Flood Analysis – The Gully

Town of Torbay, NL

Final Report

August 16, 2018

PREPARED FOR:

Town of Torbay
1288 Torbay Road, P.O. Box 1160,
Torbay, NL A1K 1K4

Progressive Engineering & Consulting Inc.

Prepared By:

Progressive Engineering & Consulting Incorporated

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1.0 Introduction

Progressive Engineering & Consulting Incorporated (PEC) is an engineering and consulting company located in Paradise, Newfoundland and Labrador. Darryl Mills, P.Eng and Kelly Hickey, CET both founded the company in 2012. In July of 2017 Progressive Engineering and Consulting Inc. (PEC) was engaged to complete a flood analysis study for the Town of Torbay. The focus area of this study was an area currently zoned as an ecological reserve in the Town known as "The Gully". This floodplain area currently consists of a series of streams and wetlands that discharge through a bottomless 1240mm x 4000mm arch culvert on Lynch's Lane. The study area is illustrated in Appendix A – Existing Storm Sewer Infrastructure.

The necessity of this study was evident given the low elevations of houses along Mahon's Lane and Lynch's Lane relative to "The Gully". As several major storm events have occurred over the last several years, it is important to analyze the effectiveness of the storm sewer infrastructure in this area. Through this study, the catchment areas, streams and existing storm sewer infrastructure associated with "The Gully" have been modelled using a 1D/2D model using XPSWMM modelling software. This means storm water runoff can be modeled within the stream channel and can also be modeled outside of the stream when the water level exceeds the top of channel resulting in overland flow, street flooding, and the creation of flood plains. The model was created using the City of St. John's XPSWMM standard template so parameters used are typical for expected conditions in St. John's and surrounding areas. XPSWMM, created by Innovyze is an industry standard for modeling storm and sanitary sewer infrastructure. This model will aid the Town of Torbay in making decisions regarding any necessary infrastructure upgrades that are evident from the results of this model.

1.1 Purpose

The intent of this report is to analyze the existing stream system as well as "The Gully" area and evaluate the effectiveness of the existing storm drainage system, particularly the 1240mm x 4000mm arch bottomless culvert that is located at the discharge location for "The Gully" on Lynch's Lane. Given that the elevation of asphalt on Lynch's Lane as well as the houses on Mahon's Lane and Lynch's Lane are relatively close to "The Gully" area, it is important to analyze the floodplain created by a major storm event to see if any of these houses could be affect by a potentially hazardous storm scenario. By analyzing the floodplain generated by the 1D/2D model and the capacity of existing upstream storm sewer infrastructure, the Town of

Torbay can take action to reduce flood risk and evaluate the success of measures that have already been implemented.

1.2 Scope

Developing a 1D/2D floodplain model requires a tremendous amount of data collection, including topographic surveys, local historical storm information, as-built surveys of existing infrastructure, and testimony from local residents on past storm events. The Town of Torbay provided PEC with LIDAR (Light Detection and Ranging) data for the entire catchment area that contributes to "The Gully". This LIDAR data served as the basis of the Digital Terrain Model (DTM) which translates a 2D landscape into 3D, and is used to create as an accurate topographic representation of the landscape in the area. The following is a breakdown of the work scope associated with this project.

1) Create a plan of the existing catchment area that feeds into "The Gully". This included locating any existing ponds, rivers, wetlands and existing storm sewer infrastructure. In the case of the existing storm sewer infrastructure, additional topographic surveying was required to complement the LIDAR data to ensure these culverts were modeled accurately.
2) Completed runoff calculations for each of the catchment areas that feeds into "The Gully" to ensure that the correct volume of runoff is being used to analyze the floodplain.
3) Ran the 1D/2D model and reviewed the results of the floodplain. This includes reviewing the location and extents of the floodplain and potential impact on adjacent properties.
4) Interpret results generated from the 1D/2D floodplain analysis and identify any issues with existing storm sewer infrastructure.

2.0 Methodology

Since the LIDAR data provided was extremely thorough, topographic surveying was only required for important storm sewer infrastructure within the catchment area of interest. This included the key culverts within the catchment area. More specifically, a detailed topographic survey was conducted for culverts in the South Pond Area, North Pond Area, Quigley's Lane and Torbay Road. All of these culverts convey storm runoff to "The Gully" from the surrounding catchment area. Another important culvert surveyed, was the 1240mm x 4000mm arch bottomless culvert located at the end of "The Gully", on Lynch's Lane. This culvert can be seen in figure 1. This photograph was taken on September 19, 2017 and is representative of flow on a typical dry day without any considerable runoff from rain. From inspection it appears that there may be limited capacity given the large volume of flow entering the area and the large catchment area associated with it. From observing the downstream end of the culvert, the existing stream also appears to have limited capacity as well.

Figure 1: Arch Bottomless Culvert - Lynch's Lane

Figure 2: Concrete Culvert - Marine Drive

The rectangular concrete culvert located on marine drive was also surveyed. This concrete culvert can be seen in figure 2. It is important to note, from a structural perspective, the deteriorated concrete and exposed rebar on the bridge structure.

Torbay consists of several major catchment areas. Shown in Appendix B are the various storm water catchment areas that are present in the Town. The catchment area titled "Pond Brook Catchment" is the catchment area associated with the model that will be discussed in this report. The LIDAR data received from the Town of Torbay did not include two houses currently under construction on Mahon's Lane. For modeling purposes the finished floor elevations of these slab on grade houses were captured as well. These elevations can be used in the form of fill areas in XPSWMM that are assigned a specific elevation. By doing this, if any flow approaches the area the model will recognize that the elevations at the locations of where these houses are located is higher than the area surrounding it. One of the houses described can be observed in the photograph below.

Figure 3: New House Located on Mahon's Lane

All of the existing river systems were identified through base mapping as well as inspection in the field. It was brought to PEC's attention that the Town of Torbay has approved four building lots in this area. While there are currently two lots that have been constructed on, it is assumed that the remaining building lots will remain at the same elevation as the two constructed lots. All components of the existing infrastructure are illustrated in Appendix A

2.1 Flood Analysis

The flood analysis model completed using XPSWMM software was an integrated 1D/2D flood model. This means storm water can be modeled within the stream channel but can also be modeled outside of the stream when the water level exceeds the top of channel resulting in overland flow, street flooding, and the creation of flood plains. The model was created using the City of St. John's XPSWMM standard template, parameters used are typical for expected conditions in St. John's and surrounding areas. As mentioned previously, the LIDAR data provided by the Town of Torbay served as the basis for creating the DTM (Digital Terrain Model). Once the DTM was created, the river network was created from a combination of 'links' and 'nodes', which tells XPSWMM what the stream channel looks like so it can be modeled properly. These 'links' and nodes' interpolate elevations from the DTM or any additional field survey that has been conducted. A catchment area was then created to model the area in which runoff will enter "The Gully" wetland area. As mentioned previously, this catchment area is the "pond catchment area" This catchment area is illustrated in Appendix C.

The XPSWMM runs a 2D model by using a 2D grid, containing cells. The software is able to run ten thousand cells. The 2D grid acts as a sort of map for the 2D portion of the model. In each cell a single value for water depth, water elevation and velocity is calculated. So the smaller the cell size is, the more accurate the model is simply based on the idea that the more cells contained within the model the more detailed the model becomes, which makes it easier to observe flow patterns on the topography. Pushing the 2D grid size to as small as possible is key in ensuring accurate results are obtained.

2D land uses were then created for all areas outside of the stream channel. This allows XPSWMM to accurately model how the water will move during flooding conditions. For example, water will flow around areas designated as buildings and will flow at a calculated rate when flowing over grassland or paved streets based on the Manning's roughness coefficients or retention capacity of these land uses. If these parameters were not specified the model would assume that the surface that the runoff is passing over is totally impervious and would be inaccurate given that some ponding should be expected in the wetland area.

Once all appropriate parameters were calculated and input into the model, various storm data files were used to simulate local storm events. Five different 100 year storms of durations 1, 2, 6, 12 and 24 hours were run in simulation through the XPSWMM model to determine their impact on the existing system. The methodology behind running 100 year storms instead of the conventional 25 year storm event is because more severe storm events have seemingly been occurring much more frequently in recent years.

The model is set-up so that the culvert that crosses Torbay Road serves as the connection point between the 1D and 2D domain for the flood model. This means that once the flow leaves the culvert in the model, it will flow over the DTM and flow patterns along "The Gully" can be observed. Once the flow reaches the arch culvert located on Lynch's Lane, the culvert will capture the flow and pass it on to the system downstream.

2.2 Field Observations

On May 30th, 2018, St. John's and surrounding areas on the Avalon Peninsula experienced a major storm event that caused some infrastructure damage in surrounding areas. In the days that followed the storm events, meteorological data was gathered from Environment Canada and it was estimated that this rain event could be classified as a 2 to 5 year storm event. PEC staff travelled to Torbay to observe any potential flood prone areas, "The Gully" being one of them. It was observed that the existing arch bottomless culvert in the area was essentially at capacity and that the outlet stream was nearing capacity as well. The routing of the flow seemed to indicate that a lot of the flow was missing the culvert and hitting the aluminum headwall, instead of passing through the culvert.

