



GUIDING SOLUTIONS IN THE
NATURAL ENVIRONMENT

Geomorphic Assessment 664, 674, & 692 Essa Road & 320 Mapleview Drive West Barrie, Ontario

Prepared For:

Pearl Builders

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Table of Contents

	page
1. Introduction	1
2. Policy Context	1
2.1 Provincial Policy Statement (2020)	1
2.2 City of Barrie Official Plan (2018 Office Consolidation)	2
2.3 Nottawasaga Valley Conservation Authority Policies and Regulations.....	2
2.3.1 Ontario Regulation 172/06	2
3. Background Review	4
3.1 Climate	4
3.2 Watershed Conditions	4
3.2.1 City of Barrie Drainage Master Plan.....	4
3.2.2 Environmental Impact Study and Channel Relocation Plan – Holly Branch of Bear Creek (Azimuth Environmental Consulting Inc. 2015)	5
3.3 Geology.....	5
4. Historical Assessment.....	6
5. Existing Conditions.....	7
5.1 Reach Delineation	7
5.1 Rapid Assessments.....	7
5.1.1 Methods.....	7
5.1.2 Results	8
5.1.2.1 Reach BE-3	8
6. Erosion Hazard Limit – Meander Belt	9
7. Conceptual Channel Realignment	10
7.1 Design Considerations.....	11
7.2 Design Elements	11
7.2.1 Corridor Dimensions	11
7.2.2 Bankfull Channel	11
7.2.3 Bioengineering Treatments and Habitat Features	12
7.2.4 Riparian Zone.....	13
8. Conclusions and Recommendations.....	13
9. References.....	15

Figures

Figure 1. Site Location	after page 2
Figure 2. Historical Assessment	after page 6
Figure 3. Existing Conditions	after page 8

Tables

Table 1. Summary of Key Historical Observations	6
Table 2. General Reach Characteristics	9
Table 3. Rapid Assessment Results	9
Table 4. Bear Creek – Recommended Meander Belt (Reach Be-3).....	10
Table 5. Parameters of the Bankfull Channel – Holly Branch.....	12

Appendices

Appendix A. Historical Photographs
Appendix B. Photographic Record
Appendix C. Conceptual Channel Design

1. Introduction

Beacon Environmental Limited (Beacon) has been retained by Pearl Builders to undertake a geomorphic assessment for the property located at 664, 674, & 692 Essa Road and 320 Mapleview Drive West, in the City of Barrie (hereto referred as the “subject property”, **Figure 1**). The Holly Branch of Bear Creek traverses the subject property, which is located within the jurisdiction of the Nottawasaga Valley Conservation Authority (NVCA). Presently, land use within subject property is agricultural, with existing residential dwellings and associated outbuildings.

The proposed development plan for the subject property identifies realignment of the Holly Branch tributary. In support of an Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBA) application for the subject property, the purpose of this geomorphic assessment is to characterize existing conditions along the portion of Holly Branch relevant to the subject property, determine a recommended meander belt dimension to inform development constraints, and develop a channel realignment design concept for Holly Branch within the context of the proposed development plan.

Specifically, the following tasks were completed in support of this study:

- Background review of available materials (topographic mapping, aerial photography, and pertinent studies and reports);
- Desktop assessment to delineate reaches based on underlying geomorphic controls;
- A field assessment to characterize existing geomorphic conditions, confirm valley floor dimensions, and document evidence of active channel processes;
- Following applicable policies and guidelines, recommend a meander belt dimension on a reach basis, referencing recent and historical aerial imagery, existing conditions and post-development conditions; and
- Development of a preliminary channel realignment design concept.

2. Policy Context

2.1 Provincial Policy Statement (2020)

The Provincial Policy Statement (MNR 2020) issued under the *Planning Act* (1990) outlines areas of provincial interest with respect to natural hazards. In support of the Policy Statement, a Technical Guide - Rivers and Streams: Erosion Hazard Limit document was prepared by MNR (2002) to outline standardized procedures for the delineation and management of riverine erosion hazards in the Province of Ontario. The guide presents erosion hazard protocols based on two generalized landform systems through which watercourses flow: confined and unconfined valley systems. Through this approach, the meander belt width plus an erosion access allowance is defined to determine the erosion hazard limit of an unconfined valley system. For confined valley systems, the erosion hazard limit is governed by geotechnical considerations, including the stable slope allowance and an applicable toe erosion allowance (i.e., channel migration component).

2.2 City of Barrie Official Plan (2018 Office Consolidation)

On April 23, 2010 The Ministry of Municipal Affairs and Housing (MMAH) approved a new Official Plan for the City of Barrie. According to the plan, “the City shall protect, maintain and enhance water and water related resources on an integrated watershed management basis”.

Activities interfering in any way with an existing watercourse, such as channel straightening or diversions, are prohibited except with written approval from the Conservation Authority. Development limits shall be established by the limit of the valley or stream corridor which includes the watercourse, associated riparian vegetation, floodplain or erosion hazard lands, top of bank, and any additional lands. Site alteration shall not be permitted within fish habitat except in accordance with Provincial and Federal requirements and may require authorization from Fisheries and Oceans Canada.

Development adjacent to a valley and stream corridor must include protections and/or enhancements to the feature and its functions to facilitate a natural, open space corridor. Land uses within the vegetation zone shall be restricted to those that maintain or enhance the natural features and ecological functions of the area.

2.3 Nottawasaga Valley Conservation Authority Policies and Regulations

2.3.1 Ontario Regulation 172/06

In February of 2007, the NVCA Board of Directors approved the administrative Procedures for the Implementation of Ontario Regulation 172/06. Specifically, this regulation allows the Authority to:

- Prohibit, regulate or provide permission for straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream, watercourse or changing or interfering with a wetland; and
- Prohibit, regulate or provide permission for development if the control of flooding, erosion, dynamic beaches, pollution or the conservation of land may be affected by the development.

The following types of lands are regulated:

- Ravines, valleys, steep slopes (escarpment areas);
- Wetlands including swamps, marshes, bogs, fens and ponds;
- Any river, creek, flood plain or valley land; and
- Lake shorelines.

For the purposes of administering the Regulation, the following direction is provided with respect to development within NVCA jurisdiction with respect to river or stream valleys:



- 2.(1) *Subject to section 3, no person shall undertake development or permit another person to undertake development in or on areas within the jurisdiction of the Authority that are,*



Legend

Subject Property



Site Location		Figure 1
664, 674, & 692 Essa Road & 320 Maplevue Drive West, Geomorphic Assessment		
		Project: 222212 Last Revised: October 2022
Client: Pearl Builders		Prepared by: DU Checked by: IK
	1:4,000	Inset Map: 1:50,000
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- (b) river or stream valleys that have depressional features associated with a river or stream, whether or not they contain a watercourse, the limits of which are determined in accordance with the following rules:
- (i) Where the river or stream valley is apparent and has stable slopes, the valley extends from the stable top of bank, plus 15 metres, to a similar point on the opposite side;
 - (ii) Where the river or stream valley is apparent and has unstable slopes, the valley extends from the predicted long term stable slope projected from the existing stable toe of the slope or, if the toe of the slope is unstable, from the predicted location of the toe of slope as a result of stream erosion over a projected 100-year period, plus 15 metres, to a similar point on the opposite side, The NVCA regulates hazards lands including valleylands, wetlands, watercourses, and shorelines, including lands adjacent to these features;
 - (iii) Where the river or stream valley is not apparent, the valley extends the greater of,
 - A. The distance from a point outside the edge of the maximum extent of the floodplain under the applicable flood event standard, plus 15 metres, to a similar point on the opposite side, and
 - B. The distance from the predicted meander belt of a watercourse, expanded as required to convey the flood flows under the applicable flood event standard, plus 15 metres, to a similar point on the opposite side.

