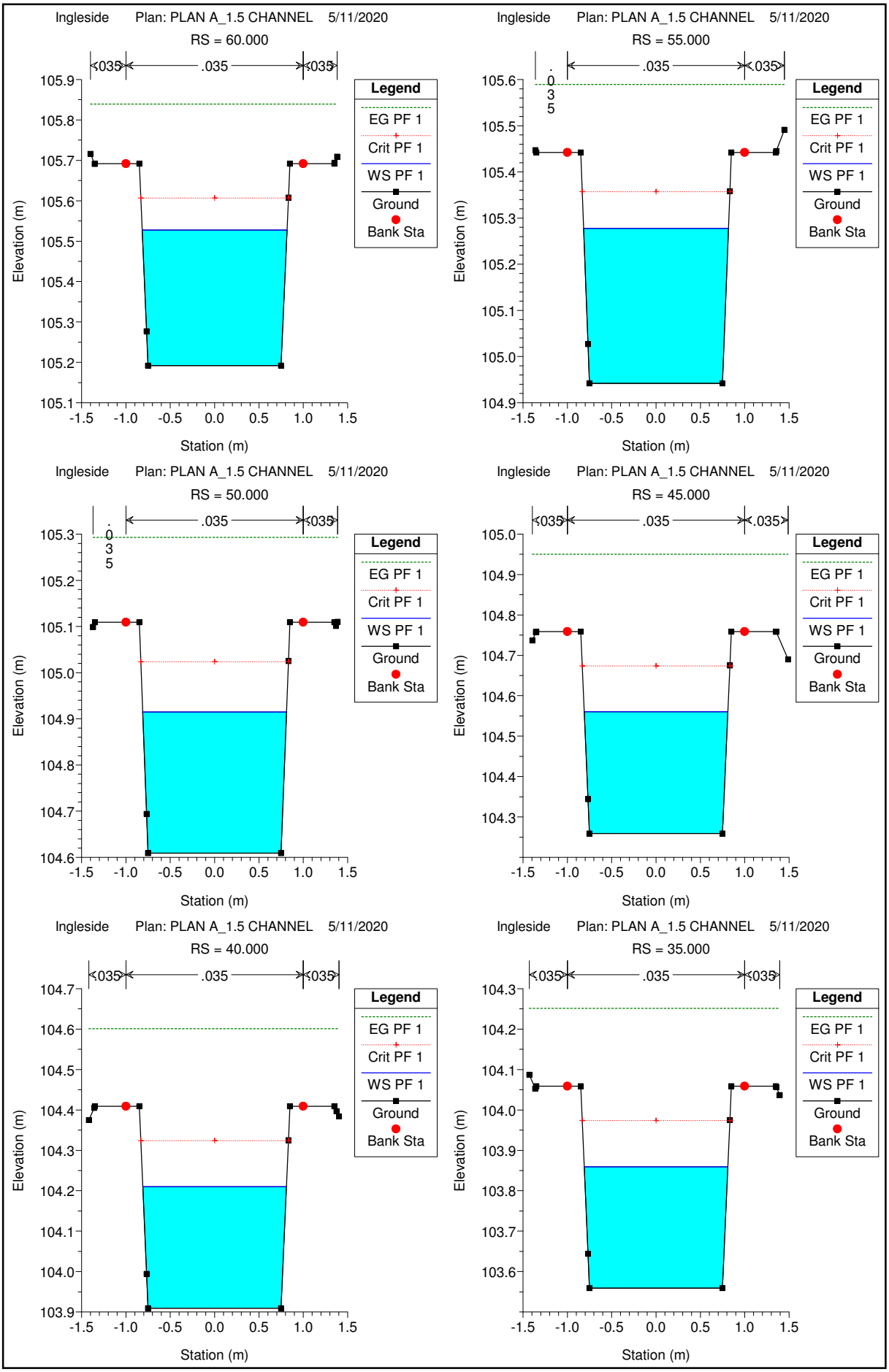
SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: HEC-CHANNEL CL