The outlet stream appeared to be nearing capacity, however no flow was passing onto the adjacent property. There was not a tremendous amount of freeboard available on the stream, indicating that if a more severe storm event should occur, flooding may be a concern for the adjacent property.

The Gully itself was saturated with flow, and photographs taken that day indicate a large amount of runoff contained within "The Gully"

This can be seen in the following figures. This provided a basis of comparison with the results presented in the following sections.

This indicated that the models accuracy can be confirmed. If this is the basis of comparison for a 2 to 5 year storm event, it is conceivable that a 100 year storm event could bring potentially major infrastructure damage in the area

Figure 4: Photographs Taken on May 30, 2018

3.0 Results

The following section discusses the results yielded from the combined 1D/2D model flood analysis of "The Gully" using the XPSWMM software.

3.1 Existing Conditions

Upon running the model to simulate the 100 year storm events, for durations of 24, 12, 6, 2 and 1 hours respectively, it was evident that the capacity of the existing stream within "The Gully" lacked the capacity to efficiently transport the storm runoff from the associated catchment areas. The peak flow rate entering "The Gully" was determined to be approximately 18 cubic meters per second, which occurred during the 100 year 6 hour storm. As the flow moves along the topography of the Gully, it appears that the flow has a tendency to pond to the north west of the bottomless arch culvert located on Lynch's Lane. This indicates that the small stream passing through "The Gully" reaches capacity at some point upstream of the arch culvert and begins to spill into the wetland located to the north west of the stream. As the storm events progressed, this water depth began to increase due to the increased amount of runoff entering the wetland. Eventually, this water depth matched the asphalt elevation depicted from the digital terrain model and began to flow across Lynch's Lane. This occurred for all of the 100 year storm events. This location of ponding can be seen in the circles shown in figure 5

Figure 5: Location of Ponding in "The Gully"

Aside from the fact that there was flooding present, the arch bottomless culvert on Lynch's Lane was above capacity, even though some of the flow from the catchment was not being routed through the arch bottomless culvert. This indicates that for a 100 year storm event, the existing arch bottomless culvert is undersized. The extents of flooding can be seen in Appendix D while the culvert, which is at capacity can be seen in figure 6. Figure 6 shows a cross-section of the existing culvert at capacity during a 100 year storm event.

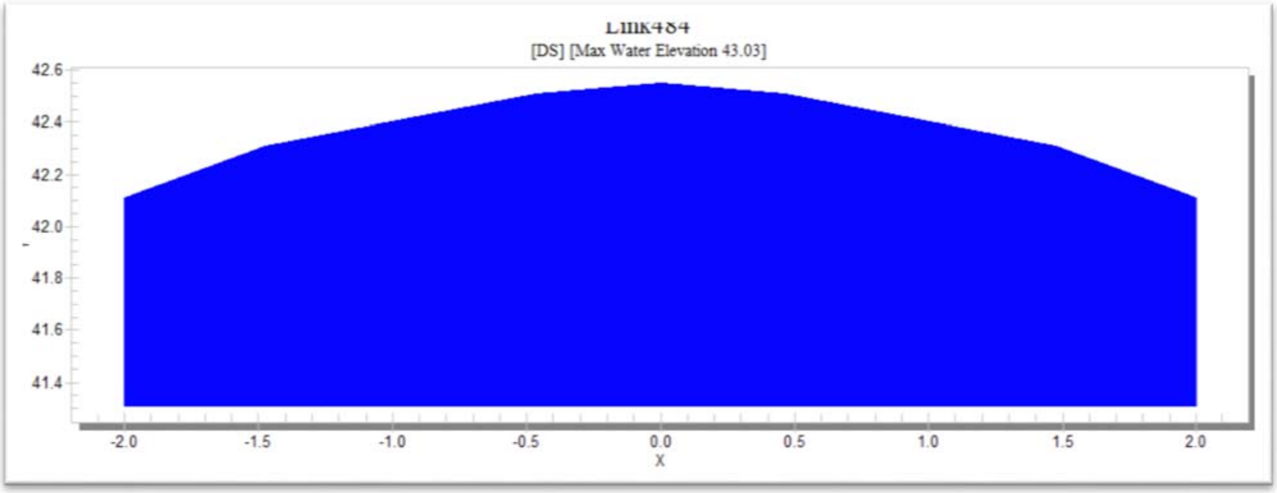

Figure 6: Existing Arch Bottomless Culvert at Capacity

From the maximum extents of flooding, it is evident that there is the potential for property damage occurring to civic # 23 on Lynch's Lane, due to both the extent of the floodplain as well as the low elevation of the property relative to the surrounding wetland.

These results indicate two problems associated with the existing system. The existing elevation of Lynch's Lane is too low relative to The Gully. According to the XPSWMM model, when a major storm event occurs, The Gully will experience significant ponding of water until this water depth reaches the elevation of the road where it will then spill on to the existing road, potentially causing significant damage to the road and private property. Another issue is that the existing arch culvert is unable to handle the amount of flow entering and leaving the Gully. The stream exiting The Gully also very little additional capacity, especially given the high volume of flow modelled during a 100 year storm event.

The maximum water elevations calculated at the two new homes on Mahon's Lane during the worst storm event modeled are shown in figure 7 and are lower than the finish floor elevations of both these slab-on-grade houses. This figure shows how the approaching flow surrounds the new houses. None of the flow passes onto the fill areas, which are discussed earlier in the report, therefore the water does not reach a depth that matches the elevation of these houses, meaning no flooding occurs. That being said, the elevations shown in the figure below indicate high water depths of water near the new homes, approaching 1.0m near the new homes. The maximum water velocity at this location is approximately 0.2m/s. Given the high water depth at this location, combined with that velocity, there exists some risk to human safety in the event that someone should fall into the water at this particular location. The velocity is not excessively high, most likely due to the high amount of vegetation in the area which in turn creates higher water depth from ponding but lower water velocity due to increased roughness.

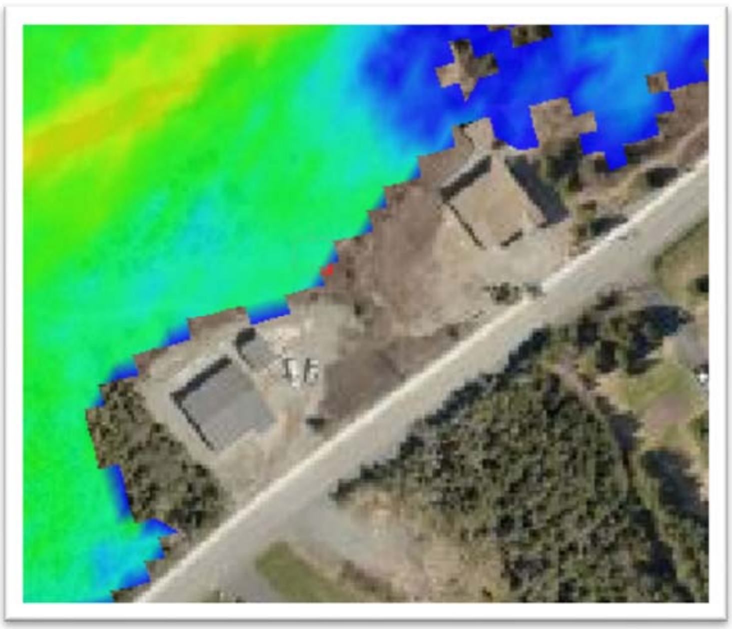

Figure 7: Maximum Water Elevations Surrounding Houses

Extending this fill area zone along Mahon's Lane represents the future construction of the remaining two building lots mentioned earlier in the report. Running the model for the 100 year storm events shows that these properties will not flood if they are assumed to be at a minimum elevation of at least 45.0m

3.2 Upgraded Conditions

Once the model was analyzed and problem areas were identified, the model was adjusted to determine what changes could be implemented to mediate the issues discussed in the previous section

A berm could be constructed along Lynch's Lane and partially along Mahon's Lane to work as a barrier between the surrounding areas and "The Gully". This will confine the runoff in the event of a major storm, so that the flow is redirected into the main drainage point of "The Gully" – the arch bottomless culvert. This was done in XPSWMM by assigning a fill area of a constant elevation where the berm should be placed. Upon placing a berm with a minimum elevation of 44.5, the maximum water depth experienced during a 100 year storm event was 0.5m along the roadsides, providing the requirement of approximately 600mm of freeboard based on the surrounding topography.

Altering the outlet side of the Gully will provide proper drainage in the event that an extreme storm event should occur and allow the runoff to be transferred to the wetland area behind the surrounding residential areas. Widening the existing left bank of the stream is unlikely due to the proximity of the adjacent property. Instead, a Gabion wall with a height of at least 1m could be constructed along the property to prevent any flow from passing onto the property. The cross-section depicted in Appendix E could be tied into the existing stream beyond the surrounding properties where the flow can discharge into the surrounding wetland, where it will follow its natural path, prior to discharging into the ocean.