Ontario Regulation 172/06 defers to the definitions of apparent (confined) and not apparent (unconfined) river and stream valleys as explained in the Technical Guide – River and Stream Systems (MNR 2002):

- *Apparent (confined) river and stream valleys: are ones in which the physical presence of a valley corridor containing a river or stream channel, which may or may not contain flowing water, is visibly discernible (i.e. valley walls are clearly definable) from the surrounding landscape by either field investigations, aerial photography and/or map interpretation. The location of the river or stream channel may be located at the base of the valley slope, in close proximity to the toe of the valley slope (i.e. within 15 metres), or removed from the toe of the valley slope (i.e. greater than 15 metres).*
- *Not Apparent (unconfined) river and stream valleys: are ones in which a river or stream is present but there is no discernible valley slope or bank that can be detected from the surrounding landscape. For the most part, unconfined systems are found in fairly flat or gently rolling landscapes and may be located within the headwater areas of drainage basins. The river or stream channels contain either perennial (i.e., year round) or ephemeral (i.e. seasonal or intermittent) flow and range in channel configuration from seepage and natural channels to detectable channels.*

Subject to conformity with the applicable Official Plan, the provision of appropriate studies and completion of the Conservation Authority permit process, development may be permitted within a regulated area, and requires the issuance of a permit from the NVCA.

3. Background Review

3.1 Climate

The regional climate, specifically precipitation patterns, dictate annual precipitation volumes and the seasonal variability of the hydrologic regime of a watercourse. As rainfall interacts with local physiography, the volume and duration of surface runoff and the release of groundwater storage between rainfall events, are what drive local geomorphology. Precipitation records from the Canadian Climate Normals (1981 to 2010) recorded at the Barrie WPCC station (Climate ID 6110557), which is located approximately 5.4 km northwest of the subject property, averaged 77 mm in winter (November through February) and 84 mm in summer (July and August; Environment Canada 2022). The increase in summer rainfall is due to convective thunderstorms. While the total precipitation and number of large rain events is greater during the summer months, snow melt and rain-on-snow events tend to produce the highest annual flows within the watershed.

3.2 Watershed Conditions

The Bear Creek watershed has a total drainage area of approximately 1700 ha (Tatham Engineering 2019) and is managed by the NVCA under the Middle Nottawasaga River Management Unit. This Unit includes the main branch of the Nottawasaga River and smaller tributaries such as Bear Creek, Thornton Creek, and Egbert Creek (NVCA 2018a). In general, NVCA (2018a) has reported that the quality of the Bear Creek system has been impacted by urban development within its headwater areas in the City of Barrie.

The NVCA Middle Nottawasaga River Subwatershed Health Check (2018b) characterizes the Holly Branch of Bear Creek within the subject property as being impaired, or in very poor health due to pollution and sediment input from roads and farmland. Under existing conditions, approximately 129.6 ha of total drainage area contributes to Essa Road culvert crossing, including the subject property (Tatham Engineering 2022). Surrounding land use is mixed, with commercial development to the south and east, residential to the west, and churches to the north, before more residential development. Based on a downstream extent at Essa Road, the channel slope is 0.54%, while the mean slope in the subwatershed is 1.6% (OFAT 2020).

3.2.1 City of Barrie Drainage Master Plan

A Drainage Master Plan was prepared by Tatham Engineering Limited for the City of Barrie in 2019. Drainage Master Plans are intended to identify drainage deficiencies in the City, evaluate alternative solutions to address the deficiencies, and recommend a preferred alternative solution for implementation. The Drainage Master Plan included a geomorphic assessment, completed by Water's Edge Environmental Solutions Team Ltd., which examined the reach of Holly Branch within the subject property. This reach was delineated as Be-3, originating downstream of a stormwater management facility and terminating at Mapleview Drive West. Reach Be-3 was described as single thread, non-sinuuous, trapezoidal and channelized watercourse with minimal riparian cover and heavy vegetation encroachment (cattails). Upstream of Essa Road, the report characterized riparian conditions as predominantly manicured lawn, while residential development was noted downstream.

A rapid geomorphic field assessment, consisting of standard field protocols (RGA and RSAT) classified Reach Be-3 as stable (*'in regime'*) and displaying a 'fair' overall degree of ecological health (further discussion of the RGA and RSAT field protocols is provided in **Section 6**). No specific management recommendations were provided for Reach Be-3 through the Drainage Master Plan, however, the reported degraded condition of the watercourse suggested a potential opportunity for restoration and enhancement.

3.2.2 Environmental Impact Study and Channel Relocation Plan – Holly Branch of Bear Creek (Azimuth Environmental Consulting Inc. 2015)

Azimuth Environmental Consulting Inc. prepared an Environmental Impact Study (EIS) in 2015, in support of a proposed multipurpose development on the subject property. The study included an assessment of vegetation communities within the site, screening for Species at Risk, characterization of fish habitat conditions, evaluation of potential impacts of the proposed development (including a channel relocation plan) on existing natural features and provided mitigation and compensation measures for any anticipated impacts.

The Holly Branch of Bear Creek within the subject property was assessed as part of the EIS. The study noted that the watercourse had been significantly altered to confine flow and create land for agricultural purposes. The channel took the form of a ditch contained within a 10 m wide and 3.0 m deep corridor, with approximately 2:1 side slopes. The banks of the ditch were vegetated with grasses, dogwood, and willow, with cattails noted within the wetted areas. The watercourse originated approximately 300 m east of the property from a large stormwater management pond through a 4.0 m wide open bottom corrugated steel pipe arch culvert. The channel then flowed through two additional culverts – the first consisted of a triple-cell corrugated steel pipe culvert, located approximately 4.0 m downstream of the pipe arch culvert. The second, further downstream, was a single 1.2 m diameter corrugated steel pipe culvert. At Essa Road, the channel crosses through an existing 1.8 m concrete box culvert. Fish sampling within the subject property was not completed; however, brook trout (*Salvelinus fontinalis*), creek chub (*Semotilus atromaculatus*), and fathead minnow (*Pimephales promelas*) were previously captured downstream of the subject property.

The 2015 EIS by Azimuth Environmental Consulting Inc. found that the development would have no negative impacts on aquatic and terrestrial natural heritage features within the area. The EIS identified that natural channel design principles be implemented during the design of a new channel, and provided the recommendations related to the construction of the new channel. Following DFO mitigation measures would reduce or eliminate impacts of the proposed development on fish or fish habitat. The quality of fish habitat would also improve as a result of the channel realignment.

3.3 Geology

The planimetric form of a watercourse is a product of the channel flow regime and the availability of sediment (i.e., surficial geology). The 'dynamic equilibrium' of the driving forces (flowing water) and the resisting forces (sediment) are what govern the planimetric form of the channel. The subject property is located within the Peterborough Drumlin Field (Chapman and Putnam 1984); a rolling, drumlinized till plain. Surficial geology consists of till, while the southwestern portion of the consists of ice- contact stratified deposits. The bedrock in the area is described as limestone of the Lindsay Formation (OGS, 2011).

4. Historical Assessment

The following section presents an overview of historical conditions with respect to land use, land cover and channel conditions in the vicinity of the subject property. Historical analyses provide insight into the scale of natural and human-induced changes within a watershed, particularly the degree of adjustment to planimetric form of the watercourse and land use changes over time.


In support of the historical assessment, black and white aerial photographs and digital colour imagery were analysed and compared to obtain a simple, qualitative assessment of the degree of land use and channel planform change over time (**Appendix A**). **Table 1** provides a summary of specific observations regarding change in land use based on available historical aerial imagery. An overlay of the historical channel alignments is provided in **Figure 2**.

Table 1. Summary of Key Historical Observations


Time Period	Scale, Source	Observations
1973	1:15,840 Northway/Photomap /Remote Sensing Ltd.	Land use surrounding the subject property was primarily agricultural. Tree cover was limited to hedgerows along agricultural fields and isolated woodlots/plantations.
		Within the subject property, the watercourse had been channelized. An informal crossing of the watercourse could be observed. Immediately west of Essa Road, the watercourse also exhibits evidence of modification but does maintain a minor degree of sinuosity before crossing under Mapleview Drive.
		Riparian vegetation was generally absent along the watercourse, with agricultural fields extending to top of bank.
1989	1:12,000 Northway/Photomap /Remote Sensing Ltd.	Land use surrounding the subject property remained largely consistent, with new residential development limited to the area southwest of the Essa Road and Mapleview Drive intersection.
		Within the subject property, land use remained agricultural, though construction of an extended laneway and new outbuildings could be observed.
		While the watercourse was difficult to discern in 1989, the channel planform appeared to have remained consistent.
2021	1:4,000 First Base Solutions	Extension of the laneway to Mapleview Drive resulted in an additional crossing of the tributary. A small offline pond could be observed immediately west of the property.
		By 2021, lands west of Essa Road in the vicinity of the subject property have transitioned to residential development.
		Land use within the subject property remained unchanged, with some additional buildings evident.
		Within the subject property, the channel maintained a channelized (ditched) form. Both informal crossings evident in 1961 and 1989 have been formalized and the channel was relocated (shifted north) between the two crossings (refer to Figure 2).
		East of the subject property, the offline pond appears to have transitioned to function as a stormwater management facility. West of Essa Road, the tributary appears to have been further channelized.


