McArthur Island Flood Protection Redesign

Prepared by Hannah Clark

Date: November 11, 2021

Abstract

Flood events are an annual issue for the City of Kamloops and especially for McArthur Island. The cost to prepare for the high-water levels and to protect the City's infrastructure is high, as is the safety risk to employees that need to work in flooding conditions. Portions of McArthur Island are unusable during flooding events. This is a plan for a redesign of a portion of McArthur Island to protect the area from flooding. It includes a raise in elevation for the multi-use path and the road to create a barrier between the river and the parks infrastructure. A retaining wall extends approximately 80% of the length of the river side of the park between the river's edge and the multi-use path. Accessible slopes were included to connect the new path level to the existing ground near the sports fields. Stairs were needed in one section. To contribute to regional flood protection, space was allocated to absorb and store extra flood water. The slough around McArthur Island was dredged to decrease the elevation by one metre. This disturbed aquatic wildlife habitats and so different levels in the grading were included as well as aquatic vegetation, rocks, and woody debris were reintroduced to rebuild the wildlife habitat.

Contents

Lists of Tables and Figures

1. INTRODUCTION

McArthur Island is a popular park in the City of Kamloops which houses many sports fields and buildings, as well as essential green spaces that get damaged annually from flooding [1]. Each year the City Services uses extensive resources to prepare for these floods as water levels rise around McArthur Island and other city parks. Protections for stormwater infrastructure are employed with large sandbags placed over drains and temporary berms created to protect locations vulnerable to flooding in high water levels. Even with such measures in place, portions of McArthur Island remain unusable in times of high water and damaged roads and fields must be repaired before being used again [2]. Additionally, the safety of City employees are put at risk when they need to work in problem areas during times of high water. The goal of this project design is to protect the McArthur Island from flood damage [3]. The goal is to use both natural measures and traditional methods to prevent flooding. Within the McArthur Island redesign, flood protection measures are also taken to protect surrounding communities from potential increased high water caused by applications used to preserve the park itself. The design is presented in Civil 3D drawings in plan view, along with several cross sections of the changes to the existing path and road. Each proposed change is outlined and assessed in this report, with a subsequent decision on whether to proceed with the project.

2. Background/Context

Seven decades ago, the recreational oasis that is McArthur Island, was a 126 acre barren sand dune. Local kids would build rafts to float across the slough or they'd just swim across to play on McArthur Island. Even back then, the island would get swampy during times of spring runoff. In 1957, the Village of North Kamloops purchased the island and plans were approved to build a provincial centennial sport field. The goal was to make McArthur Island a "future recreational playground." [1]

2.1. Flood Risks and McArthur Island

McArthur Island in its entirety falls within the 20-year flood plain. This means that every year, there is a one in twenty chance there will be a flood event. Each year the City of Kamloops prepares for flooding, with the goal of preventing any damage to structures and infrastructure. Sandbags are provided for individuals to use in protecting their homes, and catch basins are sandbagged to prevent water from overflowing onto roadways. Street or path lighting that is at risk will be shut off. Widespread flooding has significant impacts on infrastructure. The risk is that there will be significant structure and ground damage in the flooding event. During peak flood season, there is a danger to people near waterways whether they are workers or not. Erosion beneath the water's surface can make banks slippery and unstable. After the flood event, the maintenance and cleanup costs start. [2]

Flooding is the most prevalent natural hazard faced by cities worldwide [3]. Flood risk is the probability of being exposed to flooding in a way that has negative consequences. A direct risk to assets exists in the event of river floods caused by floodwater or rising groundwater, erosion or structural damage by flowing water or moving ice [4]. The costs can add up quickly if the surging waters cause a surcharge in the storm and sanitary sewers, which can cause backups in buildings or sediment and debris to deposit in piping, vaults and ducts. The underlying soil can become destabilized affecting underground pressure mains such as natural gas lines, water mains or sewage force mains, which are costly to repair.

Possibly the most expensive to reconstruct would be the structures damaged and surface accessories destroyed by flowing water. Even emergency works in flood protection such as temporary dikes can damage surface features (pole lines, landscaping, trees, fences) and the heavy equipment used could damage shallow buried ducts and piping. Temporary dikes can also limit access to business, residences and utilities leading to consequential impacts, temporary loss of residences and businesses, wage losses to employees, for example. [4]

With riverine flooding, the dynamics vary with the terrain. In flat areas, such as around McArthur Island, the land becomes covered with shallow, slow-moving floodwater for days or weeks. Flooding can be caused by annual spring snowmelt, also called high freshet flows [4], or significant weather systems with prolonged rainfall or a combination of the two [5]. In urban areas, flood problems are related to the allocation of water to open spaces. There is frequently a lack of open spaces and degraded river environments, both of which contribute to increased flood risk [3].

2.2. Flood Mitigation Techniques and Practices

2.2.1. Traditional Flood Management

Traditional flood management techniques are often ranked as a low priority in development and focus mainly on structural measures of protection [6]. These structural measures (dikes, bypass channels, reservoirs, etc.) have limited value as they only project up to a certain water level and bring heavy financial and environmental costs. Finally, traditional flood management is often planned on a local scale (within a site or municipality) and so simply shifts the flood risks to other areas.

2.2.2. Natural Flood Management

Natural flood mitigation methods, in contrast, aim to reduce the frequency of critical water levels. Natural flood management is advocated as a sustainable alternative to traditional flood management [7]. Methods include providing green open spaces, creating or modifying sloughs or channels, and incorporating riverside vegetation, all while thinking not only of the area in question but other areas that may be affected by any change in water levels downstream.

Channels and sloughs provide water storage during seasons of high water. As a method for increased flood mitigation, deepening a slough can allow more capacity for water storage as well as contribute to improved habitats for wildlife [8]. The procedure for deepening a slough or channel is either by bar scalping, which is done while the slough is dry, or dredging, which is done with wet conditions but adds risk of immediate impacts on water quality and fish habitat [4]. There is the potential of environmental disturbance during the bar scalping or dredging that could damage fish habitat or increase erosion and scour. These adverse effects can be offset by incorporating habitat enhancement features in the form of woody debris and planted native vegetation within the riparian zone [8].

There is precedence for rehabilitating a slough right here in British Columbia. In Creston, The Six Mile Slough Wetland Restoration Project was initiated. The goal was to improve and increase the habitat for local wildlife and undo some of the modifications that had occurred to control high water over the last hundred years. Part of the process was to deepen the channel by dredging it to allow for more habitat for fish species and a greater capacity for water storage in times of high water [9]. In Squamish, the Britannia Slough receives storm water surface drainage from an industrial park. Additional culverts have been connected to the Britannia Slough, allowing more fresh water, but causing problems at high tides and high flows when the slough overflows across the highway. The project included deepening the slough by one metre and grading the slopes back at a 2:1 slope. Special consideration was made for the wildlife and so large woody debris, and boulder clusters were placed within the slough as well as aquatic species planted along the slough benches. Native trees and shrubs were planted along the slopes and top of bank. Squamish was able to achieve their goal of assisting in alleviating flood hazard issues in the area all while taking care of local wildlife [8].

2.3. Consequences of Poor Flood Management

The goal of reducing flood hazards through flood control infrastructure can lead to environmental injustice. The measures taken do not eliminate the occurrence of floodwater but only redistribute that floodwater, thereby imposing new flood risks on people elsewhere. In Saskatchewan and Manitoba farmers have been, over the last few years, increasing the drainage on their wetlands to create more land that can produce crops. The result of this drainage is that massive volumes of water get moved to ditches, streams and rivers creating even higher volumes in these areas during spring runoff causing catastrophic soil erosion on the stream and river banks [10].

In Prince George, a large, collaborative effort was made to reduce the flood risk for several sites in the region. This required looking at the land as a whole and deciding which spaces could be allocated for water accumulation and which would need barriers and other methods to protect the existing assets. The goal was to absorb the flood water within the region so that no extra freshet was pushed downstream all while protecting the local sites that were repeatedly being damaged at times of high water [4]. This kind of result can be achieved right from the city planning phase for development. Lowlands and valley bottoms should be left alone to balance out the urban and environmental needs. Storage opportunities should be considered in the open space system and flood plains should be preserved. Thinking about flood control in such a way will ensure the region will manage its floods while avoiding transferring the flood problem to others. This will make our city more resilient and sustainable [3].

3. Methodology

3.1. Assess the Damage

The first step to evaluate the flooding on McArthur Island was done through research of the history of flooding in that region. The majority of the flood damage occurs along the south side of McArthur Island, which is also along the riverbank. There is damage being done to the trees along the riverbank as their roots become more exposed with the erosion. Parking areas and roadways are deteriorating faster than necessary because of their annual exposure to floodwater. Flooding at McArthur Island affects the community by reducing access to the park. Usually the flooding happens in June, during which many people use the walkways and sports fields.

3.2. Identify Flood Protection Needs

By examining each issue in the previous section, ideas for protecting these areas of the park have been generated and researched. The parking areas and roadways that are being flooded, need protection from a berm and so the road and path will be filled to increase their elevation to above the floodplain level and will act as that berm. In order not to pass the flooding problem downstream, more water storage is needed to accommodate the water that will be blocked from spilling onto the land on McArthur Island. Deepening the slough by approximately one meter will supply the needed storage.

3.3. Generate a Design Concept

The design concept was completed in AutoDesk Civil 3D. Lidar, cadastrals and planimetrics were downloaded from the City of Kamloops website and compiled into a base drawing of existing conditions at McArthur Island. Design drawings were then developed implementing solutions for the identified issues.

3.3.1. Identify and Solve Issues that Come from Changes.

- When the elevation was raised for the south side of the road and path to 347.5m, the slope from the parking areas to the sports fields became too steep to be easily accessible. Stairs and ramps became necessary to maintain accessibility. The slope on the river side also increased, which created the need for concrete retaining walls to be installed in some sections and a safety railing to be installed in most sections.

4. Roadway & Multi-Use Path

4.1.1. Problem

The elevation of the roadway and multi-use path is below the 20-year floodplain of 345.8m above sea level. Most of the road is at approximately 345m above sea level but it has portions that sink even lower allowing flooding that spills past the road, down embankments and into the soccer fields.

The stability of the riverbank also needs to be addressed; but this needs to be analyzed by an engineer and so is beyond the scope of this study.