Replacing the existing arch bottomless culvert is necessary to mitigate the risk for flooding during a 100 year storm event. Replacement of the culvert is limited by the amount of available cover on the culvert, as well as the proximity of the adjacent properties. A list of potential geometries that could be installed in this area was reviewed with local suppliers. A 6.198m x 1.372m span arch bottomless culvert could work. The new culvert size was entered into the model. The combination of the upsized culvert and altered outlet stream provided satisfactory results. The worst storm event, in terms of total flow passing through the culvert was the 100 year 6 hour storm. In this event the culvert was at capacity, but the water level was still below the elevation of Lynch's Lane, thus no flooding occurred. A cross-section of the new culvert at peak flow during a 100 year 6 hour storm can be observed in the figure below

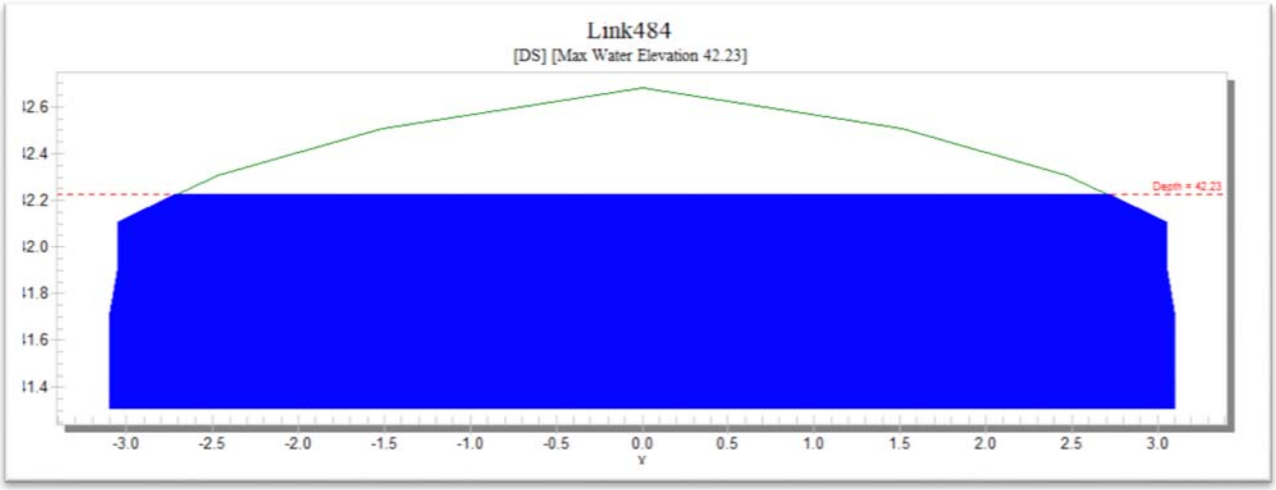

Figure 8: Upsized Culvert - 100 Year 6 Hour Storm

Revising the model to include the larger culvert at Lynch's Lane and the berm yielded a new floodplain. Shown in Appendix F, the new extents of flooding is confined to the wetland itself and there is no flooding observed on Lynch's Lane or Mahon's Lane.

Returning to the slab on grade houses that have been constructed on Mahon's Lane and the future building lots to be constructed in the area, the placement of a berm in the model results in higher water depths near these houses, but still no flooding. For protection, the berm could be continued behind these houses to ensure no flooding occurs. This is seen in Figure 9.

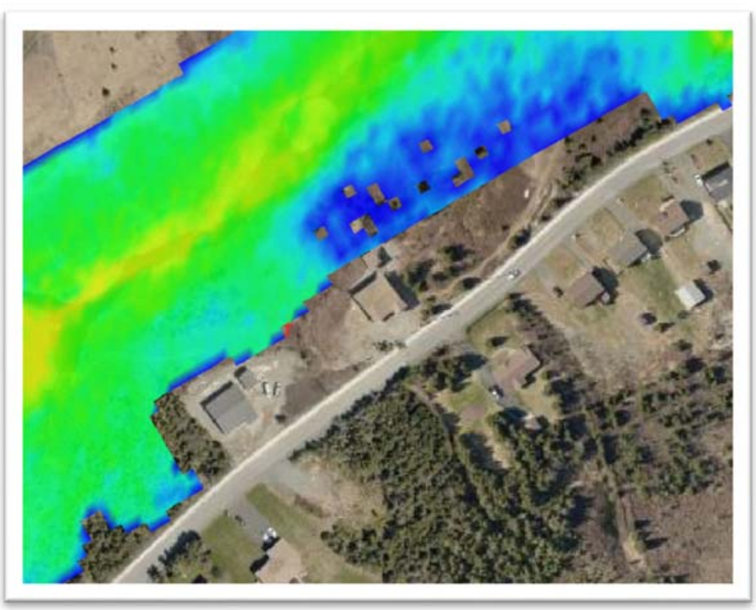

Figure 9: Water Depths at New Properties & Building Lots (Mahon's Lane)

4.0 Recommendations

As per the results discussed in the previous section, Progressive Engineering & Consulting Inc. recommends the following remedial actions.

The concrete culvert on Marine Drive has exposed rebar and deteriorating concrete. Progressive Engineering & Consulting Inc. strongly recommends that the bridge be inspected by a structural engineer to ensure that the bridge is structurally sound.

It is evident from the modelled 100 year storm events that the arch culvert located on Lynch's Lane is undersized and unable to handle the amount of flow entering "The Gully". Upsizing this culvert is clearly required given the large volume of flow occurring during a 100 year storm event and the small cross-sectional area of the existing culvert. Due to the limited height between the existing culvert and asphalt on Lynch's Lane, the arch bottomless culvert should be upsized to a 6.198m x 1.372m span arch bottomless culvert. The culvert should be replaced with another aluminum culvert because of expected low pH levels of the incoming water from the wetland.

The stream passing through "The Gully" lacks the capacity for the incoming flow. The sharp turn that the stream makes near the arch culvert likely results in flow spilling over into the surrounding wetland. This happens in several other locations as noted in the body of the report, meaning that during a storm event, not all of the flow will reach the culvert. Rerouting or deepening the existing stream that passes through "The Gully" is likely not an option because "The Gully" is a protected wetland area. Instead, by creating a berm that is of sufficient elevation would eliminate the risk of the flow from "The Gully" passing over Lynch's Lane and into the marsh area across the road. If a berm is to be constructed, it should be placed along Lynch's Lane and partially along Mahon's Lane to prevent any flow from exiting the wetland and onto the surrounding streets. Simply placing a berm along Lynch's Lane would result in containing the flow so that it begins to flow across Mahon's Lane. Creating a berm would result in deeper water elevations in "The Gully" but prevent any flow from entering the surrounding residential areas, essentially confining the storm runoff to the wetland and routing flow into the arch bottomless culvert. The placement of the berm can be seen by the red line in Appendix E. The berm should be designed so that the maximum water elevation seen during a storm event is two feet below the top of the berm. Based on the maximum water elevation identified at the location of the berm, it is recommended that the minimum berm height should be approximately 1.5 m relative to the elevation of Lynch's Lane, and 1.5m relative to the elevation of Mahon's Lane. The berm will help confine the flow to the existing stream within "The Gully" and allow for better drainage out of the wetland area.

Berm construction combined with culvert upgrading would mitigate the potential risk for flooding of the residential properties in the area. On the outlet side of the existing culvert, a small stream transports flow into a surrounding wetland area. The XPSWMM model predicts some flooding at civic #23 Lynch's Lane. Deepening the channel or placing Recon Walls on that side of the stream could potentially prevent any flow from protruding onto that particular property.

Upon reviewing base mapping of the Town, it appears that the house and drive way at Civic #23 Lynch's Lane is constructed along the conservation line for the brook. However, the owners of the property have some small sheds and gazebos located very close to the banks of the outlet stream. With only the altered right bank of the stream and no recon wall, the maximum extents of flooding does not reach the owners driveway, however the small sheds will be damaged.

Referring to the upstream infrastructure, no culverts showed signs of flooding for the storm events modelled. Shown below is a summary table stating the name and condition of upstream culverts which refers to the infrastructure outlined in Appendix A.

Culvert Location	**Culvert Condition**	**Culvert over Capacity?**
South Pond Outlet – 2000mm CSP Culvert	Good	No
South Pond Outlet – 2000mm CSP Culvert	Good	No
South Pond Road – 900mm CSP Culvert	Good	No
Quigley's Lane – Twin 600mm & 900 CSP Culverts	Poor – Partially Blocked and Deformed	No
Torbay Road – 2100mm * 3000mm CSP Culvert	Good	No

Marine Drive – 1600 * 3500mm Concrete Channel	Poor – Deteriorating Concrete & Exposed Rebar	N/A

If these storm sewer infrastructure upgrades are made it would mitigate the risk for potential flood damage occurring in the Lynch's Lane and Mahon's Lane area. It would allow for better drainage of storm runoff out of "The Gully" without altering anything within the protected wetland itself. Details of these upgrades can be seen in Appendix E. From analyzing the four future building lots on Mahon's Lane, Progressive Engineering & Consulting Inc. recommends that these building lots have a minimum elevation of 45.0m to prevent flooding from occurring on these properties.