664, 674, & 692 Essa Road & 320 Mapleview Drive West,
Geomorphic Assessment


Legend

 Subject Property


Watercourse

 Watercourse 1973


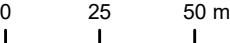
 Watercourse 1989

 Watercourse 2019



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5. Existing Conditions

5.1 Reach Delineation

To facilitate a systematic evaluation of the portion of the Holly Branch of Bear Creek relevant to the subject property, the watercourse was delineated into reaches. Reaches are sections of channel with similar characteristics in regard to hydrology, slope, boundary materials, and vegetation, therefore, be expected to behave consistently along their length to changes in the geomorphic function and sediment inputs, as well as to other modifying factors (Montgomery and Buffington 1997; Richards et al. 1997).

For the purposes of this study, the reach delineation followed by Waters Edge for the Drainage Master Plan was maintained. The reach within the subject property was labelled as Be-3 (**Figure 3**), which extends beyond Essa Road to Mapleview Drive. This delineation was confirmed during the field visit.

5.1 Rapid Assessments

5.1.1 Methods

In order to characterize existing geomorphic conditions along Reach Be-3, a field assessment was conducted on June 29, 2020. The reach was only assessed within the subject property limits. The following standardized rapid visual assessment methods were applied:

i. Rapid Geomorphic Assessment (RGA – MOE 2003)

The RGA documents observed indicators of channel instability by quantifying observations using an index that identifies channel sensitivity. Sensitivity is based on evidence of aggradation, degradation, channel widening and planimetric form adjustment. The index produces values that indicate whether the channel is stable/in regime (score <0.20), stressed/transitional (score 0.21-0.40) or in adjustment (score >0.41).

ii. Rapid Stream Assessment Technique (RSAT – Galli 1996)

The RSAT uses an index to quantify overall stream health and includes the consideration of biological indicators (Galli 1996). Observations concerning channel stability, channel scouring/sediment deposition, physical in-stream habitat, water quality, and riparian habitat conditions are used to calculate a rating that indicates whether the channel is in poor (<13), fair (13-24), good (25-34), or excellent (35-42) condition.

ii. Downs Classification Method (Downs 1995)

The Downs (1995, outlined in Thorne *et al.* 1997) classification method infers present and future potential adjustments based on physical observations, which indicate the stage of evolution, and type

of adjustments that can be anticipated based on the channel evolution model. The resultant index classifies streams as stable, laterally migrating, enlarging, undercutting, aggrading, or recovering.

5.1.2 Results

Rapid assessment results are summarized in **Table 2** and **Table 3** below. A photographic record of site conditions at the time of the assessment is provided in **Appendix B**. Photo locations are shown on **Figure 3**.

5.1.2.1 Reach BE-3

Reach Be-3 was characterized as an intermittently defined, channelized watercourse. The reach displayed minimal gradient; due to the ditched nature of the stream corridor, degree of entrenchment was characterized as high. The riparian buffer was fragmented, measuring one to five channel widths from the top of bank. Vegetation consisted of shrubs and grasses with a few trees. Bank angles ranged between 0-30 degrees with less than 5 percent of channel banks exhibiting evidence of erosion. Excessive erosion or bank failures were not identified. Bank materials consisted of clay and silt.

Development of riffle and pool morphology was not observed; generally, channel morphology consisted of run features. Channel substrate consisted of clay and silt with organic material. Bankfull widths ranged between 3.3 - 4.0 m, widening to 5.1 m near Essa Road. Bankfull depths ranged between 0.40-0.50 m, with depths in the range of 0.70 m noted near the Essa Road crossing. Wetted widths and depths at time of assessment ranged between 3.0-3.7 m and 0.25-0.30 m, respectively. Channel disturbances consisted of three crossings: a triple (1000 mm diameter) CSP culvert at the upstream extent of the reach, a 1200 mm CSP culvert mid-reach, and a box culvert at Essa Road with gabion baskets along the banks.

Rapid assessment results indicated that Reach Be-3 was stressed ('in transition'), with a score of 0.23. Aggradation was the dominant mode of adjustment. This condition is typical of ditched channels that have been over-excavated and subsequently adjust through deposition and re-working of sediment over time towards developing an active (bankfull) channel and floodplain zone. Evidence of aggradation included embedded coarse materials in riffles, siltation in pools, and poor longitudinal sorting of bed materials. An RSAT score of 18 indicated a 'fair' degree of overall ecological health, with channel scouring/sediment deposition, physical instream habitat, water quality, and riparian habitat conditions identified as the primary limiting factors. The Downs model reflected the RGA evaluation of this reach through a classification of D – 'depositional' based on sediment deposition on the bed, sediment deposition along the banks, little evidence of bank erosion and no alluvial terrace.



Reach and Photo Location **Figure 3**

664, 674, & 692 Essa Road & 320 Mapleview Drive West,
Geomorphic Assessment

Legend

- Subject Property
- Extent
- Reach Break
- Watercourse
- Photo Locations

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Table 2. General Reach Characteristics

Reach	Bankfull Width (m)	Bankfull Depth (m)	Run Substrate	Riparian Vegetation	Notes
Be-3	3.3-5.1	0.40-0.70	Clay, silt, organics	Shrubs and grasses, few trees	<ul style="list-style-type: none"> • Emergent and submergent aquatic vegetation noted, up to 80% cover • Woody debris not present • Little to no channel scour • Depositional feature

Table 3. Rapid Assessment Results

Reach	Rapid Geomorphic Assessment			Rapid Stream Assessment Technique			Downs Classification Method
	Score	Condition	Dominant Mode of Adjustment	Score	Condition	Limiting Feature	
Be-3	0.23	In Transition	Aggradation	18	Fair	Channel scouring/sediment deposition, physical instream habitat, water quality, riparian habitat conditions	D – 'depositional'

6. Erosion Hazard Limit – Meander Belt

Procedures for determining the erosion hazard limits for river and stream systems are outlined in the Technical Guide - Rivers and Streams: Erosion Hazard Limit (MNR 2002). Within the subject property, the Holly Branch of Bear Creek transitions from a relatively unconfined condition at Hollyholme Farm Road, to a more confined condition at Essa Road. This condition is reflective of the historical practice of channelization/ditching that the tributary has experienced.

As the proposed development plan identifies relocation of the tributary, a meander belt analysis was undertaken to inform stream corridor design considerations (i.e., minimum floodplain dimension) for the relocated tributary. The meander belt width is generally defined as the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. Due to the heavily modified nature of Reach Be-3, an empirical modelling approach was employed to determine an appropriate meander belt width. This approach uses power functions based on average bankfull width (W_b) and cross-sectional area (A), following relations from Williams (1986; Equation 1) and Ward et al. (2002; Equation 2). Research by Ward et al. (2002) indicated that the Williams (1986) equation, at times, under-predicted the belt width dimensions. As such, a modified approach to the relation, which incorporates a 20% factor of safety, was applied.

$$B_w = ([18 * A^{0.65}]) \quad \text{[Eq. 1]}$$

$$B_w = ([4.3 * W_b^{1.12}]) * 1.2 \quad \text{[Eq. 2]}$$

$$B_w = ([6 * W_b^{1.12}]) - \text{feet converted to meters} \quad \text{[Eq. 3]}$$

The bankfull width referenced in the empirical modelling approach was based on average riffle dimensions for the proposed channel design concept (2.3 m width and 0.25 m depth). Results are summarized in **Table 4**.