4.1.2. Solution

In the design, the roadway and multi-use path have undergone an elevation increase of approximately a metre, bringing them to 346m above sea level. This puts the elevation along the river's edge above the 20-year flood plain. When the road was raised, considerations were made as to how the shoulder of that road would integrate down to existing ground. The options are to slope away from the road until existing ground is met, or to put in a retaining wall. Due to the close proximity of the river's edge on the river side of the path, putting in a retaining wall is the best option, as illustrated in Figure 1.

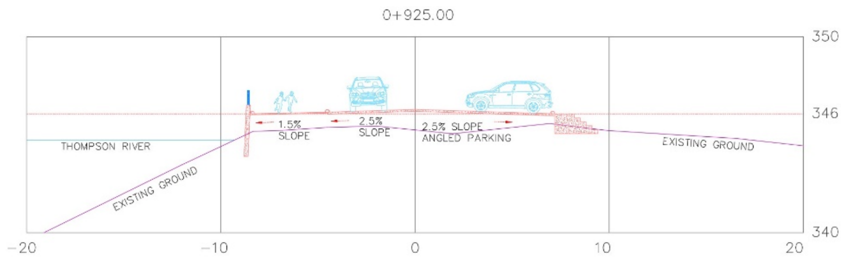

Figure 1: Cross Section of Path, Road, and Angled Parking

Source: Author generated

Initially, the plan was to put in a natural option for retaining wall, such as an MSE wall, but in a personal interview with Urban Systems' Engineer-in-Training – Water Resources, Cole Becker, it was determined that the river is too turbulent for that to be a long-term solution. A concrete retaining wall will have the strength and durability needed in times of high water.

On the park side of the road and path, the goal was to slope the new elevation down to the existing ground. In a couple of sections this wasn't possible, such as at station 0+925 shown as Figure 1. The 10% slope needed would have been too steep for pedestrians to be able to walk down to the soccer fields so a few stairs are needed to get to existing ground. The standard is a maximum 5% slope for a person's ability to walk down it and a lower slope is even better. For other areas of the road, a lower slope was possible and implemented for a comfortable walk to the sports fields, as shown in Figure 2 with a 3% slope and Figure 3 with a 2.5% slope.

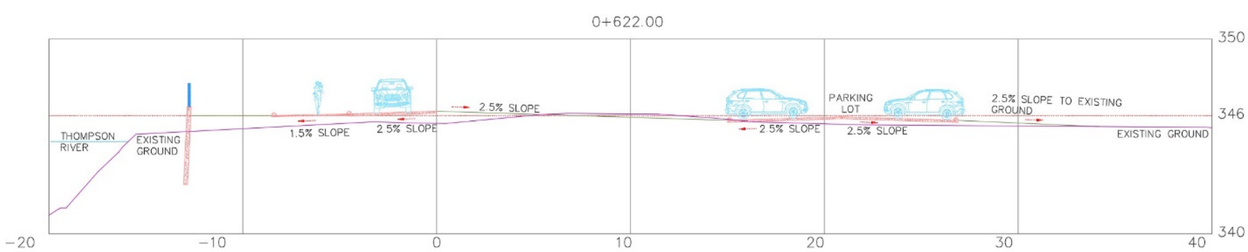

Figure 2: Cross Section of Path, Road, and Parking Lot

Source: Author generated

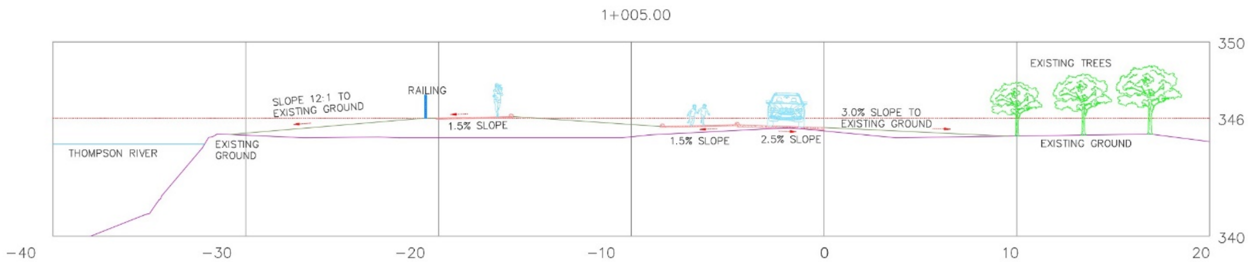

Figure 3: Cross Section of Nature Path, Path, and Road

Source: Author generated

The nature path on the West side of the park does not have the same requirement of a walkable slope on the sides due to the lack of infrastructure beyond the path itself and so a 10% slope to existing ground is what is planned for both sides of the path, as seen in Figure 4, except for when a retaining wall is needed due to the proximity of the river's edge as in Figure 5.

Figure 4: Cross Section of Nature Path

Source: Author generated

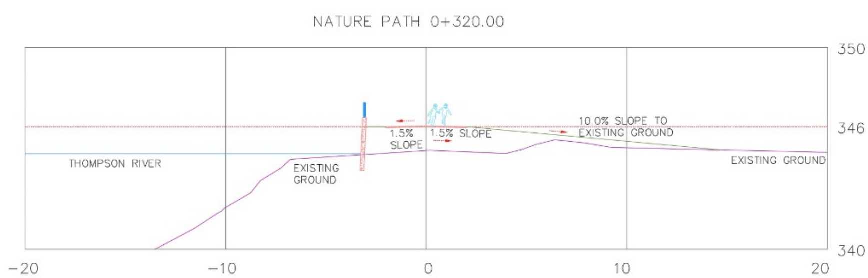

Figure 5: Cross Section of Nature Path

Source: Author generated

The elevation was not raised for the roadway or path anywhere along the slough. The elevation in this portion of the park needs to match the elevation of the residential area on the other side of the slough, otherwise the flooding would just occur on that side. The one exception is the section that contains the outdoor exercise equipment. Urban Systems and The City of Kamloops already have a project underway to raise the elevation of the path in that section (shown in Figure 6).

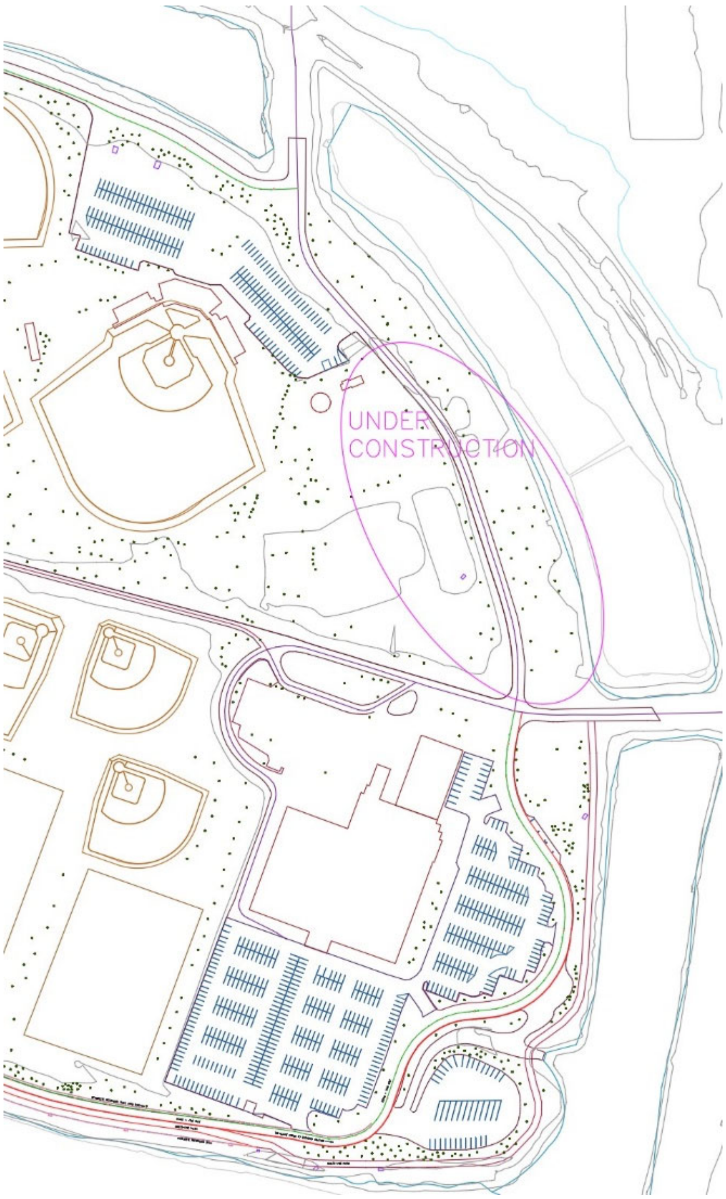

Figure 6: Portion of McArthur Island Under Construction

Source: Author generated

As part of the process to raise elevation, existing trees need to be protected from these grade changes. Trees need special consideration to maintain life and health through grade changes. When the grade is elevated, a deep fill technique is employed to ensure the protection of the tree's bark and an aeration system is put in place to keep the roots healthy [11]. These methods are detailed in Figure 7, Figure 8 and Figure 9. When the grade is decreased, the method to maintain tree health involves leaving the original ground from the trunk to the tree's dripline and building steps or a small retaining wall down to the new grade. This case does not occur in this project.