4.1 Cost Estimate

Class "D" budgetary estimates were developed for the improvements discussed previously. Estimated costs can be seen in full detail in Appendix H. The following is a summary from the cost estimate

- Channel Excavation - $12,200
- Berm Construction - $41,040
- Arch Bottomless Culvert Replacement - $352,345

Total Construction Cost: $516,860.03

Total Engineering Cost: $77,529.00

Total Cost: $594,389.03

5.0 Conclusion

It is evident from the results of the 1D/2D XPSWMM storm water model that some infrastructure upgrades are required to effectively convey runoff in the event of a major storm event in Torbay in the area of Mahon's Lane and Lynch's Lane. More specifically, the arch bottomless culvert on Lynch's Lane should be upsized to a 6.198m x 1.372m arch bottomless culvert. A berm should also be constructed to prevent flooding from occurring along Lynch's Lane and Mahon's Lane to prevent property damage presently occurring on civic# 23 on Lynch's

Lane. This property is currently within the floodplain during a 100 year storm under existing conditions. Given the fact that Civic # 23 Lynch's Lane, adjacent to the outlet stream is within the current floodplain, and that there is some infrastructure that has been placed beyond the border of the conservation zone, the Town could decide whether it is feasible to place some form of recon wall or retaining wall to prevent flow from passing onto the property. The Town could also advise the homeowner that the shed and gazebo structures have to be moved.

APPENDIX 'A'
Existing Streams & Infrastructure

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which is valid for the year 2018

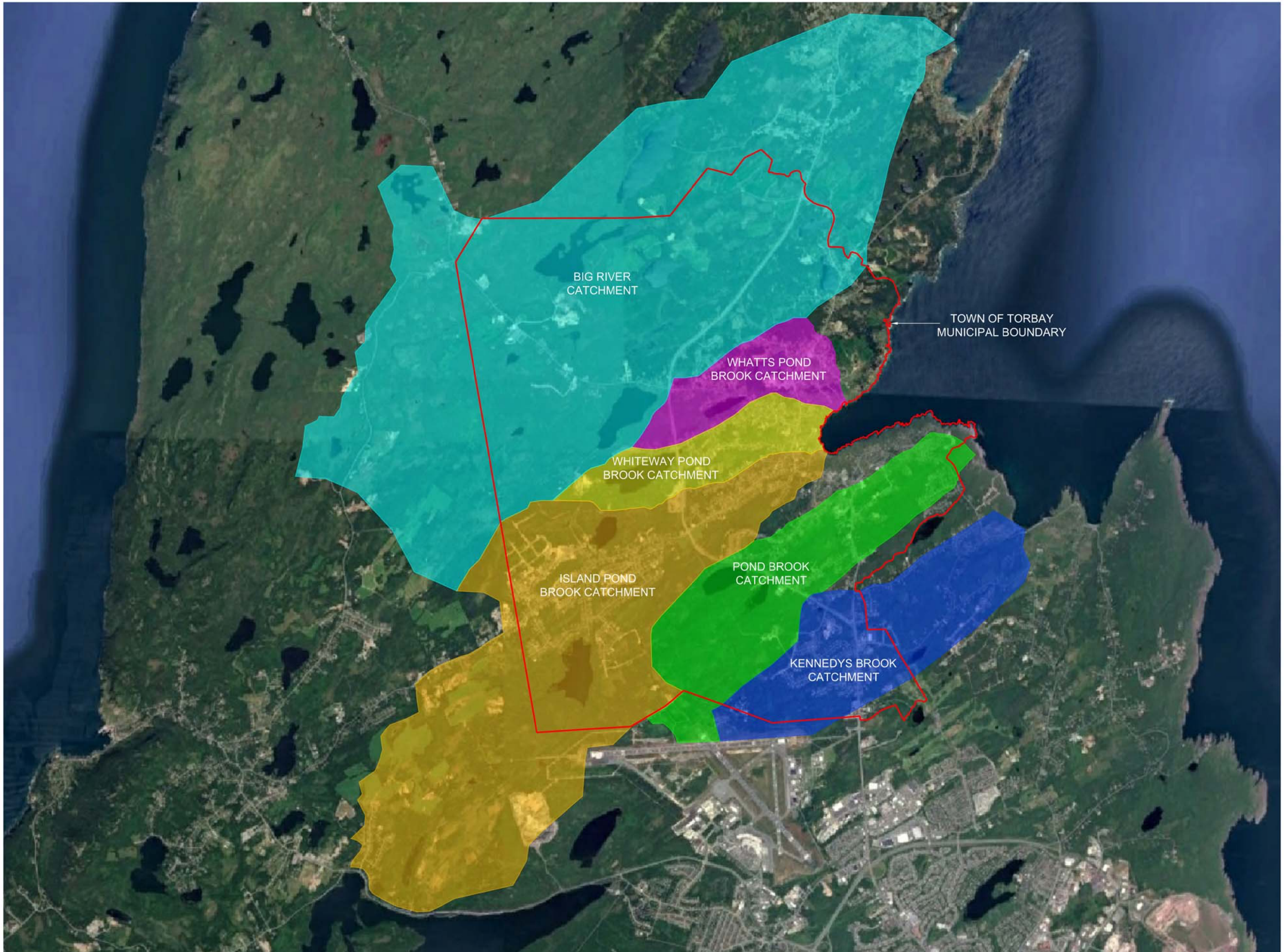
OWNER/CLIENT NAME:
TOWN OF TORBAY

PROJECT TITLE:
TORBAY FLOOD ANALYSIS GULLY

DRAWING TITLE:
APPENDIX A

DRAWN BY:	DESIGNED BY:	APPROVED BY:
C.L	C.L	
MAE No: N/A	DATE: MAY 2018	SCALE: AS SHOWN
PROJECT No: 2017-043	DRAWING No: PR1	REV:

APPENDIX 'B'
Catchment Areas



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STAMP: DARRYL MILLS — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF NEWFOUNDLAND — SIGNATURE 13/XX/XX DATE

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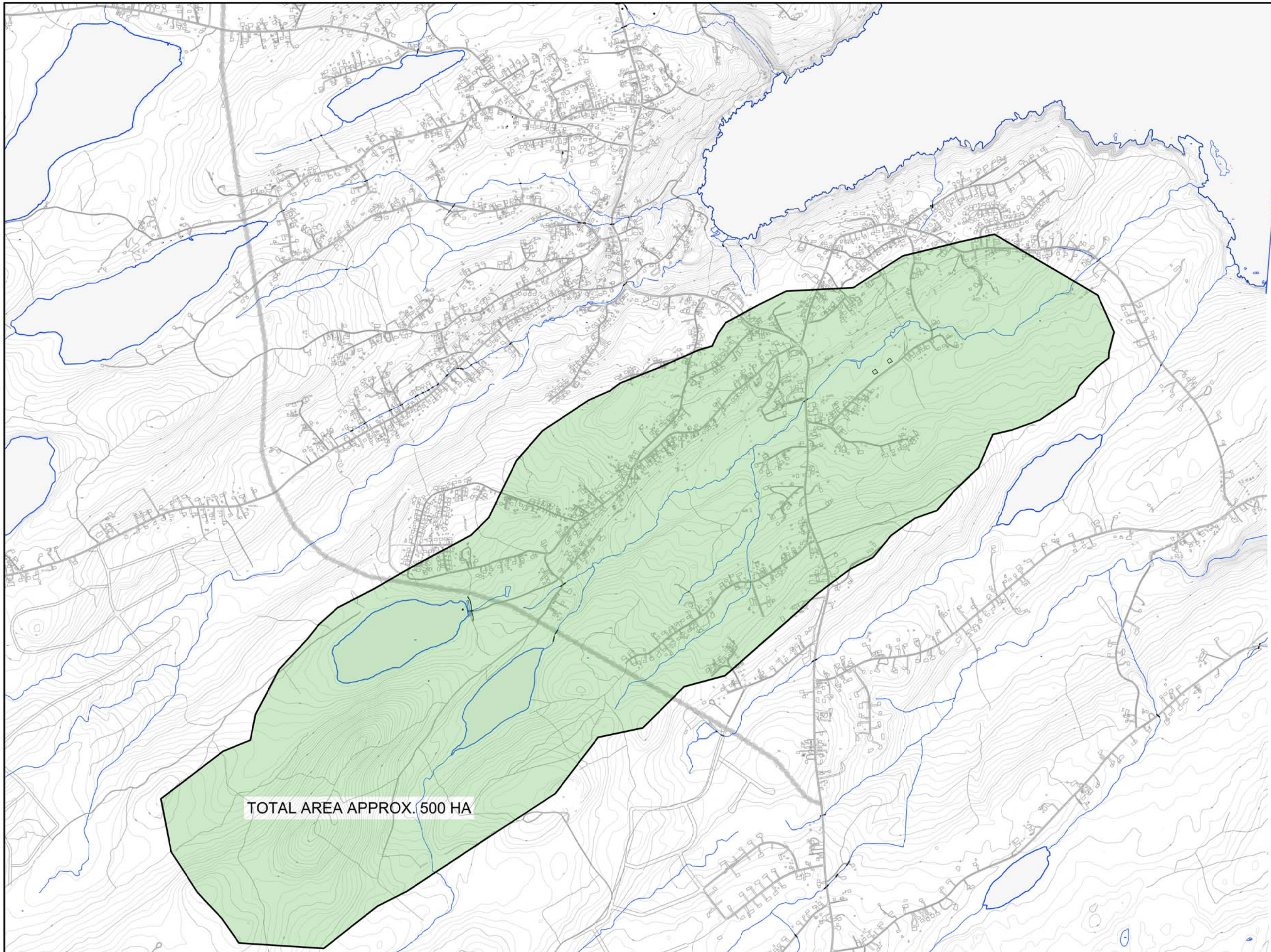
PROJECT TITLE: TORBAY FLOOD ANALYSIS GULLY