Table 4. Bear Creek – Recommended Meander Belt (Reach Be-3)

Reach	Modelled Meander Belt (m)			Recommended Meander Belt (m)
	Williams (1986) Ave Bankfull Width	Williams (1986) Cross-sectional Area	Ward (2002) Average Bankfull Width	
Be-3	13	12	18	14

7. Conceptual Channel Realignment

The primary objective of the relocation design concept for Holly Branch is to demonstrate replication and enhancement of existing geomorphic, aquatic habitat and terrestrial habitat conditions. Specifically, NVCA (email dated August 31, 2020) identified the following design requirements for the realigned corridor:

- A natural channel design (riffle-pool sequences, meanders etc.);
- A 30 m buffer measured from on both sides of the proposed channel (from bankfull flow banks);
- The channel needs to have full access to its floodplain and ability to meander, i.e., proposed pedestrian/recreational infrastructure in the buffer would need to be back far enough that it won't impinge the ability of the creek to move. No artificial hardening (gabion baskets, etc.) to protect the pedestrian/recreational items from channel movement;
- The natural channel design should improve the habitat and state of the watercourse and surrounding riparian community;
- The location of future pedestrian and vehicular crossings should be noted, and consideration for installing bridge abutments/infrastructure at the channel relocation phase should be made to avoid secondary watercourse interference permit requirements during the build-out phase of the project;
- The location in concept of future recreational/pedestrian trails and walkways, as well as any seating and open space areas proposed to be integrated alongside the channel area (NVCA staff will recommend the channel and its 47 m buffer be zoned EP, and recreation/pedestrian areas outside the immediate channel buffer); and
- Planting plans for of an appropriate mix of herbaceous and woody native re-vegetation within the 30 m channel buffer.

The following sections provide an overview design elements and considerations for the low flow (bankfull) channel design. The overall corridor grading plan, restoration planting plan and Site Plan amenities are being developed by others.

7.1 Design Considerations

The proposed low flow channel design concept proposes restoration of the tributary by reinstating a more natural, sinuous channel planform and riffle-pool morphology. The low flow channel design concept was developed using natural channel design principles and incorporates bioengineering bank treatments to enhance channel stability and aquatic habitat diversity. In developing the proposed corridor design concept, the following additional objectives were considered:

- Upstream and downstream tie-in elevations – the relocated low flow channel will need to match tie-in invert elevations at the upstream existing outlet pipe and downstream Essa Road culvert. These tie-in elevations will need to be confirmed prior to construction;
- Floodplain storage – The proposed corridor design must provide sufficient floodplain storage volume for the uncontrolled Regional storm event;
- Hazard mitigation – The proposed floodplain dimension must accommodate the meander belt to mitigate risk of long-term erosion and adjustments in channel planform, while the proposed corridor must accommodate the regulatory floodplain;
- Aquatic habitat enhancement – The proposed low flow channel design concept must enhance the overall quality and function of aquatic habitat within the tributary; and
- Riparian and terrestrial habitat – The proposed corridor design concept must enhance the overall quality and function of terrestrial habitat.

7.2 Design Elements

7.2.1 Corridor Dimensions

The proposed corridor for Reach Be-3 will need to incorporate a floodplain dimension that is sufficient to accommodate potential long-term adjustments from channel migration. The recommended 14 m meander belt dimension will allow for the provision of a more natural, sinuous channel form as well as adjustments from channel migration. The proposed 69 m wide valley corridor incorporates a 14 m floodplain dimension based on the recommended meander belt. At a maximum slope of 2.75H:1V, geotechnical erosion hazard limits and design considerations have also been accommodated. This corridor has been designed to provide safe conveyance of the uncontrolled 100-year peak flow from the upstream drainage area, while providing floodplain storage volume matching for the uncontrolled Regional storm event (Tatham Engineering 2022).

7.2.2 Bankfull Channel

Dimensions for the riffles and pools were governed by the bankfull design discharge, which is commonly referred to as the 'channel forming discharge'. Typically, this is back-calculated from a 'reference reach', along with support from hydrological modelling. In lieu of a reference reach, the bankfull discharge was determined referencing the 2-year modelled post-development flow of 0.49 m³/s, as provided by Tatham Engineering. Proposed riffle and pool geometries, as well as calculated instream hydraulic parameters for the bankfull channel are provided in **Table 5**.

Table 5. Parameters of the Bankfull Channel – Holly Branch

Channel Parameter	Riffle	Pool
Gradient (%)	0.95	0.26
Roughness (Manning's n)	0.040	0.035
Bankfull width (m)	2.3	3.0
Average bankfull depth (m)	0.25	0.34
Maximum bankfull depth (m)	0.40	0.70
Bankfull width-to-depth ratio	8	9
Discharge to accommodate (m ³ /s)	0.49	0.49
Mean bankfull velocity (m/s)	0.97	0.48
Calc. Bankfull discharge (m ³ /s)	0.69	0.49
Froude number	0.59	0.27
Maximum shear (bed) (N/m ²)	37	10
Stream power (W/m)	56	7
Unit stream power (W/m ²)	25	2
Max. grain size entrained (m)	0.04	0.01
Max. grain material	Gravel-Very Coarse	Gravel-Medium
Mean grain size entrained (m)	0.03	0.01
Mean grain material	Gravel-Coarse	Gravel-Medium

7.2.3 Bioengineering Treatments and Habitat Features

The following bioengineering treatments and habitat features are being considered as appropriate for this system. The exact treatments and their locations and quantities will be refined at the detailed design stage.

- **Brush mattress** – the brush mattress consists of pioneering species that are anchored to the bank with stakes and usually includes some form of toe protection. This bioengineering element will create structural channel bank protection that will minimize bank erosion by reducing erosion rates. Over time sediment will be captured to allow for root growth and formation thereby providing vegetative stabilization. The establishment of the plants acts to impede flow velocities along the bank, thus protecting the bank. Terrestrial and aquatic habitat is generally enhanced due to the additional vegetation. Further growth will provide shade to the stream and food inputs into the channel;
- **Vegetated layering** – The vegetated layering consists of dormant cuttings installed in the channel bank above the low water level, in lifts separated by well-compacted soil and native material mix. The bank treatment is blended with the existing bank to provide a smooth, natural transition. A biodegradable blanket is placed on the bank to provide immediate stabilization. The vegetated layering will reduce flow velocities in the outer meander bends and limit erosion, through the establishment of the plantings. Additionally, vegetation establishment will provide local stream shading and vegetation overhang;
- **Offline wetland features** –offline wetland features will be installed on the floodplain next to the channel to provide greater variety in terrestrial habitat and a more natural floodplain form. These features will also provide a short-term water retention function as well as a sediment bank within the floodplain. The irregular form provides an increased perimeter for a given

area and thus extensive transition zones between aquatic and terrestrial habitats. Deeper wetland pools have been incorporated for additional variability; and

- Woody debris habitat features – micro-habitat features for wildlife to provide greater variety in terrestrial habitat within the floodplain. The features are located sporadically along the floodplain and will consist of mounds of locally sourced stable interconnected wood debris.

7.2.4 Riparian Zone

To improve the quality and function a draft Landscape Concept Plan has been prepared for the corridor by Strybos Barron King (2022). The proposed plan incorporates a diverse mix of native plantings and groundcover.

8. Conclusions and Recommendations

Beacon was retained by Pearl Builders to undertake a geomorphic assessment for the property located at 664, 674, & 692 Essa Road and 320 Mapleview Drive West, in the City of Barrie.

Key study findings of the geomorphic assessment are as follows:

- A review of historic aerial photographs and topographic mapping indicated that Holly Branch, a tributary of Bear Creek within the subject property, had been historically modified and channelized within a narrow corridor;
- Within the subject property, Holly Branch transitions from a relatively unconfined condition at Hollyholme Farm Road to a more confined condition at Essa Road. Due to the ditched nature of the watercourse, the watercourse exhibits limited sinuosity and a high degree of entrenchment;
- Rapid geomorphic assessment results for Reach Be-3 identified the reach as being in a transitional state (score of 0.23), with evidence of aggradation observed;
- The RSAT assessment indicated that the reach displayed a fair degree of ecological health. Channel scouring/sediment deposition, physical instream habitat, water quality, and riparian habitat conditions were noted as the limiting factors to overall stream health;
- As the proposed development identifies the realignment of Holly Branch, a meander belt width of 14 m was recommended to inform corridor floodplain dimensions; and
- The proposed low flow channel design reinstates a more natural, sinuous form to the Holly Branch of Bear Creek. Riffle-pool bed morphology provides enhanced aquatic habitat diversity relative to existing conditions.

Through subsequent detail design stages, the following next steps have been identified in relation to the proposed corridor design from a geomorphic perspective:

- Confirmation of channel tie-in elevations and locations;
- Confirmation of design criteria to be accommodated within the proposed channel;
- Confirmation of bioengineering treatments and habitat elements to be used within the channel and corridor; and
- Agency consultation to identify an appropriate post-construction monitoring plan.