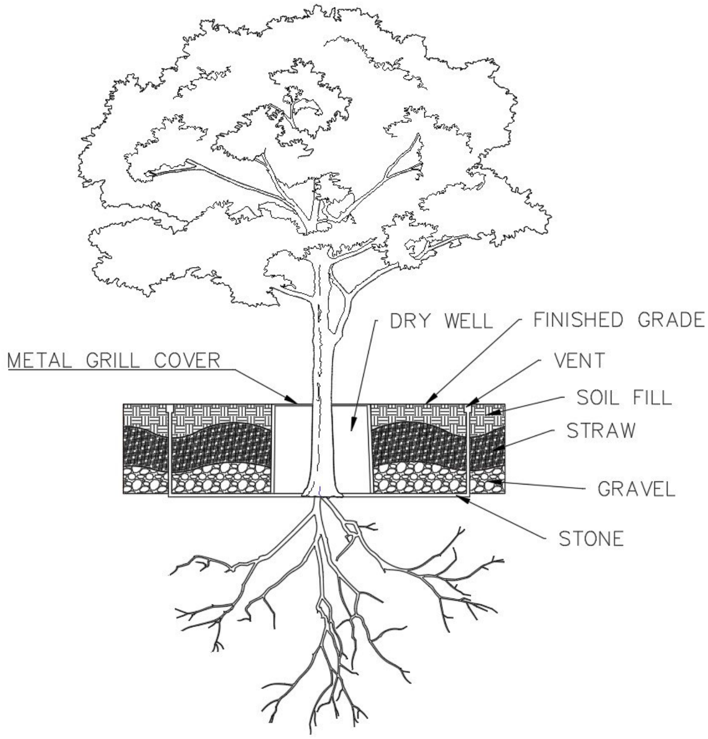

Figure 7: Procedure for Grad Increase of 0.6m or More

Source: Author generated from information found: https://aggie-horticulture.tamu.edu/earthkind/landscape/protecting-trees/

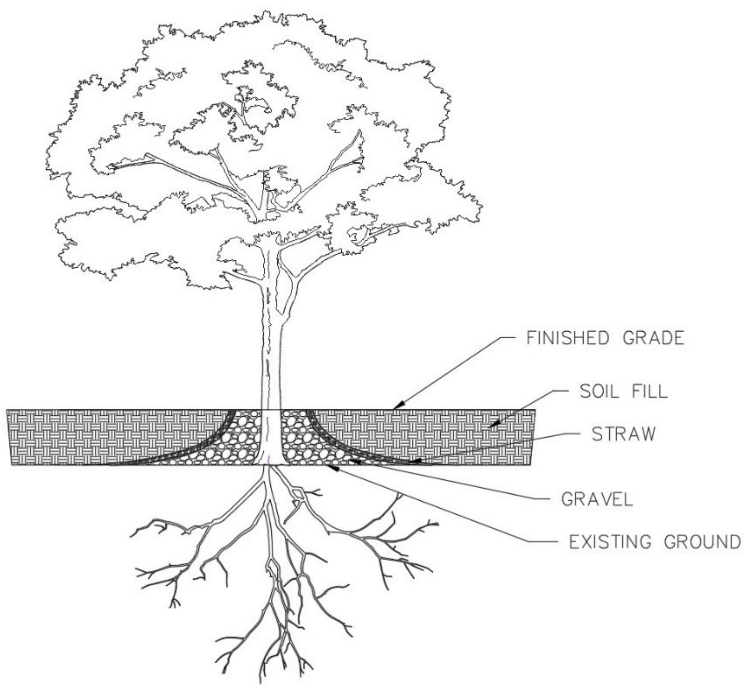

Figure 8: Procedure for Grade Increase of 0.6m or Less

Source: Author generated from information found: https://aggie-horticulture.tamu.edu/earthkind/landscape/protecting-trees/

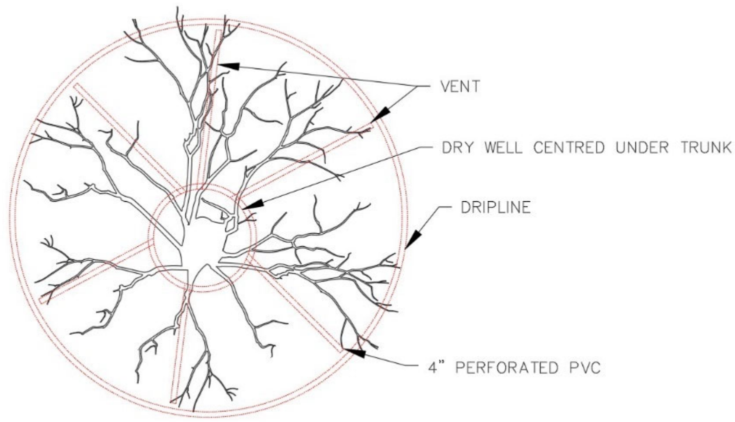

Figure 9: Well and Drainage Detail - Plan View

Source: Author generated from information found: https://aggie-horticulture.tamu.edu/earthkind/landscape/protecting-trees/

5. Slough Expansion and Revitalization

5.1.1. Problem

If every property built a barrier to protect their property from high flood water, the high water would flood those properties that didn't or were unable to create a flood protection barrier. The flooding that would occur on those properties would be significantly greater than what was experienced before. Looking at this problem as a regional issue, properties could be protected and other land in the region could be designated as wetlands for high water absorption. This is a natural method that would protect the region as a whole from high water damage.

5.1.2. Solution

As the contribution to regional flood protection after placing a barrier along the riverbank, McArthur Island's slough has been allocated to absorb and store more flood water. The safest time to bar scalp the area is during the season that the slough is dry as most of the living aquatic wildlife has moved to other areas. The slough is to increase in depth by 1.0m. Such a drastic change will create extensive upheaval to wildlife habitats and these need to be rebuilt. Woody debris, rocks, and plants native to the area will be planted to recreate and improve the existing habitats. Also, different levels will be created within the slough to create habitats for the aquatic wildlife that require shallower water for optimum health, see Figure 10.

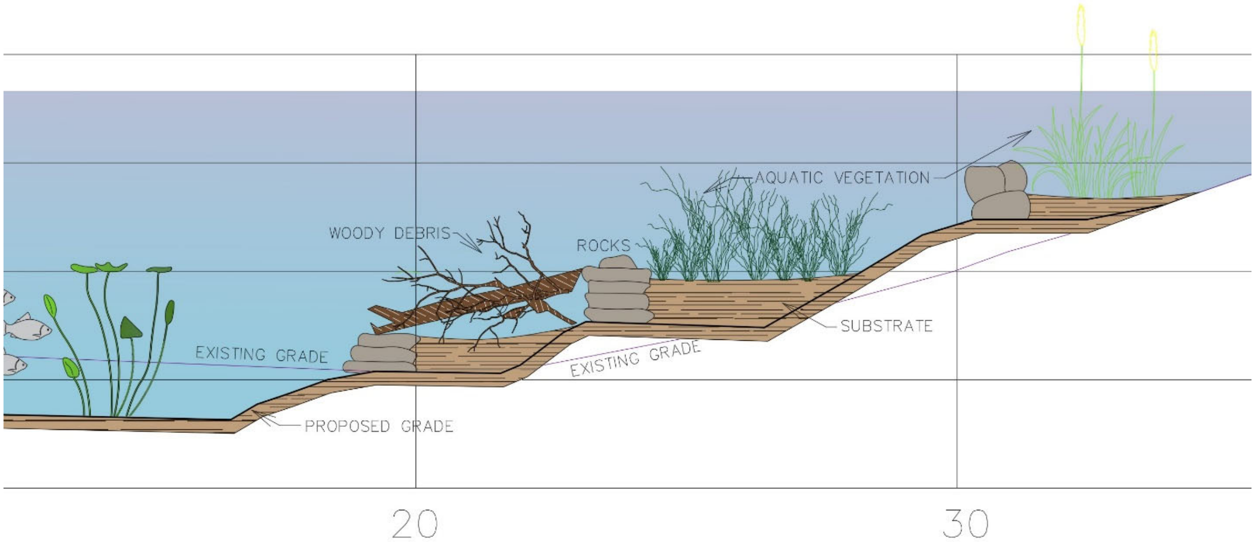

Figure 10: Aquatic Wildlife Habitat Rebuild Detail

Source: Author generated

This portion of McArthur Island's project will be the hardest to get approval from government agencies for. Dredging or bar scalping is quite difficult to get approval from Ministry of Forests, Lands, Natural Resource Operations & Rural Development Contracts (FLNRORD) and Department of Fisheries and Oceans Canada (DFO). However, there have been similar projects in BC that have been approved and completed. An environmental engineer should be consulted to make sure all the requirements are met in the design for the best chance for approval.

6. Conclusion

The plan presented will prevent most of the flooding that occurs on McArthur Island from ever happening, saving the City of Kamloops resources usually spent on annual flood mitigation and repairs, eliminating safety concerns for City employees doing work in high water conditions, and keeping the park in use year-round. Traditional flood protection measures are stronger and more durable and so are used to protect the roadway and path from high water overflow. The natural flood protection method of water storage allocation was used along the slough. Excess high water diverted from the site by the retaining wall and raised elevation of the road will run into the slough to prevent pushing larger volumes of water downstream to damage other properties. Approaching flood management from a regional perspective is an essential yet unmandated part of local flood mitigation.

7. Recommendations

7.1.1. Implement Mandatory Wetland Allocation

It is recommended that government agencies such as the Ministry of Forests, Lands, Natural Resource Operations & Rural Development Contracts and Department of Fisheries and Oceans Canada look into putting together a mandate for when large portions of river side land undergo a significant elevation change or has a long barrier along it to prevent flooding, that other land within the region be set aside for water storage in the form of wet lands.

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8. Appendix A

The drawings A1 - A12 represent the proposed changes outlined in this report.

MCARTHUR ISLAND FLOOD PROTECTION REDESIGN

KAMLOOPS, BC

NOVEMBER 11, 2021

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No.	Revision	Date	By

PROJECT NAME
MCARTHUR ISLAND FLOOD PROTECTION

DRAWING TITLE
COVER

SCALE
1:5000

DRAWN BY	CHECKED
H. CLARK	M. MARSHALL
DATE	JOB NO.
11 NOV 2021	2021-001

DRAWING NO.