DRAWING TITLE: APPENDIX B

DRAWN BY: CL	DESIGNED BY: CL	APPROVED BY:
MAE No: N/A	DATE: MAY 2018	SCALE: AS SHOWN
PROJECT No: 2017-043	DRAWING No: PR2	REV:

APPENDIX 'C'
"The Gully" Catchment Area



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C - No. OF DRAWING WHERE 'A' IS DETAILED

CATCHMENT AREA

RIVERS AND STREAMS

No.	REVISIONS	APP	DWN	DATE
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PROJECT TITLE:
TORBAY FLOOD ANALYSIS GULLY

DRAWING TITLE:
APPENDIX C

DRAWN BY: CL	DESIGNED BY: CL	APPROVED BY:
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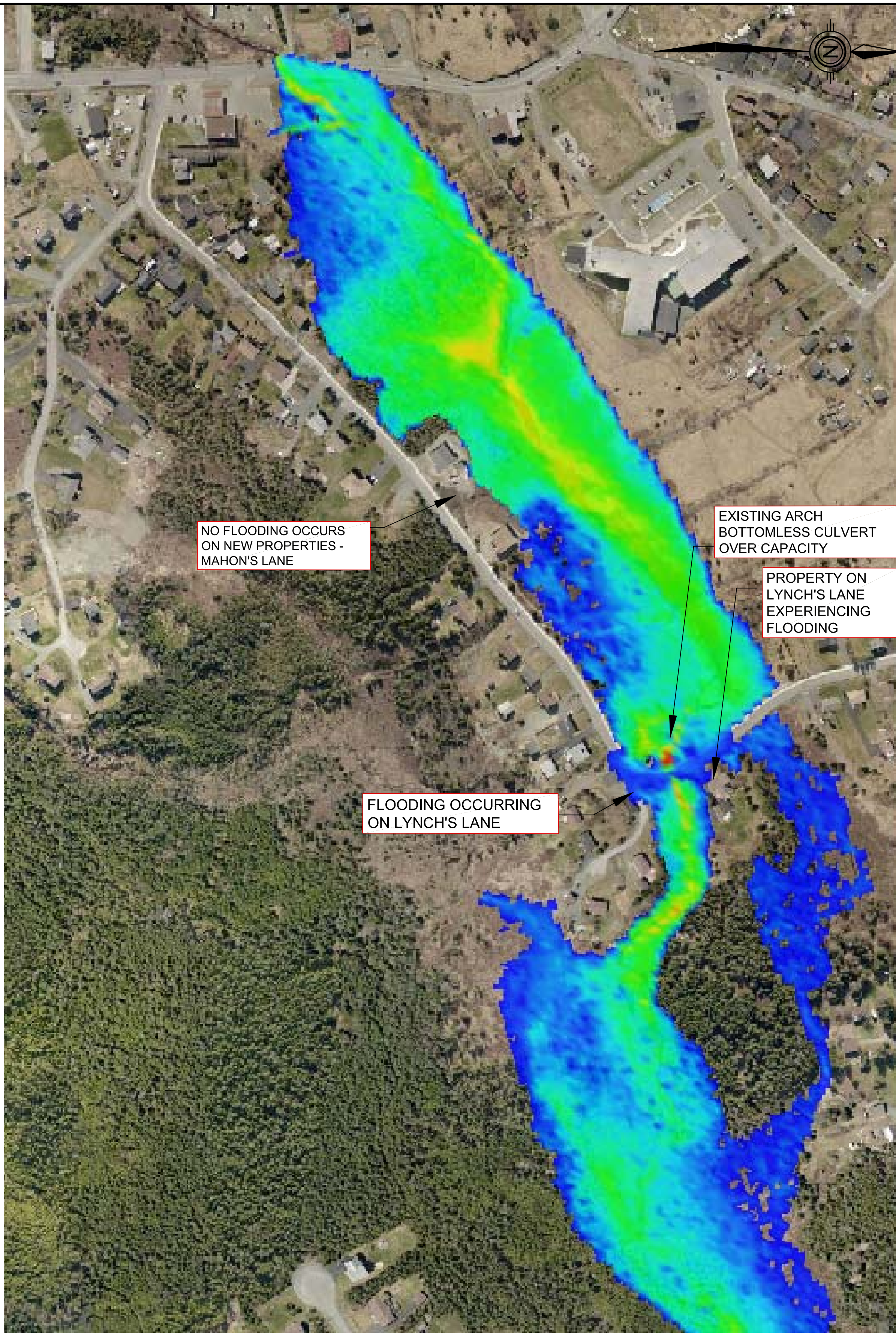
PROJECT No: 2017-043	DRAWING No: PR3	REV:

APPENDIX 'D'
Floodplain Results – Existing Conditions



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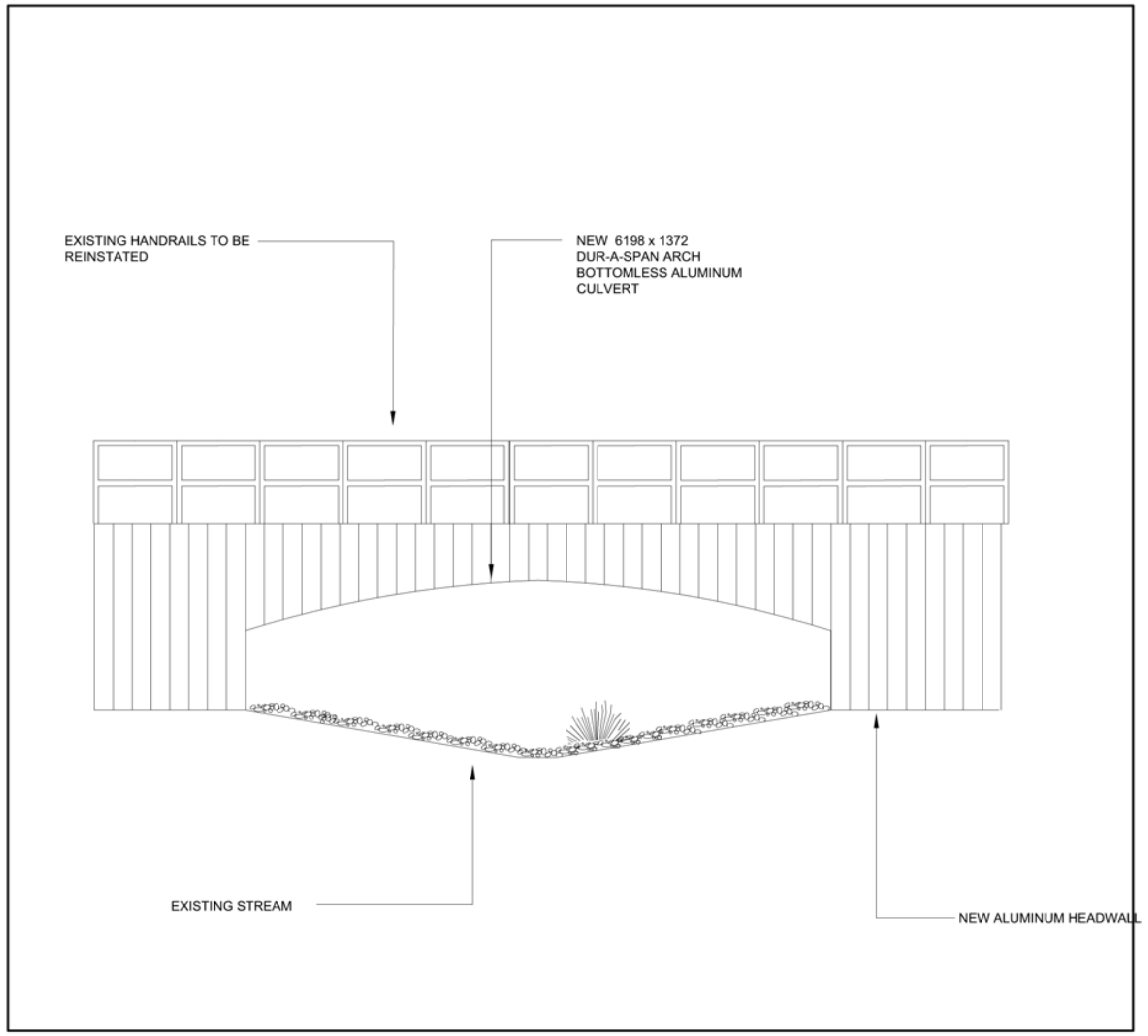
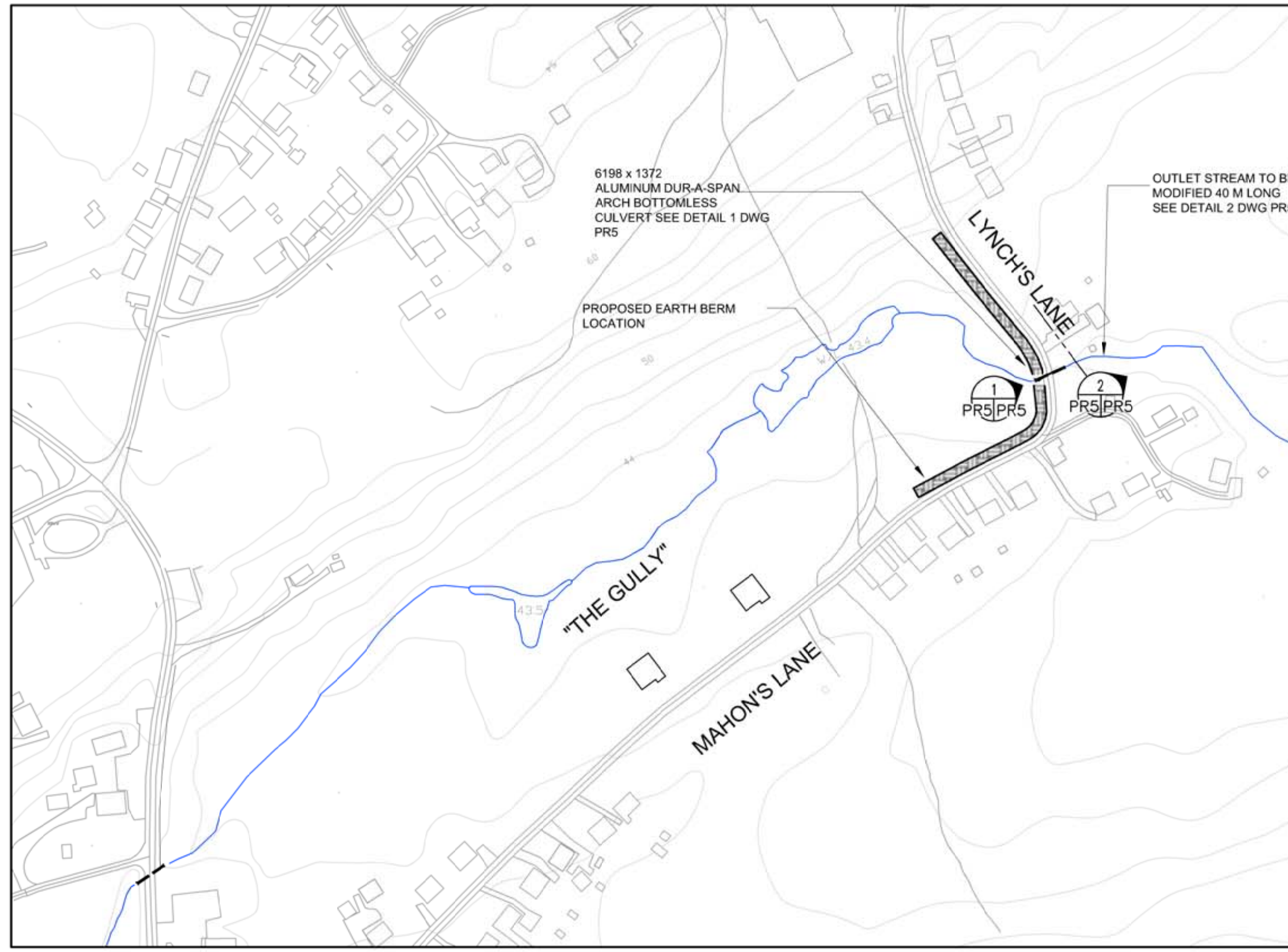
		DRAWING NO. PR4	REV.

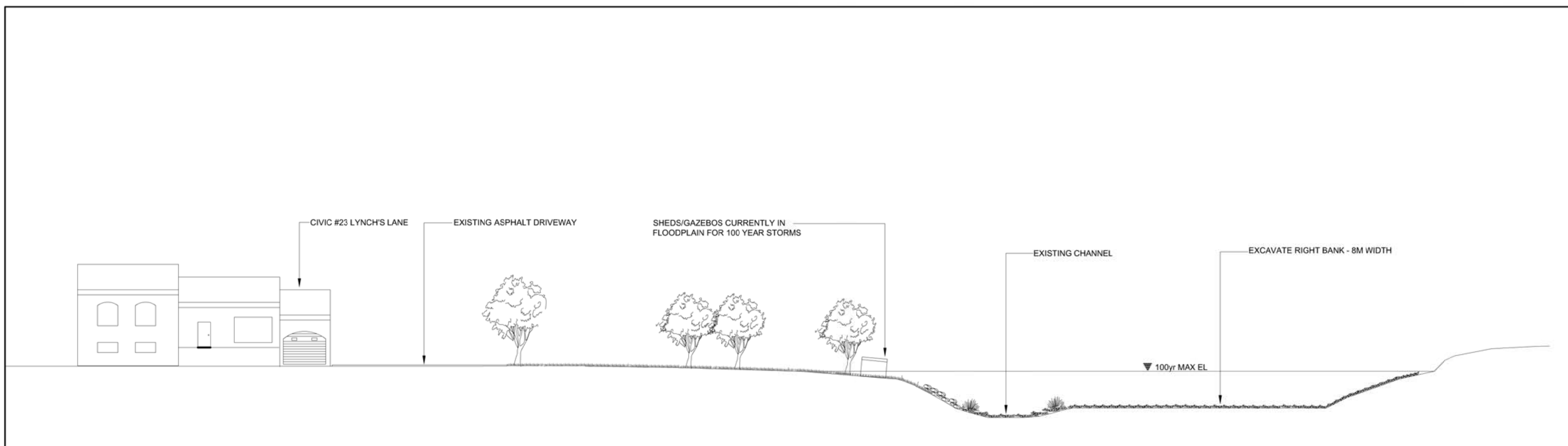
APPENDIX 'E'
Recommended Upgrades



DUR-A-SPAN ARCH BOTTOMLESS CULVERT ELEVATION - N.T.S

1
PR6 PR6





MODIFIED OUTLET SECTION - N.T.S

2
PR6 PR6

CONTRACTOR MUST VERIFY ALL DIMENSIONS AND CONDITIONS ON SITE BEFORE PROCEEDING WITH ANY PORTION OF THIS WORK. REPRODUCTIONS OF THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. REFER TO GRAPHIC SCALE. DO NOT SCALE DRAWINGS FOR CONSTRUCTION.

A - PLAN, SECTION, ELEVATION, OR DETAIL No.
B - No. OF DRAWING WHERE 'A' IS ON SITE PLAN
C - No. OF DRAWING WHERE 'A' IS DETAILED

No.	REVISIONS	APP	DWN	DATE
X	X	X	X	X

NORTH:

STAMP:

Progressive Engineering & Consulting Inc.

PERMIT STAMP:

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PEG
PERMIT HOLDER
This Permit Allows
PROGRESSIVE ENGINEERING & CONSULTING INC
To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEG N0566 which is valid for the year 2018