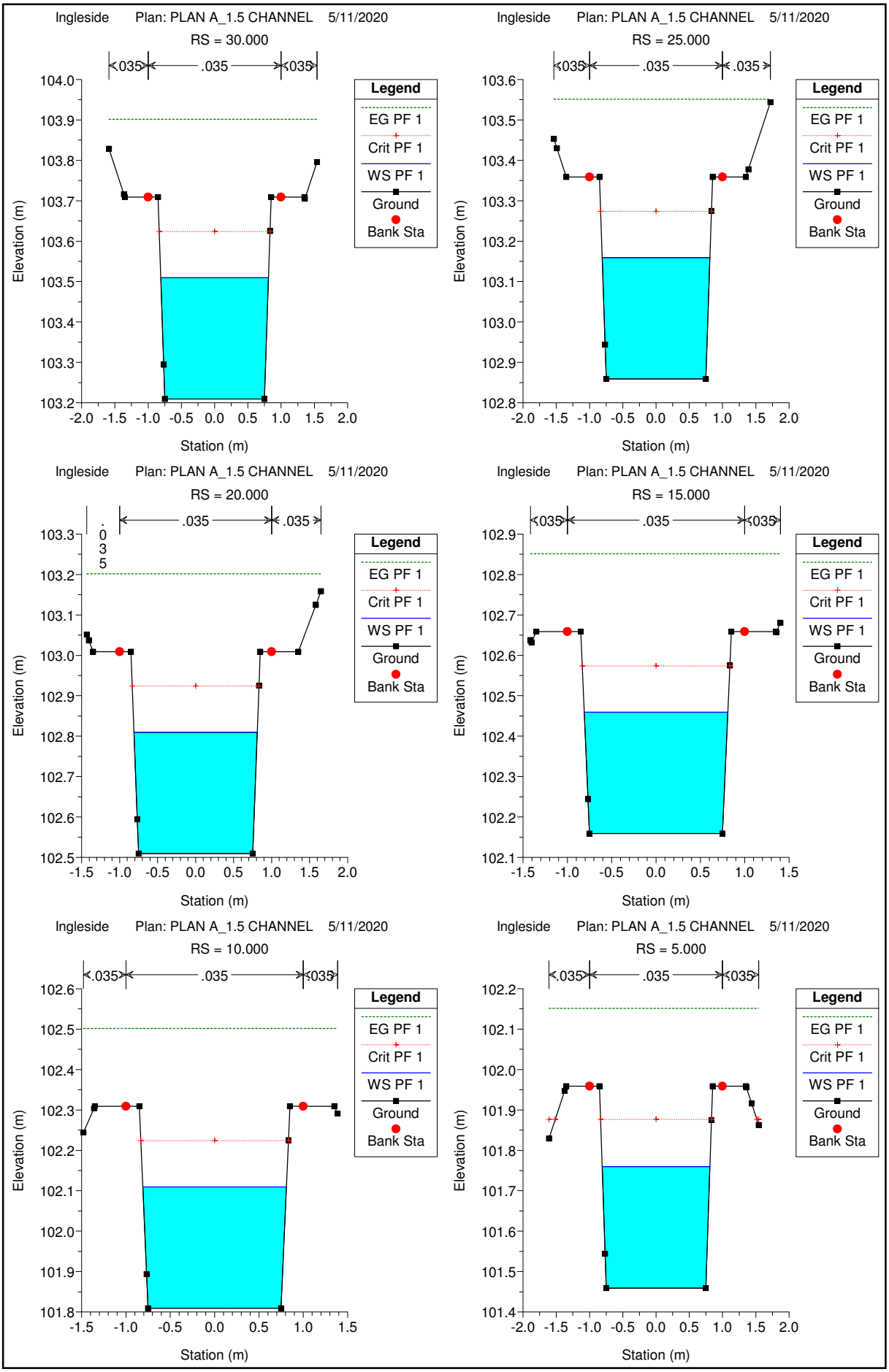
Reach	River Sta.	Contr.	Expan.
Br-1	114.151	.1	.3
Br-1	110.000	.1	.3

Br-1	105.000	.1	.3
Br-1	100.000	.1	.3
Br-1	98.597	.1	.3
Br-1	94.670	.1	.3
Br-1	90.000	.1	.3
Br-1	85.000	.1	.3
Br-1	80.000	.1	.3
Br-1	75.000	.1	.3
Br-1	70.000	.1	.3
Br-1	65.000	.1	.3
Br-1	60.000	.1	.3
Br-1	55.000	.1	.3
Br-1	50.000	.1	.3
Br-1	45.000	.1	.3
Br-1	40.000	.1	.3
Br-1	35.000	.1	.3
Br-1	30.000	.1	.3
Br-1	25.000	.1	.3
Br-1	20.000	.1	.3
Br-1	15.000	.1	.3
Br-1	10.000	.1	.3
Br-1	5.000	.1	.3


Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 114.151
.035 .035 .035
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 110.000
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 105.000
.035 .035 .035
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 100.000
.035 .035 .035
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 98.597
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 94.670
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)


Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 90.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 85.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 80.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 75.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 70.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 65.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)


Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 60.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 55.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 50.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 45.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 40.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 35.000
.035
.035
.035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)


Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 30.000
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 25.000
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 20.000
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 15.000
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 10.000
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Ingleside Plan: PLAN A_1.5 CHANNEL 5/11/2020
RS = 5.000
.035 .035 .035
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)