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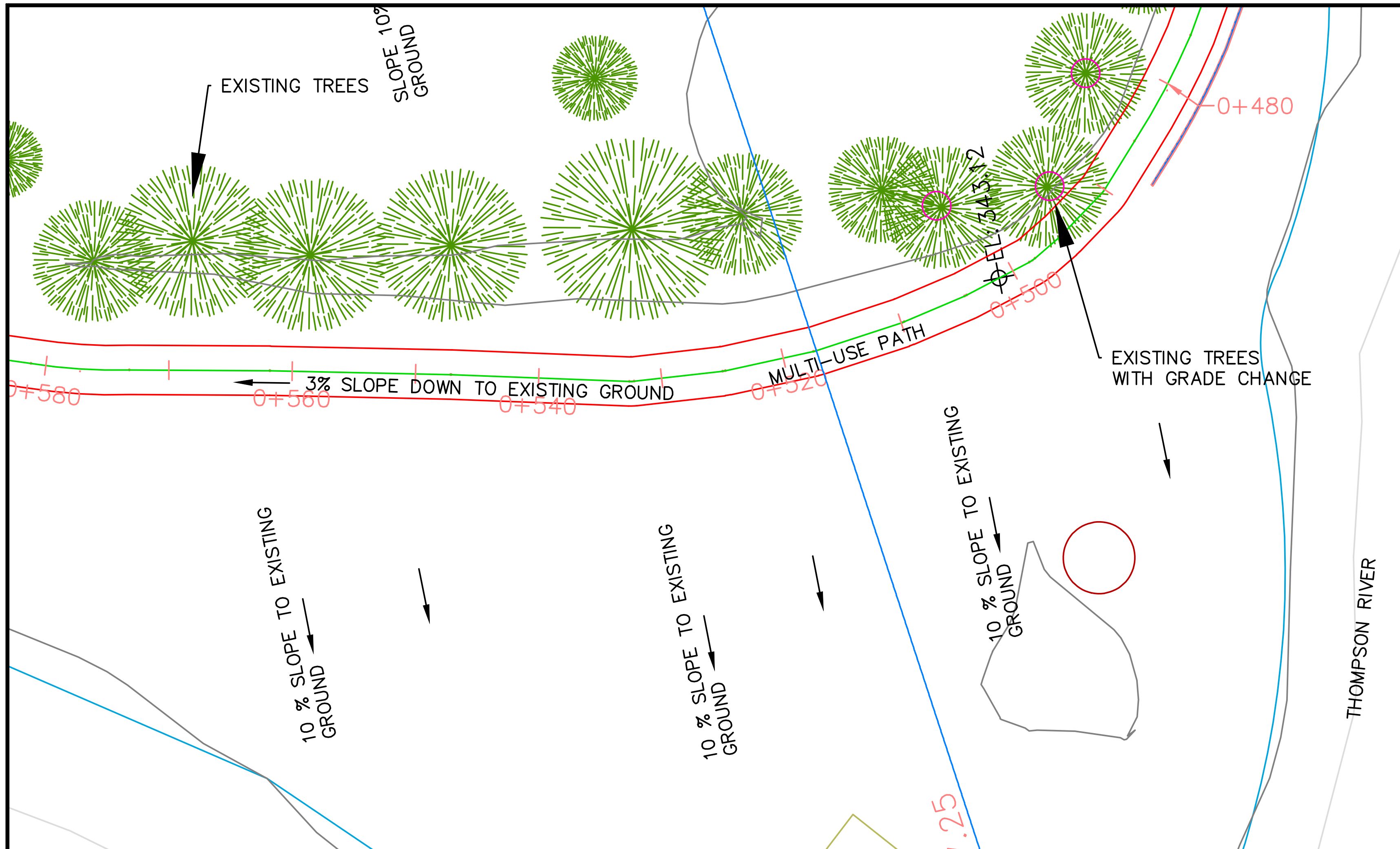

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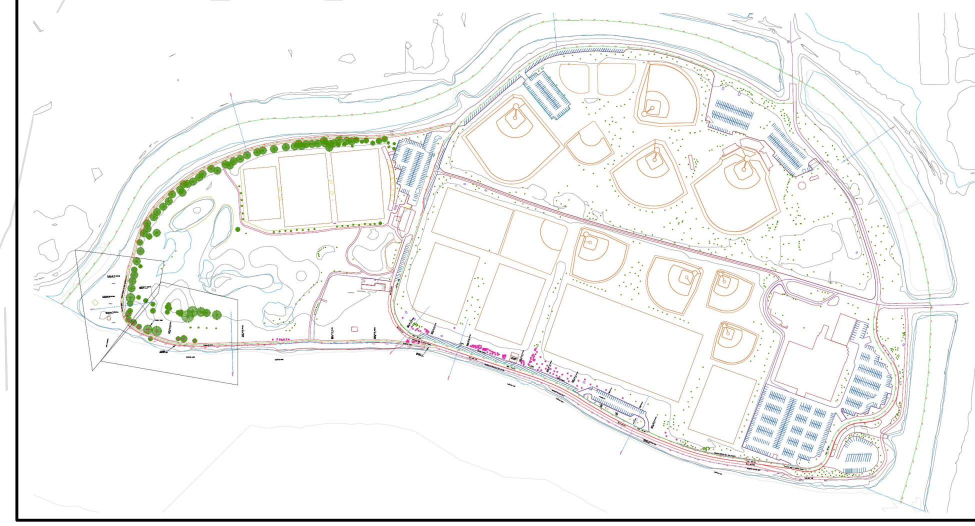
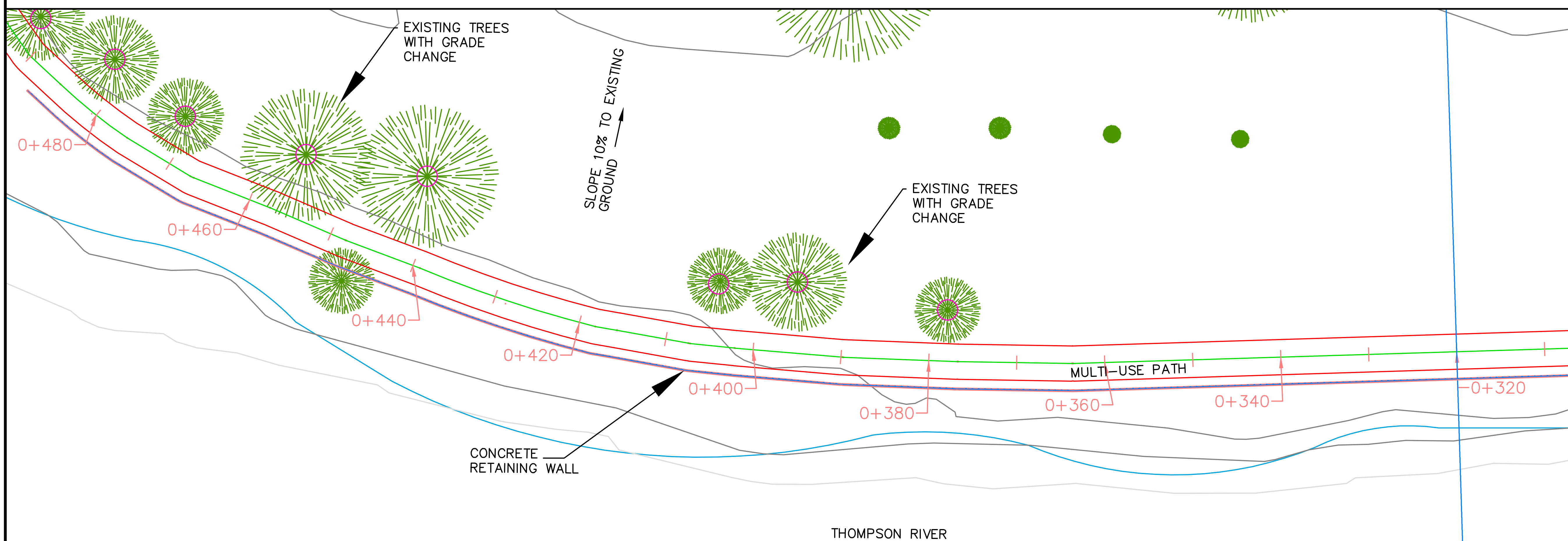


LEGEND

- CONCRETE RETAINING WALL WITH RAILING
- EDGE OF PAVEMENT
- RAILING
- EXISTING TREE TO BE PROTECTED FROM GRADE INCREASE
- EXISTING TREE TO BE PROTECTED FROM GRADE DECREASE



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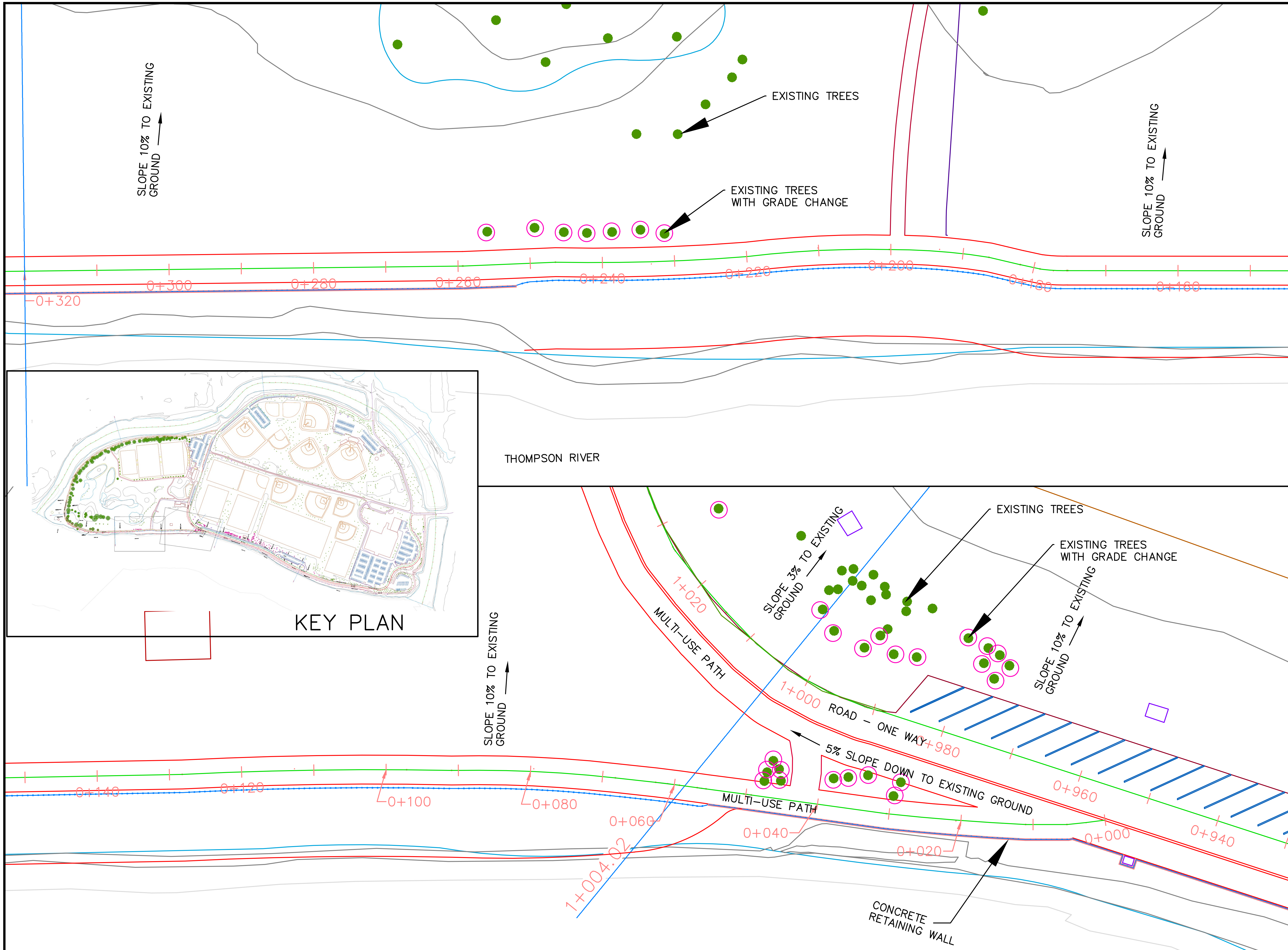