OWNER/CLIENT NAME:
TOWN OF TORBAY

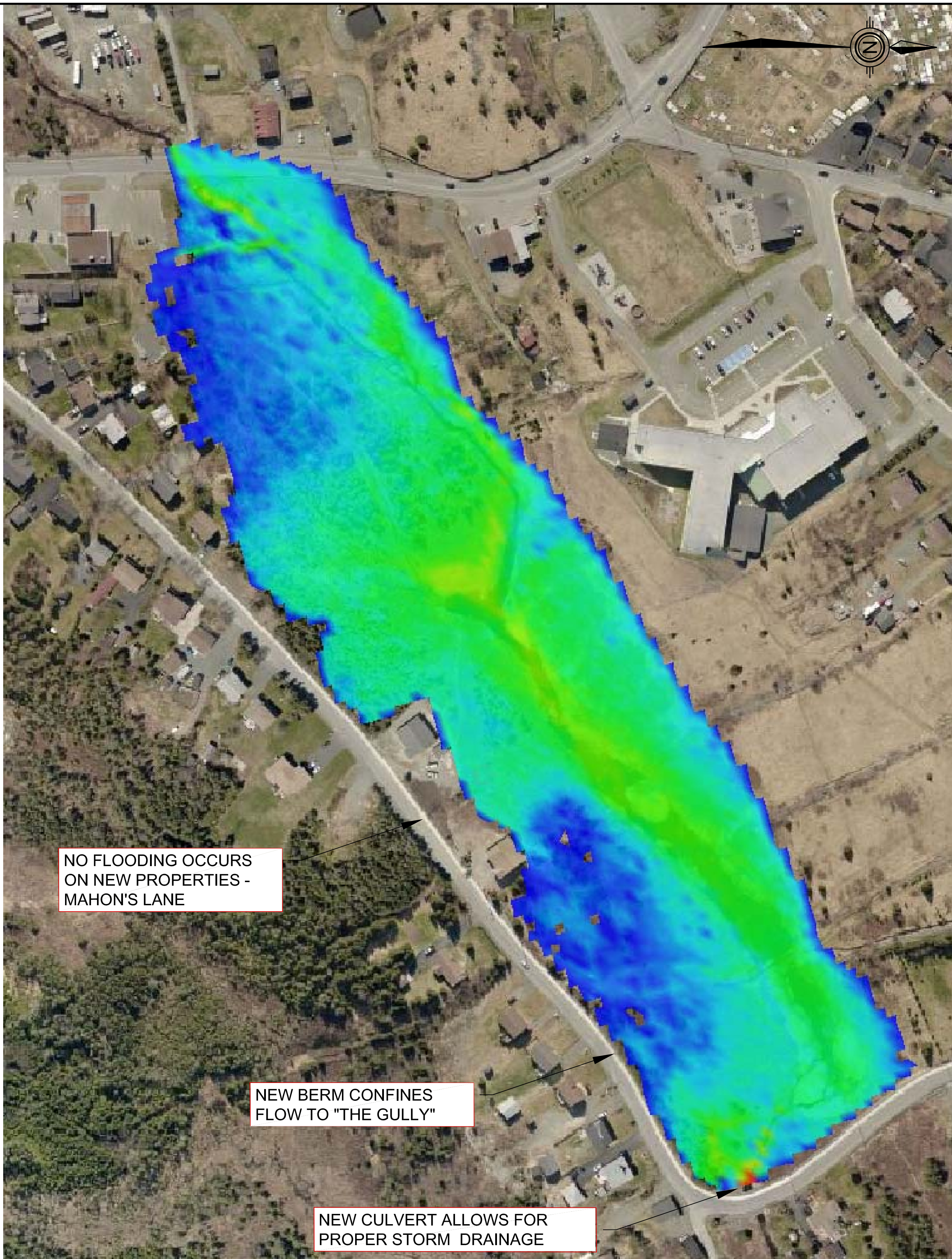
PROJECT TITLE:
TORBAY FLOOD ANALYSIS GULLY

DRAWING TITLE:
APPENDIX E

DRAWN BY:	DESIGNED BY:	APPROVED BY:
CL	CL	
MAE No: XXXXXX	DATE: MAY 2018	SCALE: AS SHOWN
PROJECT No: 2017-043	DRAWING No: PR6	REV:

APPENDIX 'F'

Floodplain Results – Post Upgrades



OWNER/CLIENT NAME: TOWN OF TORBAY	Progressive Engineering & Consulting Inc.	DESIGNED: CL	APPROVED:
PROJECT: TORBAY FLOOD ANALYSIS GULLY		DRAWN: CL	DATE:
DRAWING TITLE: POST UPGRADES FLOODPLAIN		SCALE: NTS	
		PROJECT NO. 2017-043	
		DRAWING NO. PR6	REV.

APPENDIX 'G'

Budgetary Pricing - Dur-A-Span – DS -54B

Atlantic Industries Limited

BUDGETARY PRICING

Date: 5/9/2018

Reference No.: 2018-00389

Project: **Lynch's Lane Box Culvert Upgrade**

Structure: **A - DAS DS-54B**

Customer:	Progressive Engineering Consulting Inc.	Email:	Cameron@pec-eng.ca
Contact:	Cameron Legge	Phone:	(709) 368-7117
Delivery:	8 Weeks Upon Approved Drawings	Fax:	________
F.O.B.:	Truck, Torbay, Newfoundland		

Item	Qty.	Unit	Description	Unit Price	Total Price
1	12.344	m	Dur•A•Span® *Aluminum Structural Plate* *230 mm x 64 mm Corrugation Profile* *9 Rings @ 1.37m Per Section = 12.344 m*	$7,700.00	$95,048.80
2	1	L.S.	Dur•A•Span® *Aluminum Corrugated Headwall* *Estimated Area: 60 m2* *c/w the following:* *Structural Engineering Design & Shop Drawings* *Assembly Hardware* *Pre-Construction Meeting* *2 Days of Site Assistance* **Additional Site Assistance** Site Assistance by a designated AIL representative at $1000 per shift plus travel and accomodation expenses.	$35,000.00	$35,000.00

1	**Structure Parameters:** 1) Structure Number: DS-54B 2) Shape: Box 3) Bottom Span: 6.198 m 4) Maximum Span: 6.198 m 5) Rise: 1.372 m 6) End Area: 6.79 m^2 7) Thickness: To Be Designed 8) Footing Type (By Others): Cast-In-Place Concrete 9) Headwall Type: Aluminum

Atlantic Industries Limited
P.O. Box 187 • Mount Pearl, NL • A1N 2C2
Phone: (709) 738-2747 • Fax: (709) 738-2773 • Email: sryan@ail.ca

Atlantic Industries Limited

BUDGETARY PRICING

Date: 5/9/2018

Reference No.: 2018-00389

Project: **Lynch's Lane Box Culvert Upgrade**

Structure: **A - DAS DS-54B**

Item	Qty.	Unit	Description	Unit Price	Total Price
1			**Design Parameters:** 1) Design Life: 75 Years 2) Live Load: CL-625 3) Minimum Cover: .45 m 4) Maximum Cover: .5 m 5) End Treatment: Square 6) Design Code: CAN/CSA-S6-14 (CHBDC) 7) Engineered Backfill Standard Proctor: CAN/CSA-S6-14 (CHBDC) 8) Engineered Backfill Zone on each side of the Structure: CAN/CSA-S6-14 (CHBDC) m		
ALL			**Additional Notes (applicable to all items):** 1) This pricing is based on the preliminary design parameters listed above and the preliminary information provided by Consultant Name. Should further design changes occur, this pricing may no longer be valid. 2) Escalation has not been factored into the above pricing. 3) The AIL Scope of Work (attached) forms part of this pricing. 4) Unloading and installation at jobsite by others. 5) This pricing is based on supplying total quantities listed. 6) Prices do not include sales taxes. 7) Terms are contingent upon credit approval. 30% deposit is due within 5 business days of receipt of approved drawings. The remaining 70% is due 30 days from delivery. 8) **FREIGHT IS INCLUDED IN PRICE.**		

Pricing Prepared By: ______________________

Stephen Ryan, PTech
Technical Sales Representative

Atlantic Industries Limited
P.O. Box 187 • Mount Pearl, NL • A1N 2C2
Phone: (709) 738-2747 • Fax: (709) 738-2773 • Email: sryan@ail.ca

1) Design Parameters

The design of the AIL Structure(s) will be based on the design parameters and other information as listed in the Quotation.

2) Foundation

AIL is not responsible for foundations and does not warrant that the foundation is suitable for the AIL Structure(s). Design of the foundation including depth and material to provide adequate bearing capacity and protection from scour, erosion, and frost is the responsibility of a qualified Engineer, retained by others. Foundation improvements, if necessary, are the responsibility of others. A letter from a qualified Engineer, retained by others, certifying that the foundation and backfill material within and outside of the engineered backfill zone meets or exceeds the technical specifications noted on the AIL drawings, including sufficient bearing capacity, shall be submitted to AIL for their records prior to commencing installation of the AIL Structure(s).

3) Stability

Global stability analysis of the site shall be the responsibility of a qualified Engineer, retained by others. For Vist-A-Walls, the external stability including sliding and overturning, and the internal stability, including pullout and rupture will be analyzed by AIL based on the design parameters as listed in the Quotation.

4) Drainage

The structure design requires a non-saturated backfill. The prevention of contamination of the select backfill by salt laden run-off or other corrosive chemicals is required to maintain structure integrity and service life. For some applications, mechanical drainage control and/or protective membranes may be required to ensure surface and subsurface drainage requirements are met.

Drainage design and control is site specific. Drainage design is the responsibility of the Bridge Engineer or Road Design Engineer or both who must have detailed knowledge of the project plans, details and specifications to ensure proper implementation, including addressing the above drainage issues. On-site drainage control is the responsibility of the contractor who carries out the work according to the design.

Design of the drainage system for the soils contained within, behind, above, and under the AIL Structure(s) is also the responsibility of others. If ground water is encountered during excavation or construction of the AIL Structure(s) the Bridge Engineer and/or Road Design Engineer shall be notified, in writing, of the location and source of the water.

AIL has not been retained to prepare the drainage design and control nor to do the work to implement the design. AIL accepts no responsibility whatsoever for these aspects of the Project.

5) Settlement

Calculation and analysis of total and differential settlement will not be completed by AIL. Unless otherwise reviewed and approved by AIL and stated on AIL's drawings, AIL will assume that anticipated settlements are within the following limits:

	Maximum Differential Settlement	**Maximum Total Settlement**
Structural Plate	Minimum of 150 mm or 1% on span/length in the longitudinal/transverse direction	150 mm
Bolt-A-Bin	1% on length	50 mm
Precast Panel Walls	1% on length	150 mm
Wire Face Walls	2% on length	500 mm

6) Design Verification

If any of the design parameters listed in the Quotation or technical specifications noted on the AIL drawings cannot be satisfied and/or there is a discrepancy between AIL's drawings and the Contract Documents, AIL must be notified in writing prior to drawing approval. A design check may be required to ensure that the revisions do not impact the design. Should changes to the design be required, all costs associated with the re-design will be at the expense of the Customer. In addition, should the re-design impact the pricing, a revised Quotation reflecting the changes will be issued by AIL.