We trust that the submission meets your requirements at this time. If you have any questions or concerns regarding the information as presented, please do not hesitate to contact the undersigned.

Prepared by:
Beacon Environmental



Maureen Attard, M.Sc.
River Scientist

Reviewed by:
Beacon Environmental



Shelley Gorenc, M.Sc., P.Geo.
Senior Geomorphologist

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Appendix A

Historical Photographs



Legend

 Subject Property

Historical Aerial Imagery

1973

664, 674, & 692 Essa Road & 320 Mapleview Drive West,
Geomorphic Assessment



Project: 222212
Last Revised: October, 2022

Client: Pearl Builders

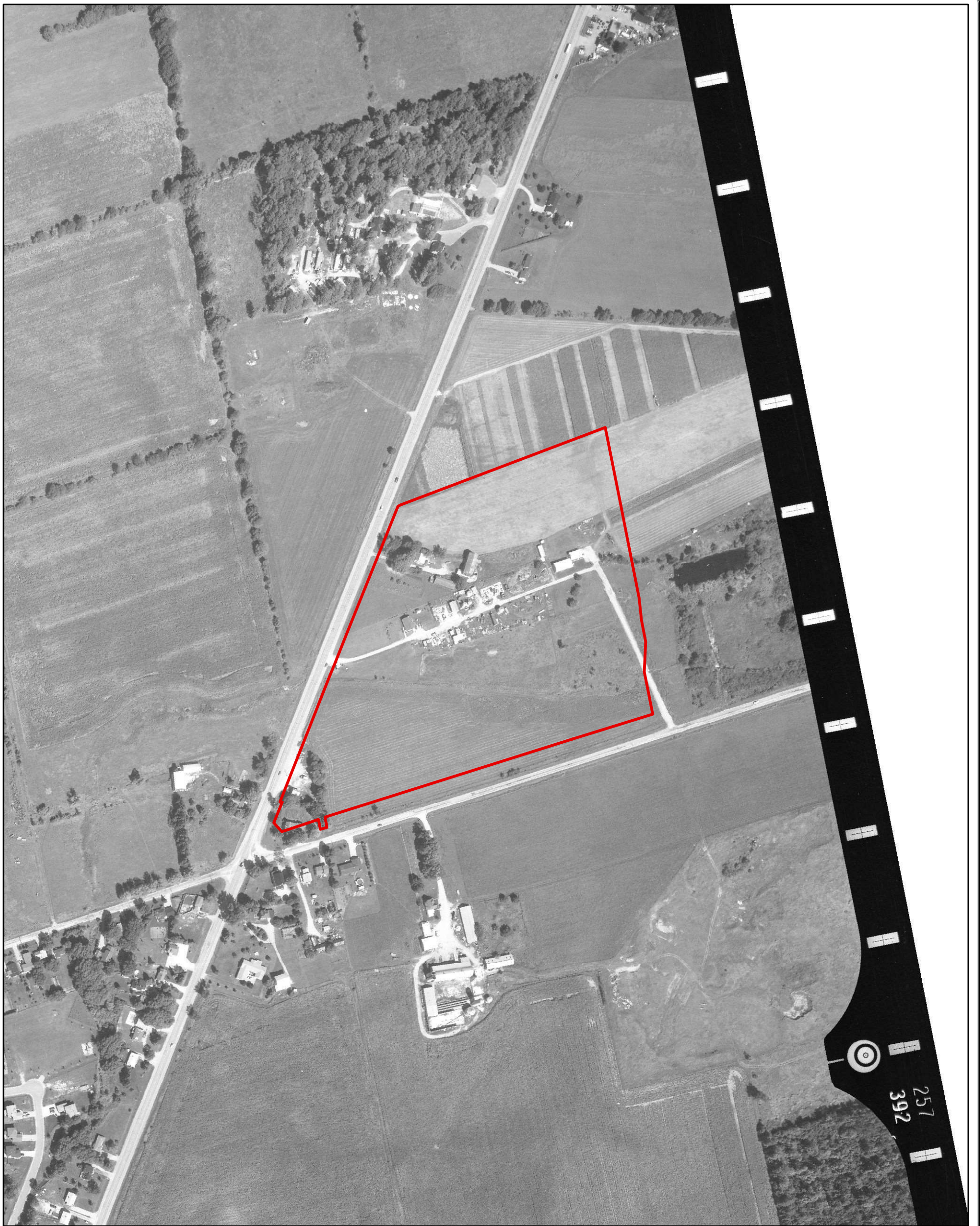
Prepared by: DU
Checked by: AS




1:4,000

0 50 100 m

Contains information licensed under the Open Government License—
Ontario Orthoimagery Basemap: Northway/Photomap/Remote Sensing Ltd.



Legend

 Subject Property

Historical Aerial Imagery

1989

664, 674, & 692 Essa Road & 320 Mapleview Drive West,
Geomorphic Assessment



Project: 222212
Last Revised: October, 2022

Client: Pearl Builders

Prepared by: DU
Checked by: AS



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Legend

 Subject Property

Historical Aerial Imagery

2019

664, 674, & 692 Essa Road & 320 Mapleview Drive West,
Geomorphic Assessment



Project 222212
Last Revised: October, 2022

Client: Pearl Builders

Prepared by: DU
Checked by: AS



1:4,000

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Ontario Orthoimagery Baselayer: FBS Barrie 2019

Appendix B

Photographic Record



Photograph 1. Location 1.
Box culvert at Essa Road, at the downstream extent of the assessed reach. Note the presence of gabion baskets (top of photo). Also note backwatering.



Photograph 2. Location 2.
Looking downstream towards Essa Road. The channel was found within a narrow corridor.



Photograph 3. Location 3.
Looking upstream towards a 1200 mm diameter CSP at an old crossing.



Photograph 4. Location 4.
View of the channel upstream of the old crossing. Note the presence of cattails and other instream vegetation.



Photograph 5. Location 5.
Looking upstream towards the upstream limit of the reach. Note the vegetation encroachment into the channel.



Photograph 6. Location 5.
General channel conditions in the reach. Note the vegetation encroachment into the channel and a narrow open water component.