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NATURE PATH STATIONS 0+000 - 0+150

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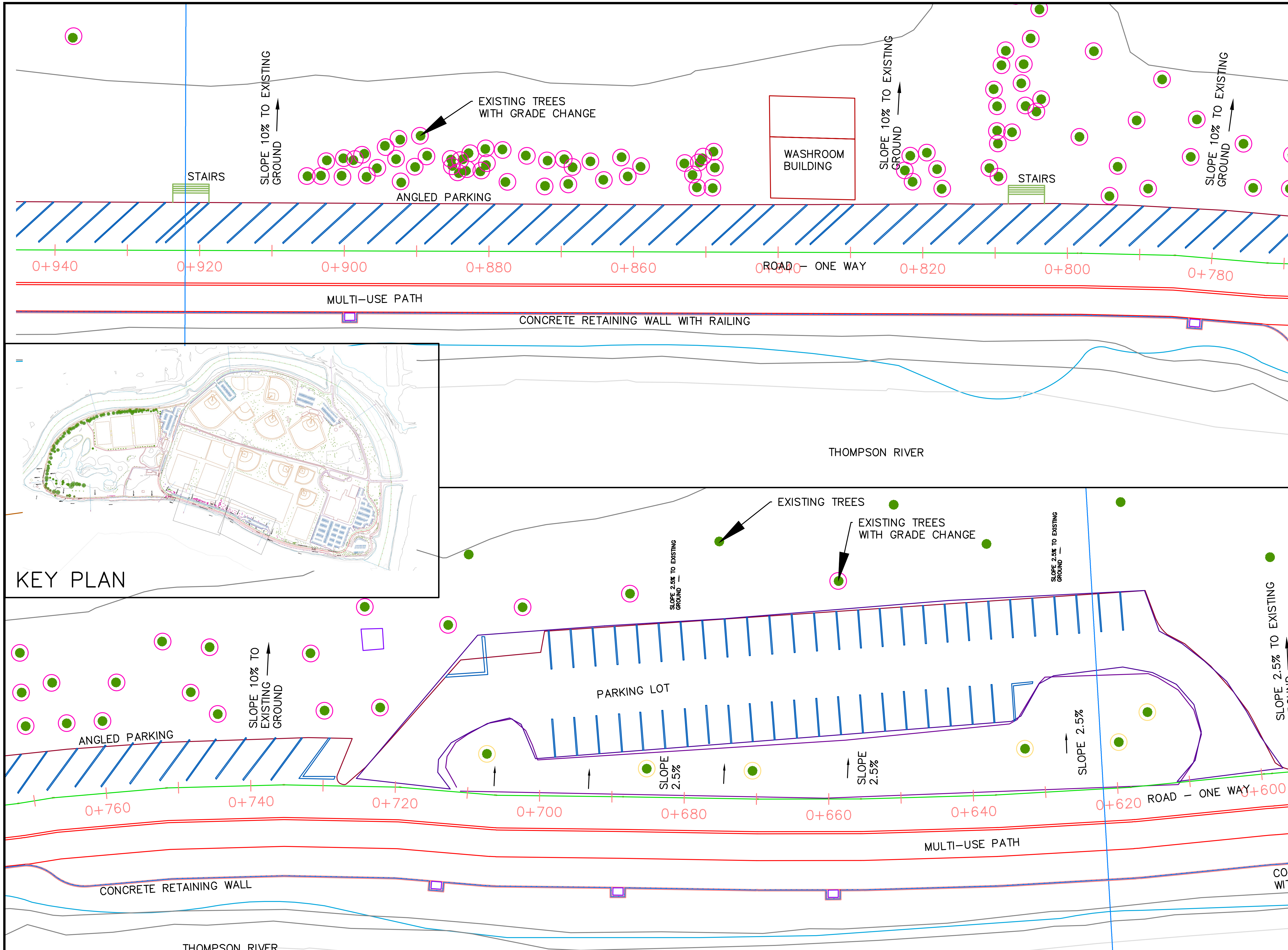

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ROADWAY STATIONS 0+600 - 0+940

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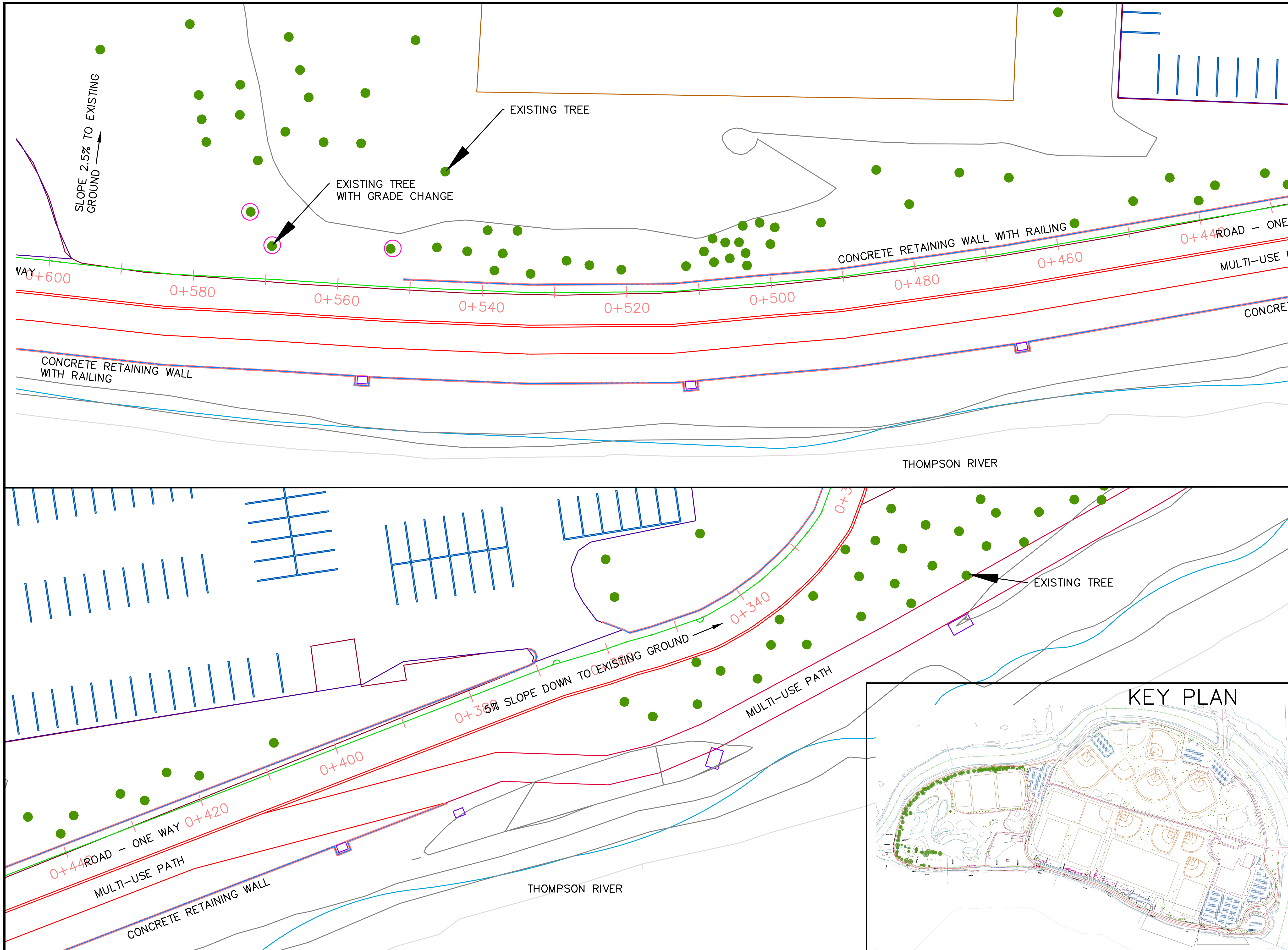

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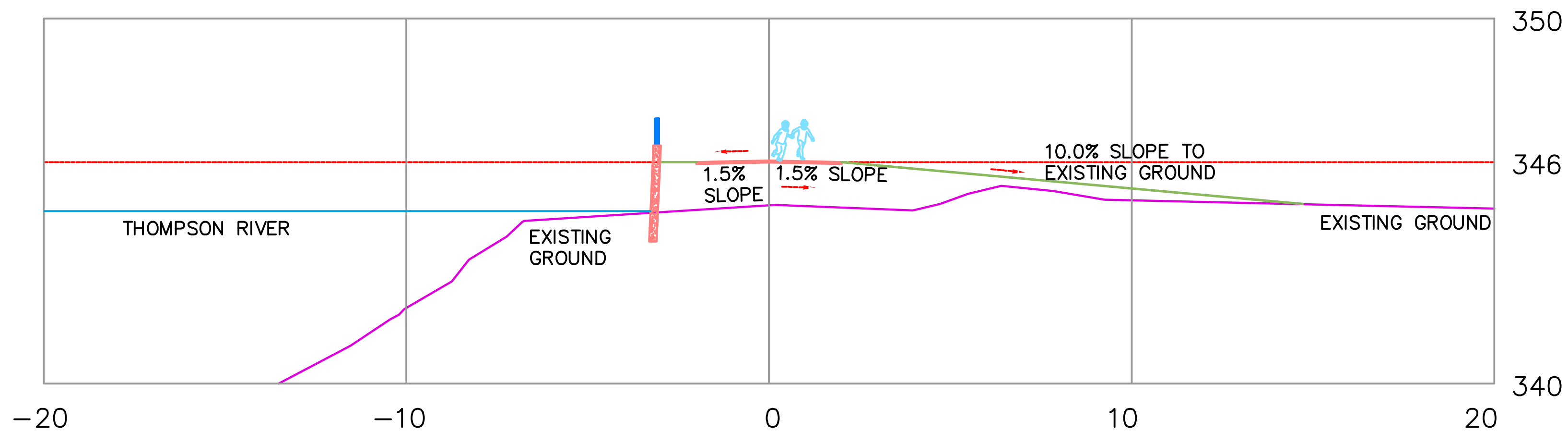