7) Third Party Review

Upon request, an independent review of the structural design by a third party can be arranged by AIL. Unless noted otherwise, the cost of such a review is not included in the Quotation.

8) Drawings

The shop drawings, which include installation and backfill procedures, will be submitted electronically by AIL. Drawings will be stamped and signed by a Professional Engineer who is licensed in the appropriate jurisdiction when required.

9) Revisions

Pricing includes two (2) minor revisions to the AIL Issued for Approval drawings. The cost of additional revisions or revisions made after drawing approval, initiated by others, will be charged to the Customer.

10) Material Manufacturing

Manufacturing of the AIL Structure(s) will commence when the AIL Issued for Approval drawings have been approved, unless otherwise agreed to in writing or as specified in the material purchase order. The cost of any changes, initiated by others, made after approval of the drawings or direction to proceed with ordering of materials and/or manufacturing will be charged to the Customer.

11) Inspection

If an inspection of the AIL Structure(s) is required, as per the Contract Documents, it is the responsibility of others to retain the services of a qualified Inspector. The Inspector must contact AIL for coordination of the inspection. AIL will advise the Inspector of the projected completion date and provide access to inspect the materials at the manufacturing plant(s). A copy of the inspection report(s) shall be submitted to AIL for their records. All costs associated with the inspection shall be the responsibility of others.

12) Materials Supplied by AIL

Only the materials listed in the Quotation are supplied by AIL. For additional materials, tools, and equipment required for installation of the AIL Structure(s), please refer to the AIL Installation Guide(s), available upon request.

13) Footings (If Applicable for Structural Plate Projects)

AIL is not responsible for the design and/or supply of the footings unless noted otherwise in the Quotation. Footing loads from the AIL Structure(s) are available upon request.

a) Cast-In-Place Footings

AIL will provide the base channels, bolts, and nuts to connect the footings to the AIL Structure(s).

b) Pre-Cast Footings

If included in the Quotation, AIL will provide the pre-cast footings c/w the base channels, hook bolts, and nuts to connect the footings to the AIL Structure(s).

c) Corrugated Metal Footings

If included in the Quotation, AIL will provide the corrugated metal footings c/w the base channels, bolts, and nuts to connect the footings to the AIL Structure(s).

14) Pre-Construction Meeting

A pre-construction meeting is recommended prior to the start of construction. An AIL representative will be available to discuss the drawings and installation procedures with the Customer and other representatives as coordinated by the Customer.

15) Engineered/Select Backfill Material

A letter from a qualified Engineer, retained by others, certifying that the engineered/select backfill material meets or exceeds the contract specifications and technical specifications noted on the AIL drawings shall be submitted to AIL, along with all supporting documentation, for their records prior to commencing placement of the backfill. All costs associated with certifying and testing the backfill material shall be the responsibility of others.

In addition to any soil parameters listed in the Quotation, the engineered/select backfill material must meet all of the requirements, including gradation and electrochemical limits, as per the technical specifications noted on the AIL drawings. This information is available upon request.

16) Delivery

AIL will not be held responsible for any damage to the materials due to off-loading. For recommended off-loading procedures please refer to the AIL Construction Manual(s), available upon request. It is the responsibility of the Customer to inspect all materials against the packing slip upon arrival at the site to ensure complete delivery in good order. AIL must be advised in writing of any damaged or defective materials within 24 hours of delivery, otherwise the materials will be deemed to be acceptable.

17) Installation

AIL does not contract the installation of AIL Structure(s). This is the responsibility of others. For the installation procedures please refer to the AIL Construction Manual(s), available upon request.

18) Site Assistance

Site assistance shall not relieve the Installer of their responsibility to install the AIL Structure(s) according to the plans, specifications, and contract documents. The AIL Representative will *not* be responsible for inspection, quality control, or safety. Additional site assistance for the installation of the AIL Structure(s) by a designated AIL representative is available upon request. Rates for site assistance are as per the Quotation. AIL requires a minimum of 4 weeks notice should additional site assistance be requested. The purpose of site assistance is to ensure that the Installer is aware of AIL's requirements and to interpret AIL's drawings and technical specifications.

19) Compaction Testing

Compaction testing of each lift of backfill by a qualified Geotechnical Engineer or Technician, retained by others, is required to ensure the compaction requirements as noted on the AIL drawings are being met. A copy of the compaction test results shall be submitted to AIL for their records. All costs associated with compaction testing shall be the responsibility of others.

20) Shape/Alignment Monitoring

Dimensional checks will be required during installation and backfilling of the AIL Structure(s) to ensure correct horizontal and vertical alignment. The shape monitoring procedures and/or alignment control plan must be submitted to AIL for review and acceptance prior to construction. For large span structural plate structures, control points can be defined by AIL and shown on the drawings. All costs associated with shape/alignment monitoring shall be the responsibility of others.

21) Field Changes

Any deviations from the AIL drawings and/or technical specifications must be submitted in writing to AIL and approved by AIL prior to proceeding. It is the responsibility of others to ensure that any changes approved by AIL do not impact the Contract Documents and/or any other disciplines, including geotechnical, and to obtain any approvals necessary.

22) Letter of Certification

If required, as per the Contract Documents, AIL will provide a letter of certification for the AIL Structure(s). It is the responsibility of the Customer to advise AIL of this requirement prior to construction. If additional site assistance is required by AIL to obtain the information necessary to certify the installation of the AIL Structure(s), the costs will be passed on to the Customer at the rate listed in the Quotation.

APPENDIX 'H'
Cost Estimate

PROJECT: THE GULLY FLOOD ANALYSIS

JOB #:2017-043 PRELIMINARY COST ESTIMATE

BUDGET ESTIMATE: $594,389.03

SECTION	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	TOTAL
REV:A	ISSUED FOR APPROVALS	DATE:	4-Jul-18	APPROVED BY:	
			CONSTRUCTION COST:		$516,860.03
			ENGINEERING:		$77,529.00
			TOTAL:		$594,389.03
	DIVISION #1				
01010	MOBILIZATION & DEMOBILIZATION	LS	UNIT	$5,000.00	$5,000.00
	(Not greater than 5% if on the Island. Or 10% if in Labrador, of Item a. "sub-total" on last page)				
01020	CASH ALLOWANCE				
	Misc Works as Directed by Owner	Allowance	Allowance	$20,000.00	$20,000.00
01570	TRAFFIC REGULATIONS				
	Flagperson's Wages	HOUR	400.00	$20.00	$8,000.00
	DIVISION #2				
02104	LANDSCAPING, SEEDING AND TREE PRESERVATION				
	Supply & Placing Topsoil	M^2	640.00	$8.00	$5,120.00
	Hydraulic Seeding & Mulching	M^2	640.00	$6.00	$3,840.00
02111	CLEARING & GRUBBING				
	Clearing	HA	0.20	$10,000.00	$2,000.00
	Grubbing	HA	0.20	$10,000.00	$2,000.00
02215	SITE WORK & SITE GRADING				
	USM Removal	M^3	200.00	$30.00	$6,000.00
	Imported Glacial Till	M^3	427.00	$40.00	$17,080.00
02233	SELECTED GRANULAR BASE & SUB-BASE MATERIALS				
	Class "A" Granular Base	tonne	34.22	$20.00	$684.40
	Class "B" Granular Base	tonne	51.30	$22.00	$1,128.60
02552	HOT MIX ASPHALT CONCRETE PAVING				
	Surface Course	tonne	7.64	$150.00	$1,146.00
02528	CONCRETE WALK, CURB & GUTTERS				
	Supply & Place Grannular Base Material	M^3	1.90	$30.00	$57.00
	Concrete Walks	M	17.00	$100.00	$1,700.00
02434	PIPE CULVERTS				
	Supply & Placement of Aluminum Arch Bottomless Culvert				
	6,198mm x 1,372mm Dur-A-Span Culvert with Aluminum Headwa	EACH	1.00	$325,122.00	$325,122.00
02574	RESHAPING & PATCHING ASPHALT PAVEMENT				
	Removal of Asphalt Pavement	M^2	152.80	$2.50	$382.00

PROJECT: THE GULLY FLOOD ANALYSIS
JOB #:2017-043 PRELIMINARY COST ESTIMATE
BUDGET ESTIMATE: $594,389.03

SECTION	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	TOTAL
REV:A	ISSUED FOR APPROVALS	DATE:	4-Jul-18	APPROVED BY:	
02283	SUPPLY & INSTALLATION OF HAND RAIL				
	Standard Steel Pipe Posts & Rail	M	17.00	$125.00	$2,125.00
02481	CHANNEL EXCAVATION, CLEARING & DEEPENING				
	Channel Excavation				
	Common	M^3	360.00	$20.00	$7,200.00

a) SUB TOTAL	$408,585.00
b) CONTINGENCY (10%)	$40,858.50
b) H.S.T. 15% of a & b.	$67,416.53
c) GRAND TOTAL	$516,860.03