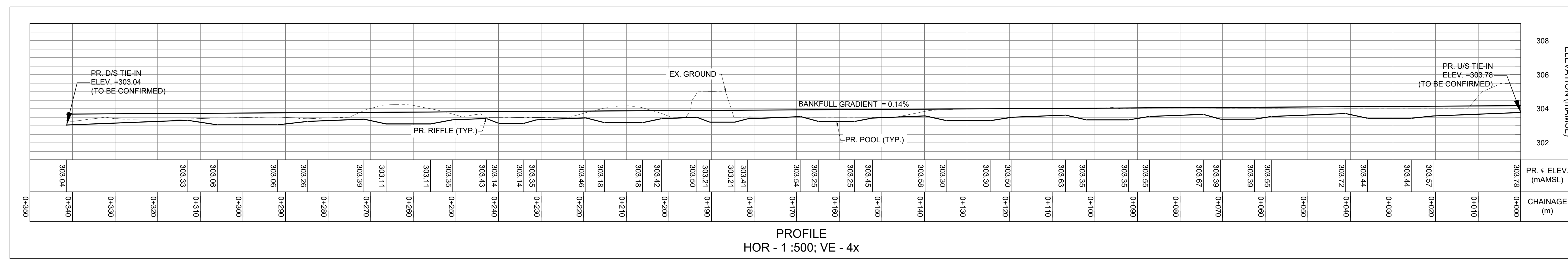
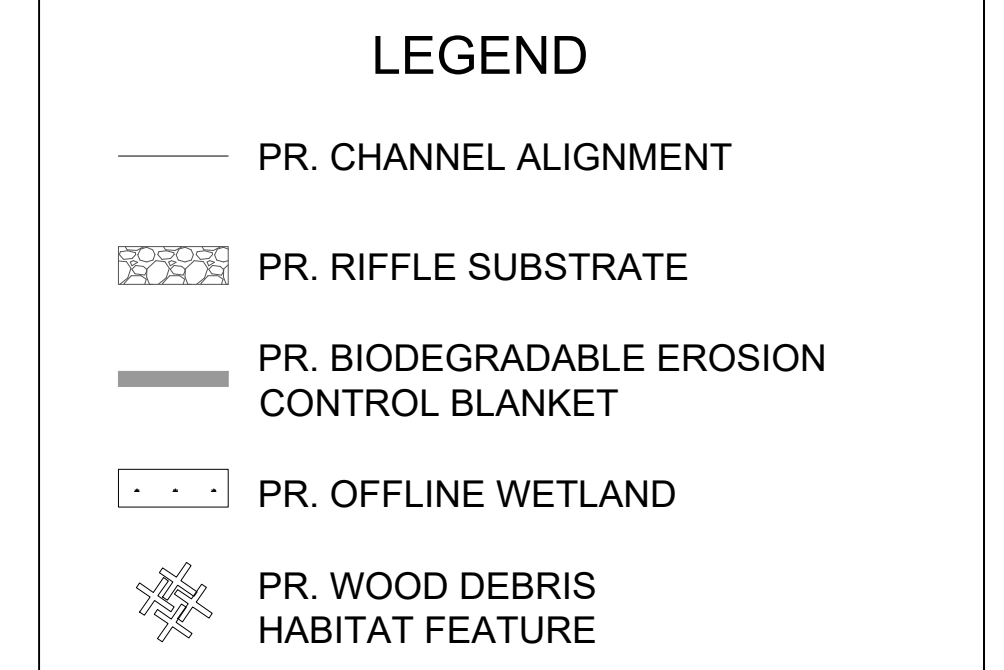
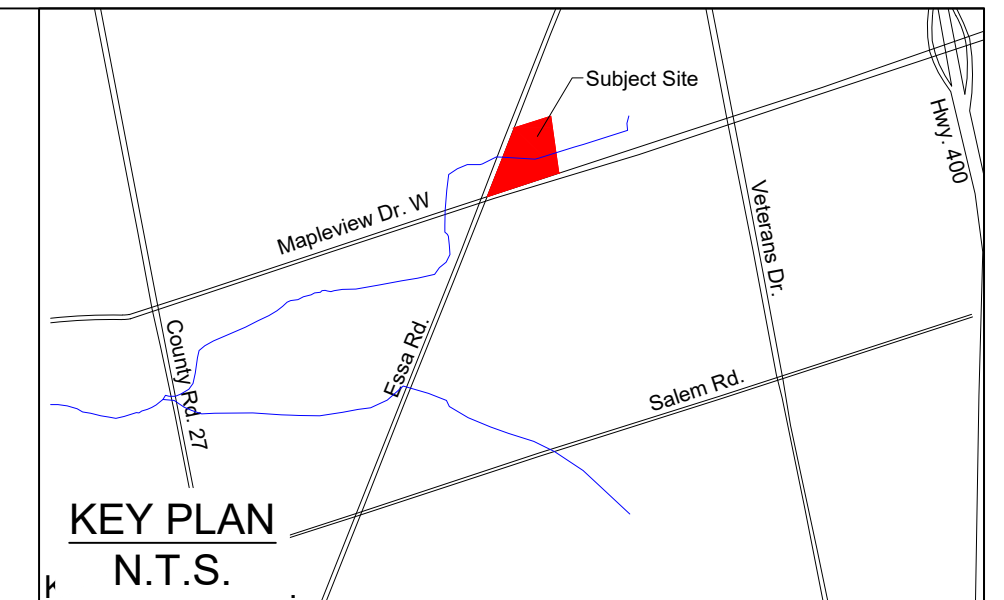
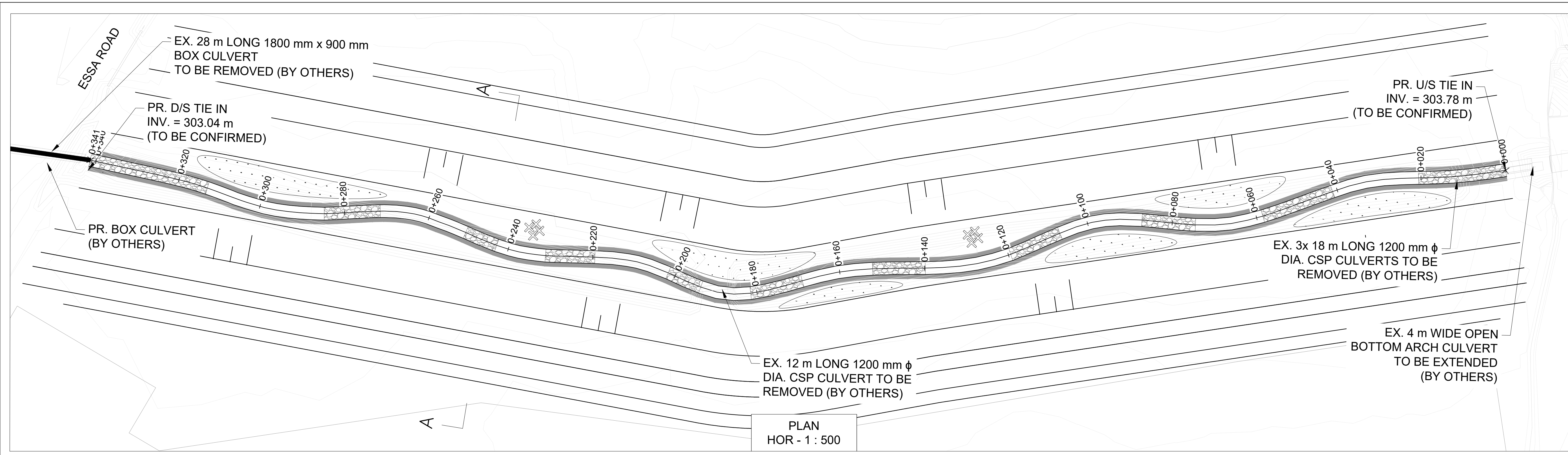
Photograph 7. Location 6.
Looking downstream towards the three 1000 mm diameter CSPs at the upstream extent of the reach.



Photograph 8. Location 6.
Looking upstream towards the crossing at Hollyholme Farm Road.