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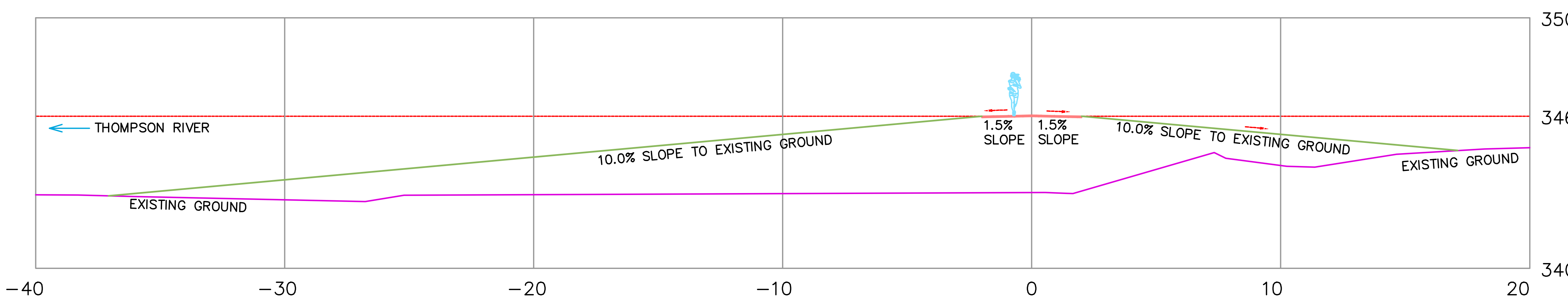

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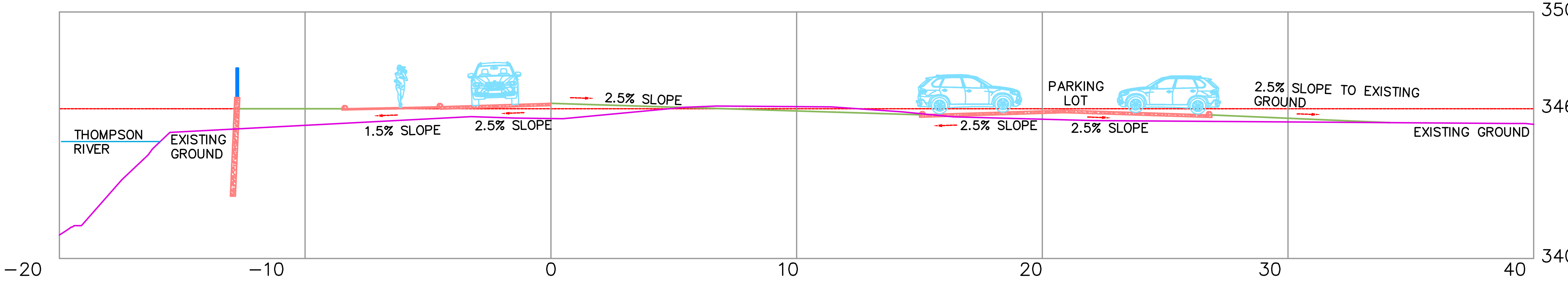

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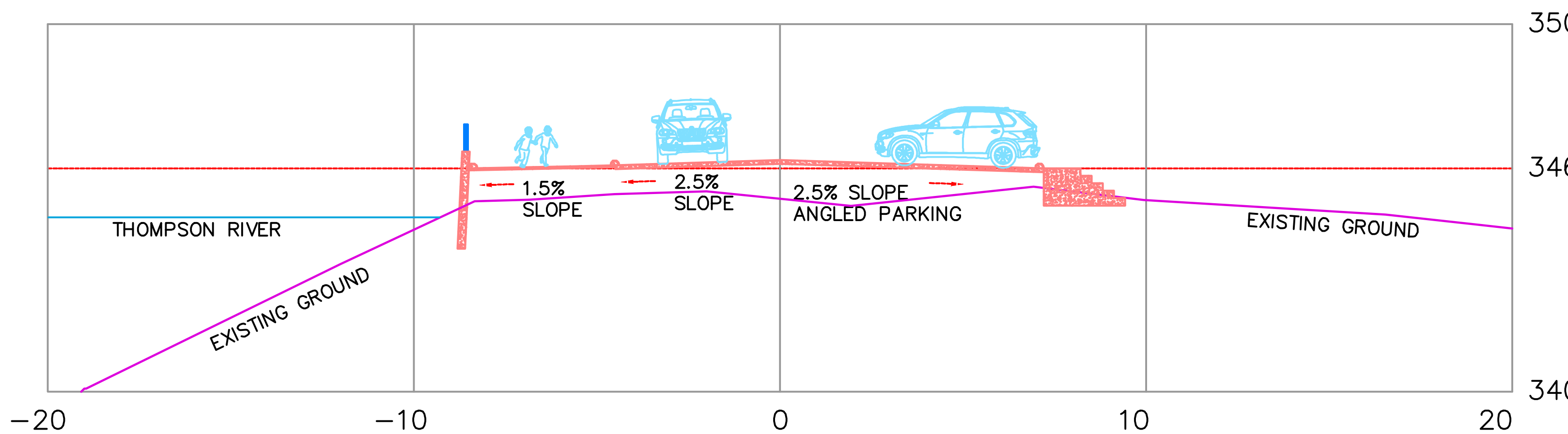

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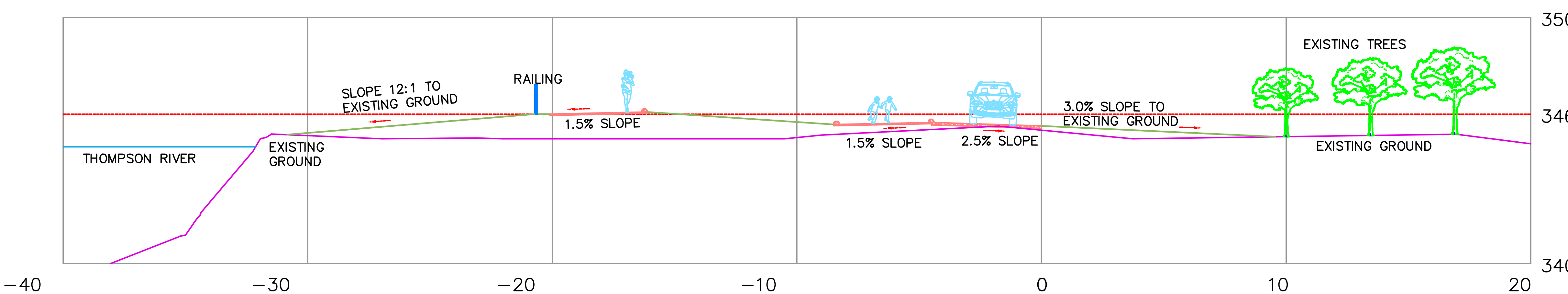

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No.	Revision	Date	By

PROJECT NAME
MCARTHUR ISLAND FLOOD PROTECTION

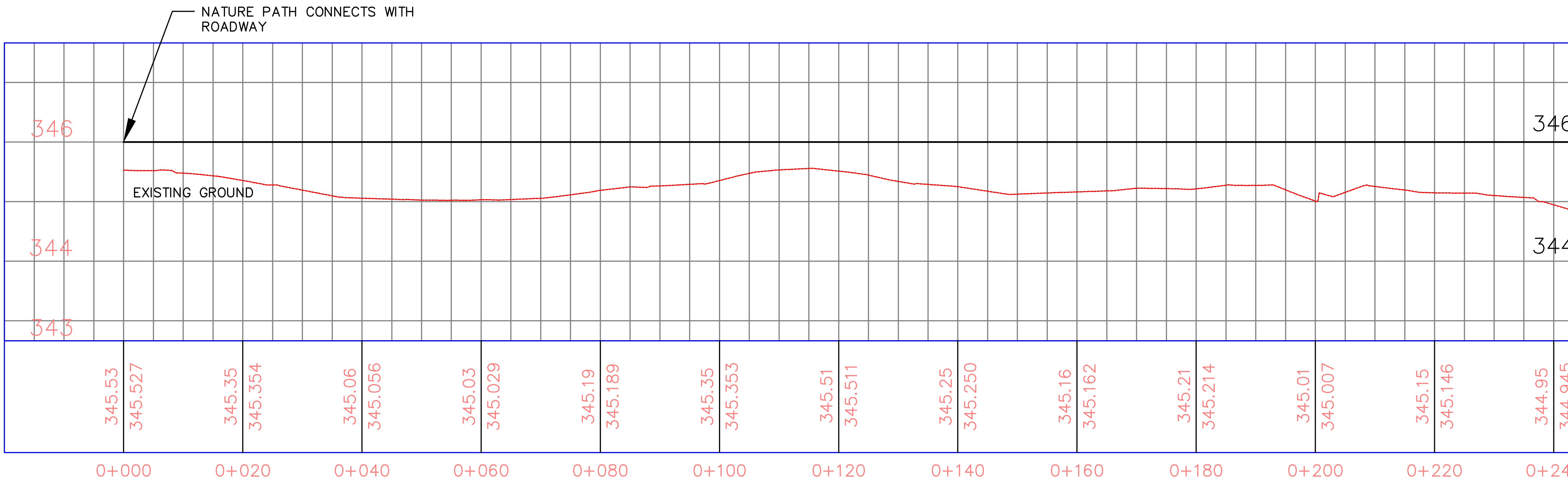
DRAWING TITLE
ROADWAY CROSS SECTIONS

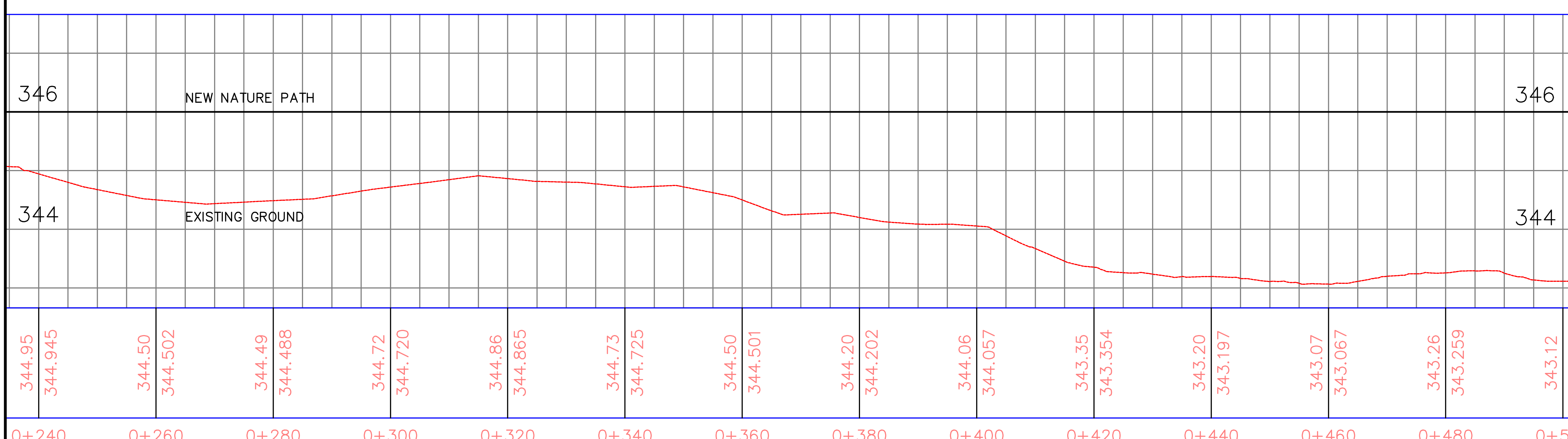
SCALE
1:200

DRAWN BY	CHECKED
H. CLARK	M. MARSHALL

DATE	JOB NO.
11 NOV 2021	2021-001

DRAWING NO.
A7





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No.	Revision	Date	By

PROJECT NAME
MCARTHUR ISLAND FLOOD PROTECTION

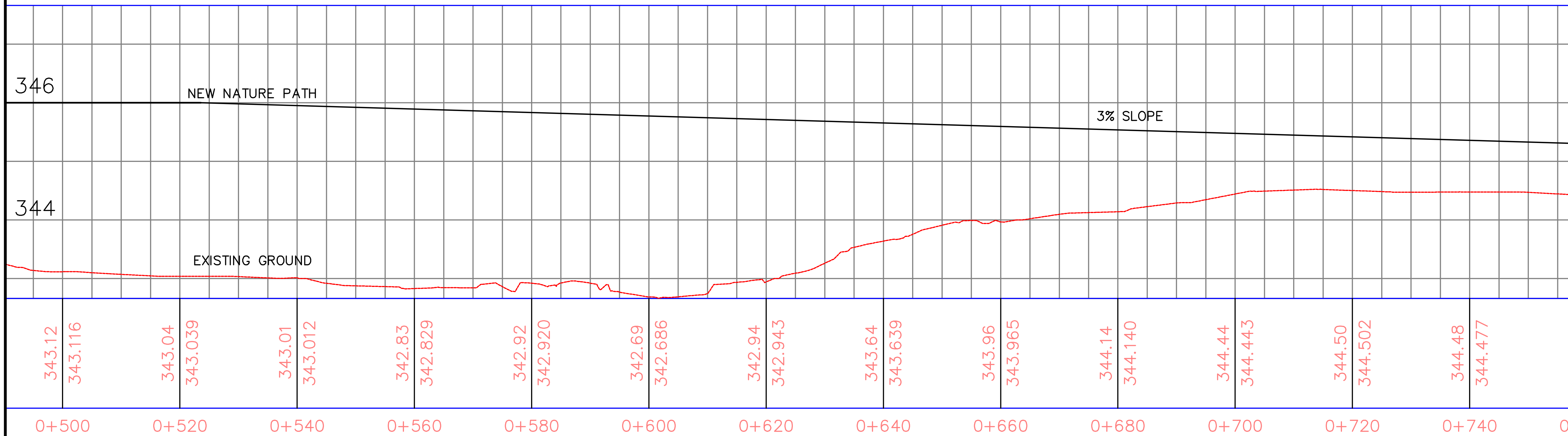
DRAWING TITLE
NATURE PATH PROFILE

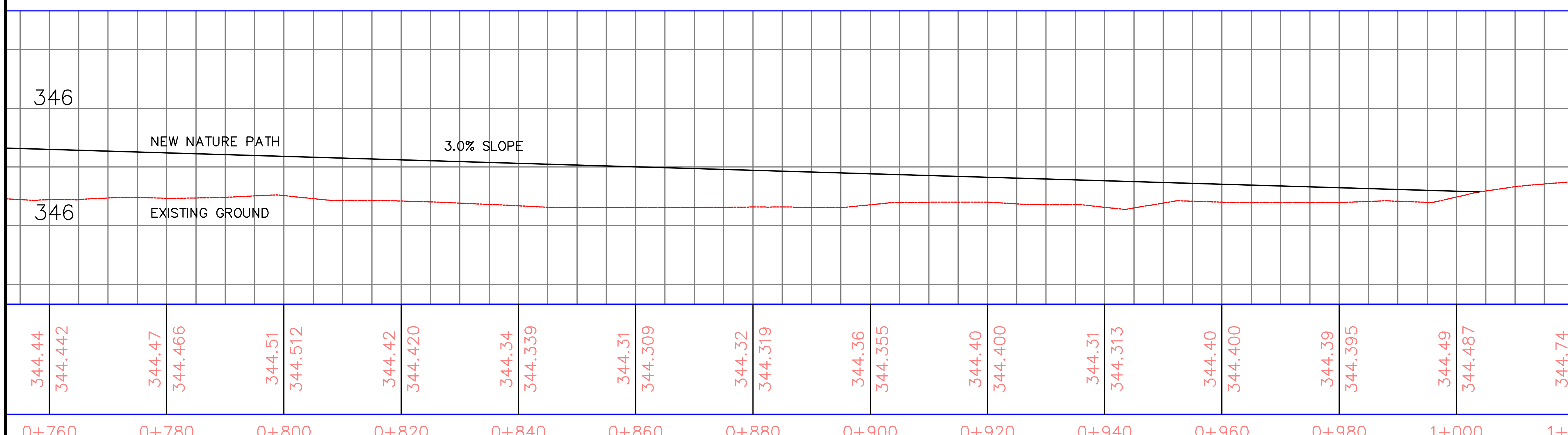
SCALE: NTS

DRAWN BY: H. CLARK | CHECKED: M. MARSHALL

DATE: 11 NOV 2021 | JOB NO.: 2021-001

DRAWING NO.
A8





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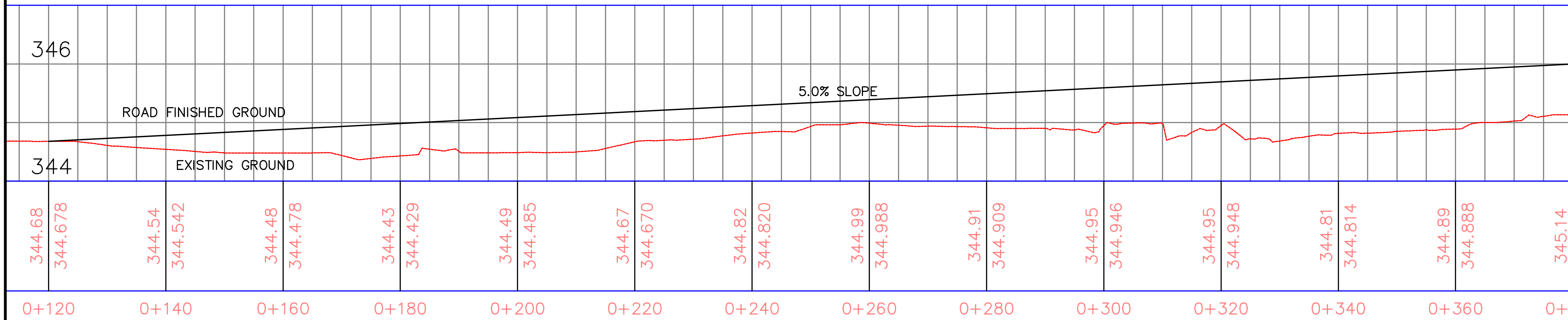
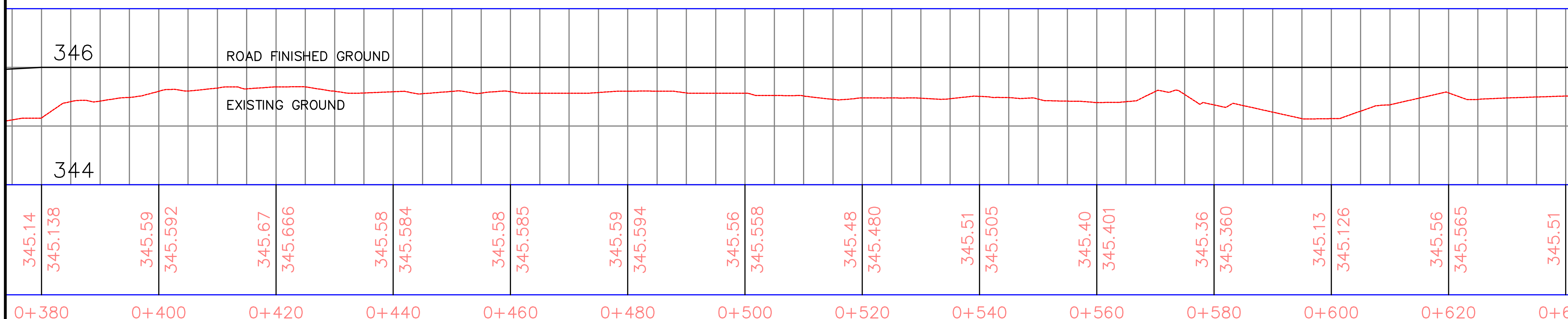
PROJECT NAME
MCARTHUR ISLAND FLOOD PROTECTION