Appendix C

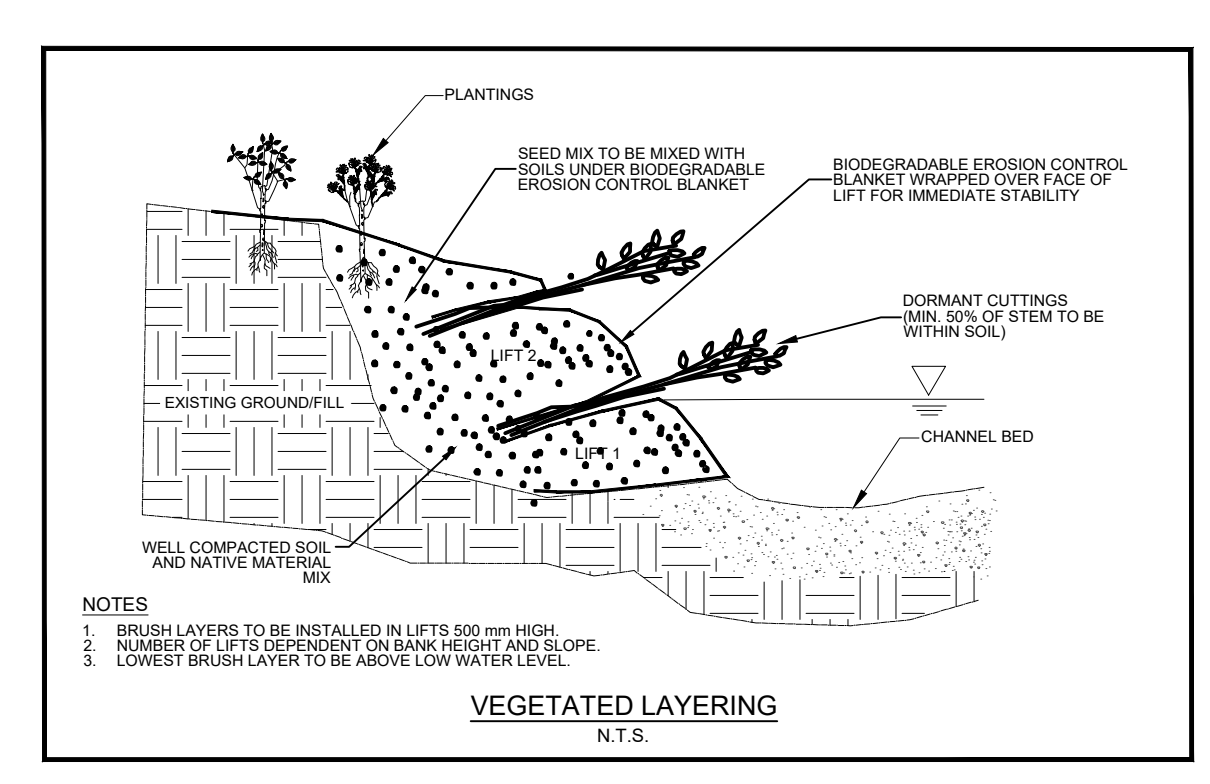
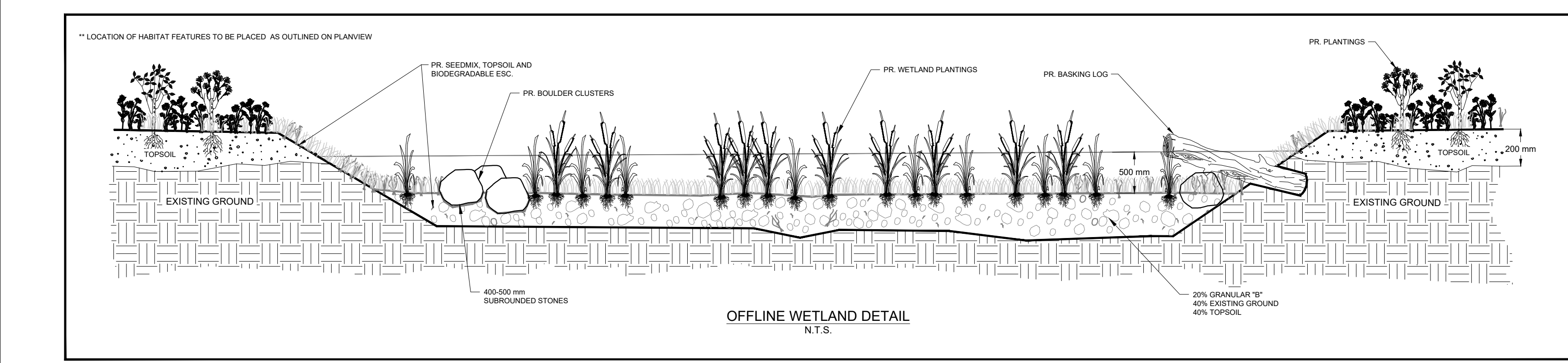
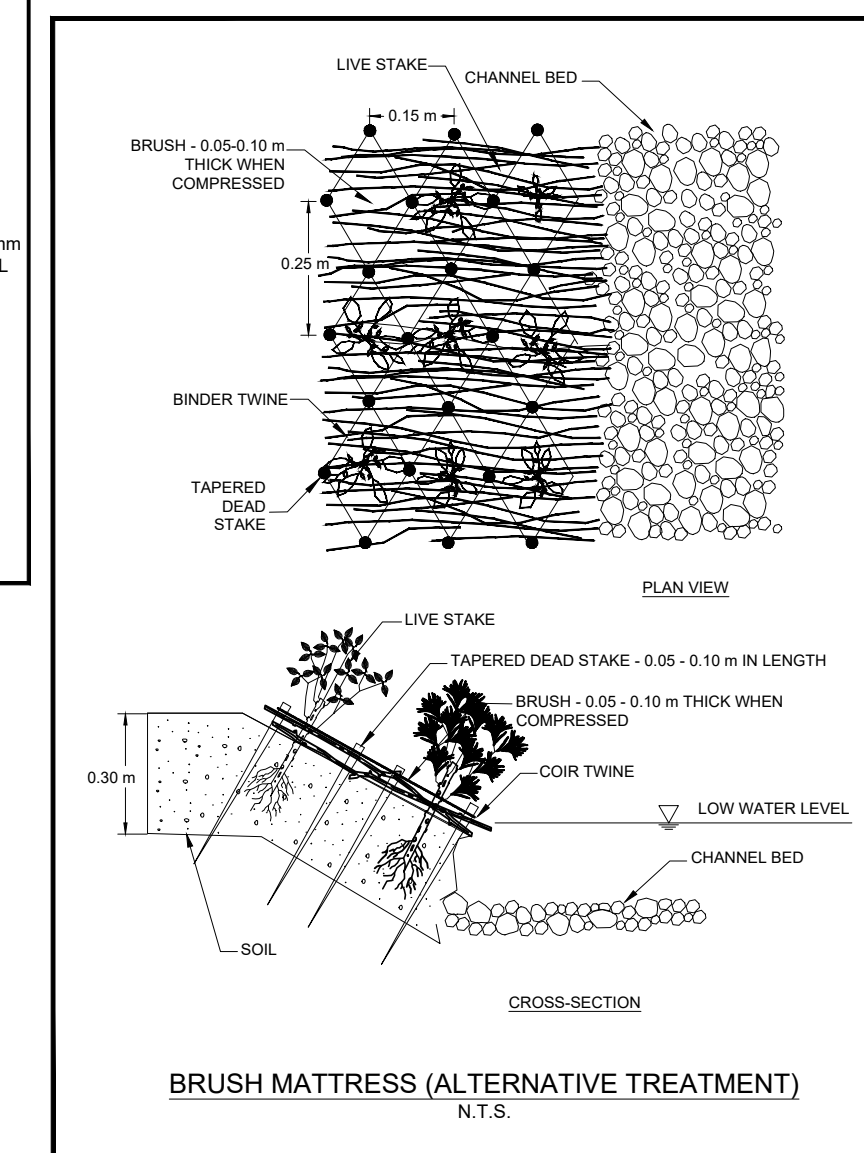
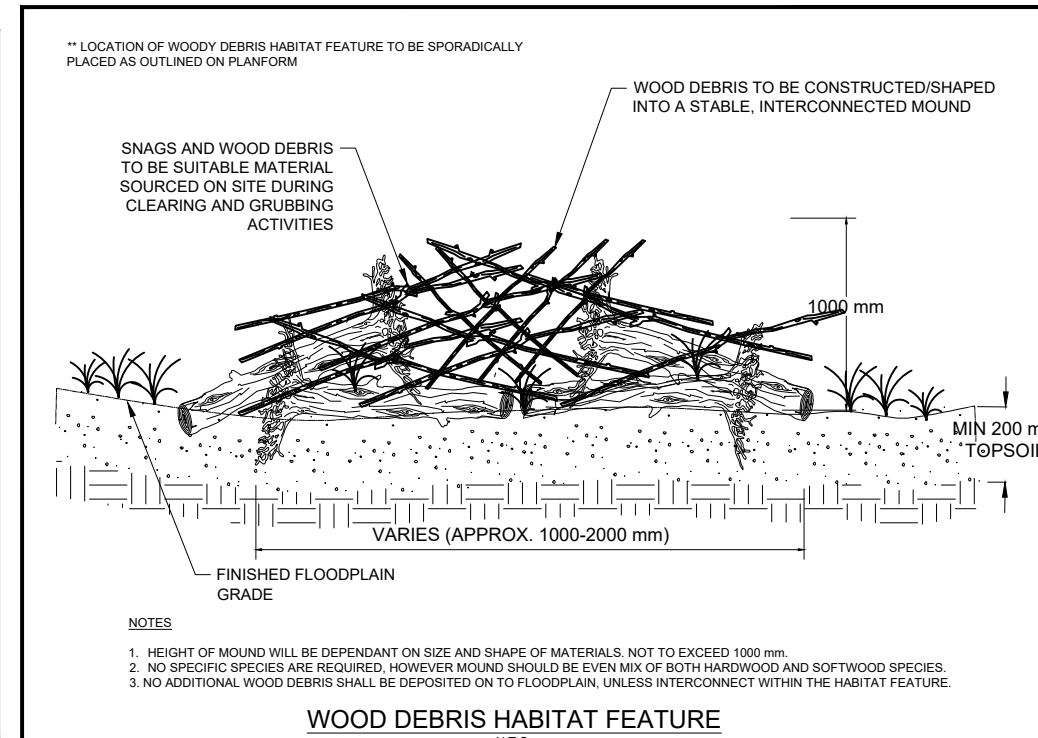
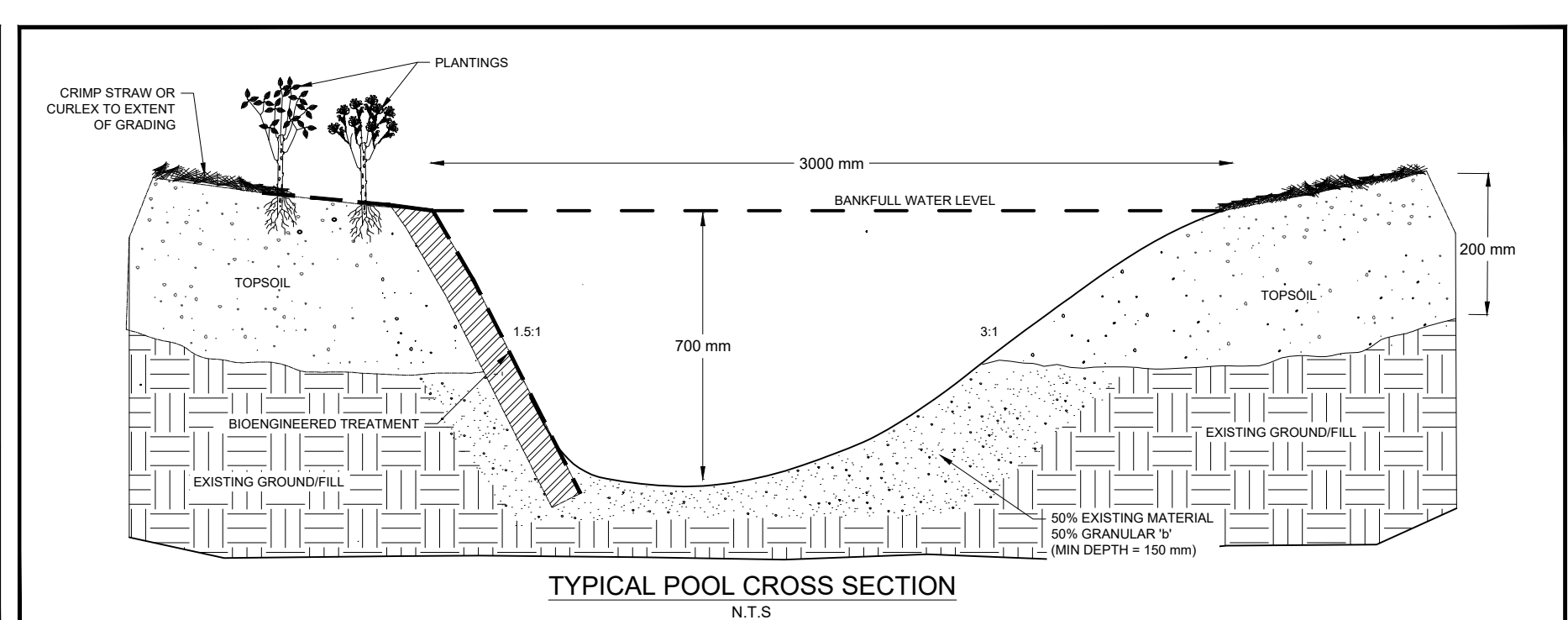
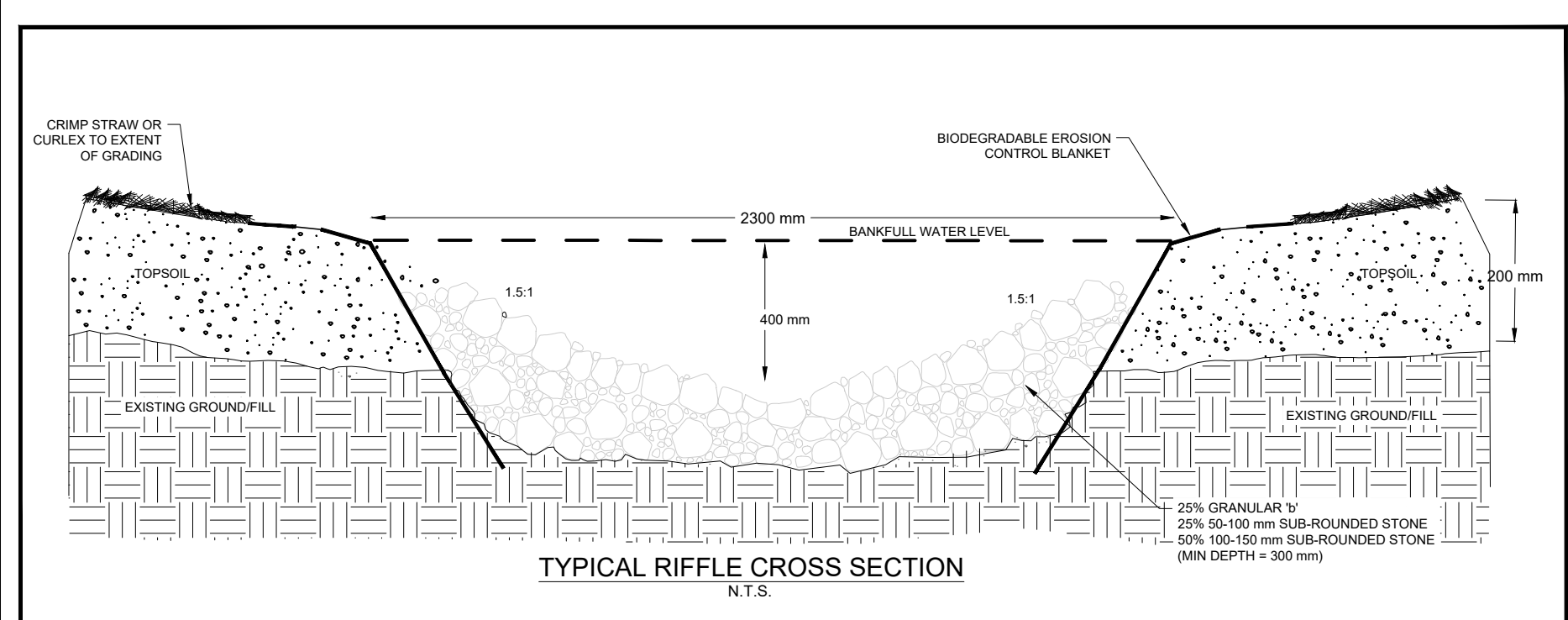
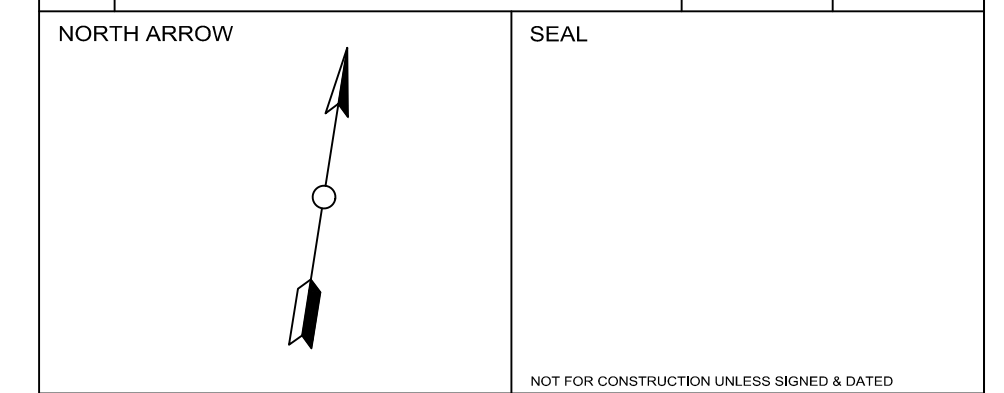
Conceptual Channel Design



CONCEPTUAL DESIGN NOT FOR CONSTRUCTION

NOTES: SCALE SHOWN IS FOR AN 36" X 24" PAGE. FOR ILLUSTRATIVE PURPOSES. DO NOT SCALE.

Nº	REVISIONS	DATE:	BY:
6			
5			
4			
3			
2			
1			



PROJECT

MAPLEVIEW ESSA DEVELOPMENT
BEAR CREEK TRIBUTARY CHANNEL REALIGNMENT CONCEPT

SHEET TITLE

PLAN, PROFILE AND DETAILS

DESIGN BY:	AS	PROJECT Nº:	222212
DRAWN BY:	AS	FIGURE Nº:	
CHECKED BY:	SG		
DATE:	11 November 2022		
SCALE:	1:500		

G-1