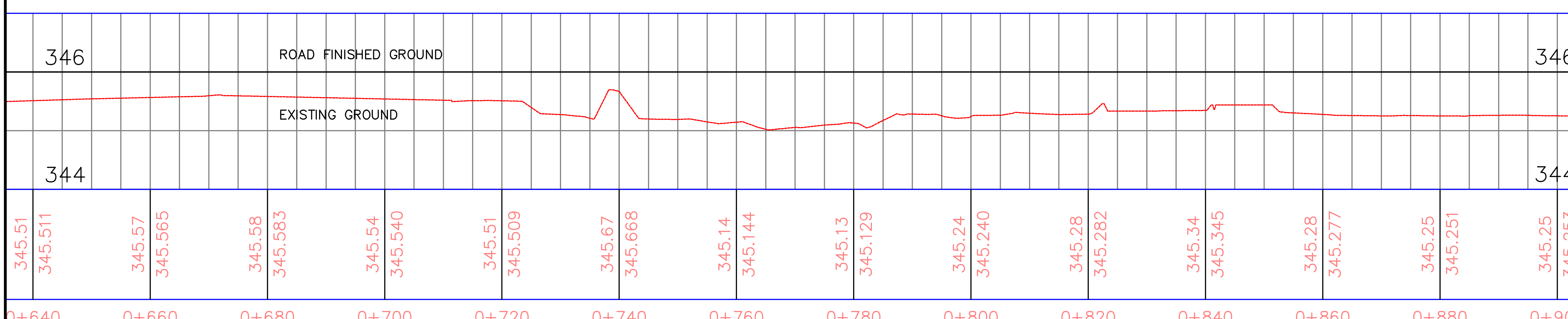
DRAWING TITLE
NATURE PATH PROFILE

SCALE NTS	
DRAWN BY H. CLARK	CHECKED M. MARSHALL
DATE 11 NOV 2021	JOB NO. 2021-001

DRAWING NO.
A9







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ROADWAY PROFILE

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NTS

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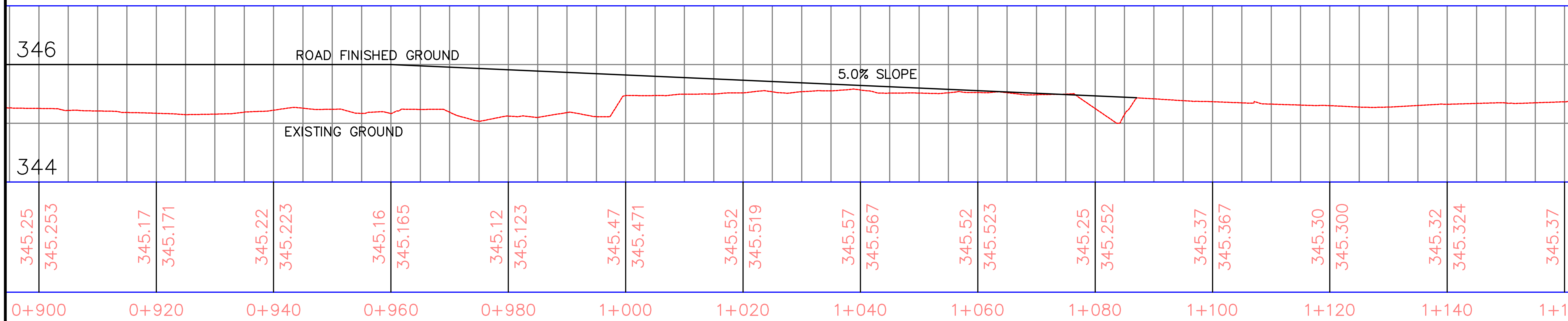
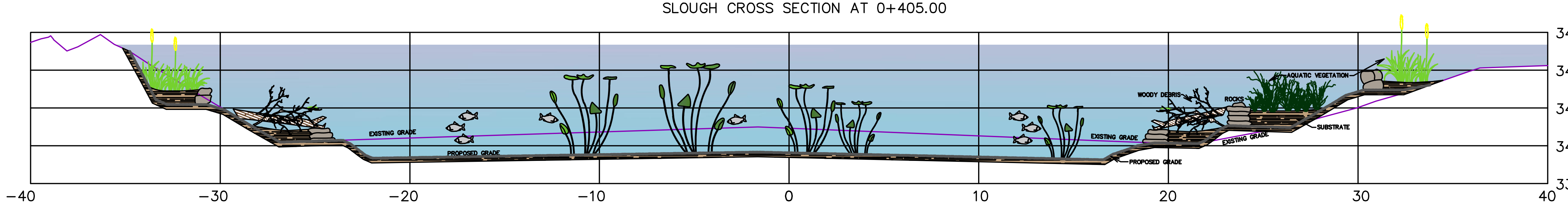
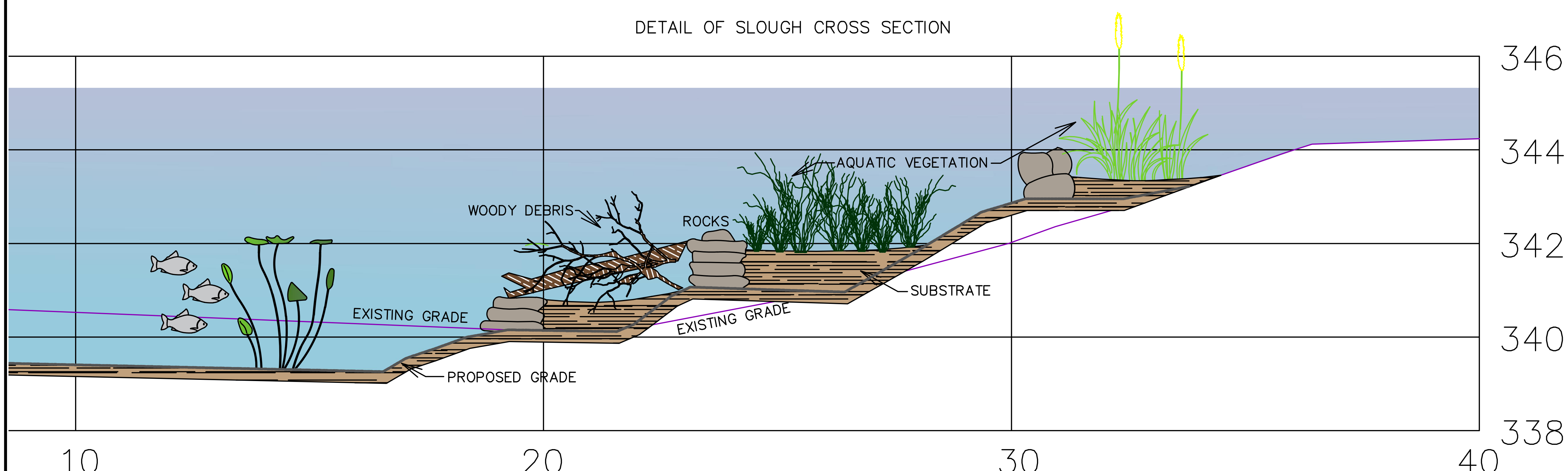
A10



SLOUGH CROSS SECTION AT 0+405.00



DETAIL OF SLOUGH CROSS SECTION



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DRAWING TITLE
SLOUGH CROSS SECTION AND DETAIL

SCALE
NTS

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DATE	JOB NO.
11 NOV 2021	2021-001

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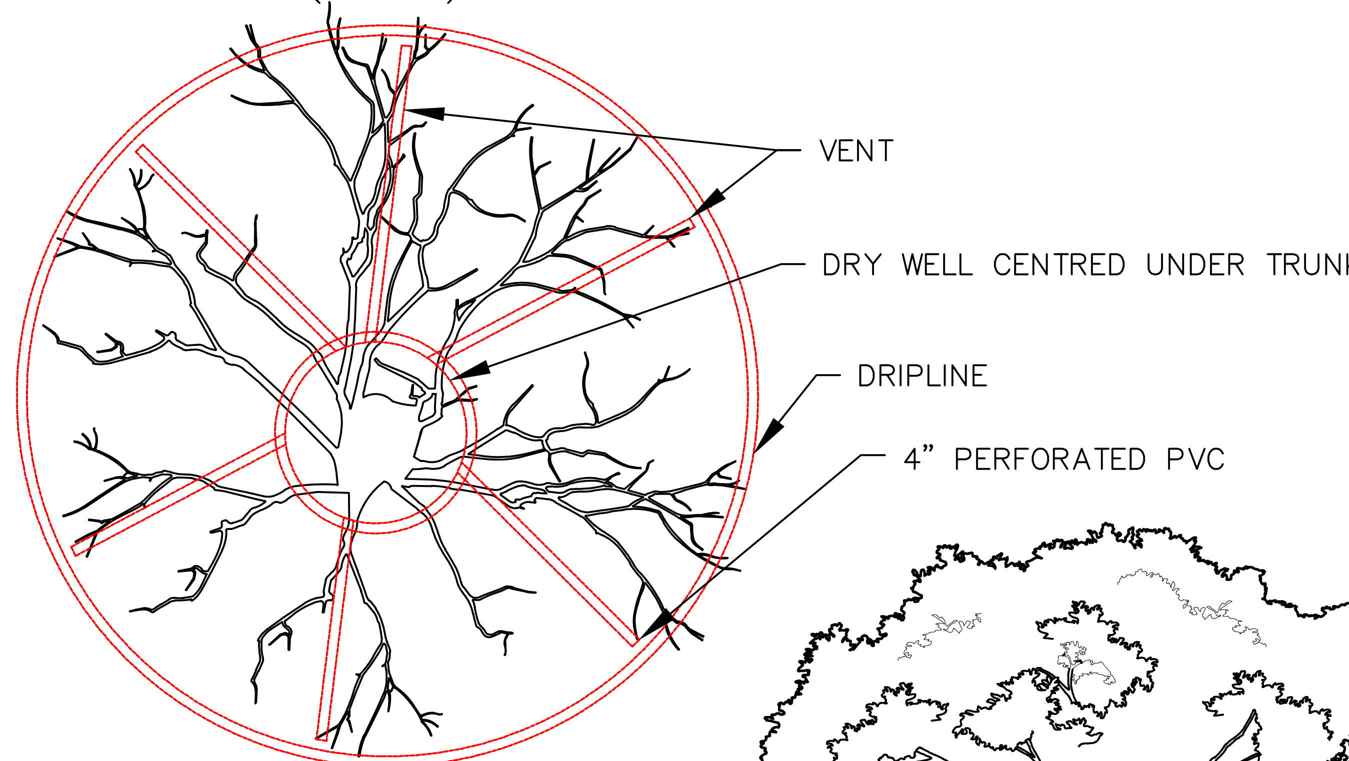
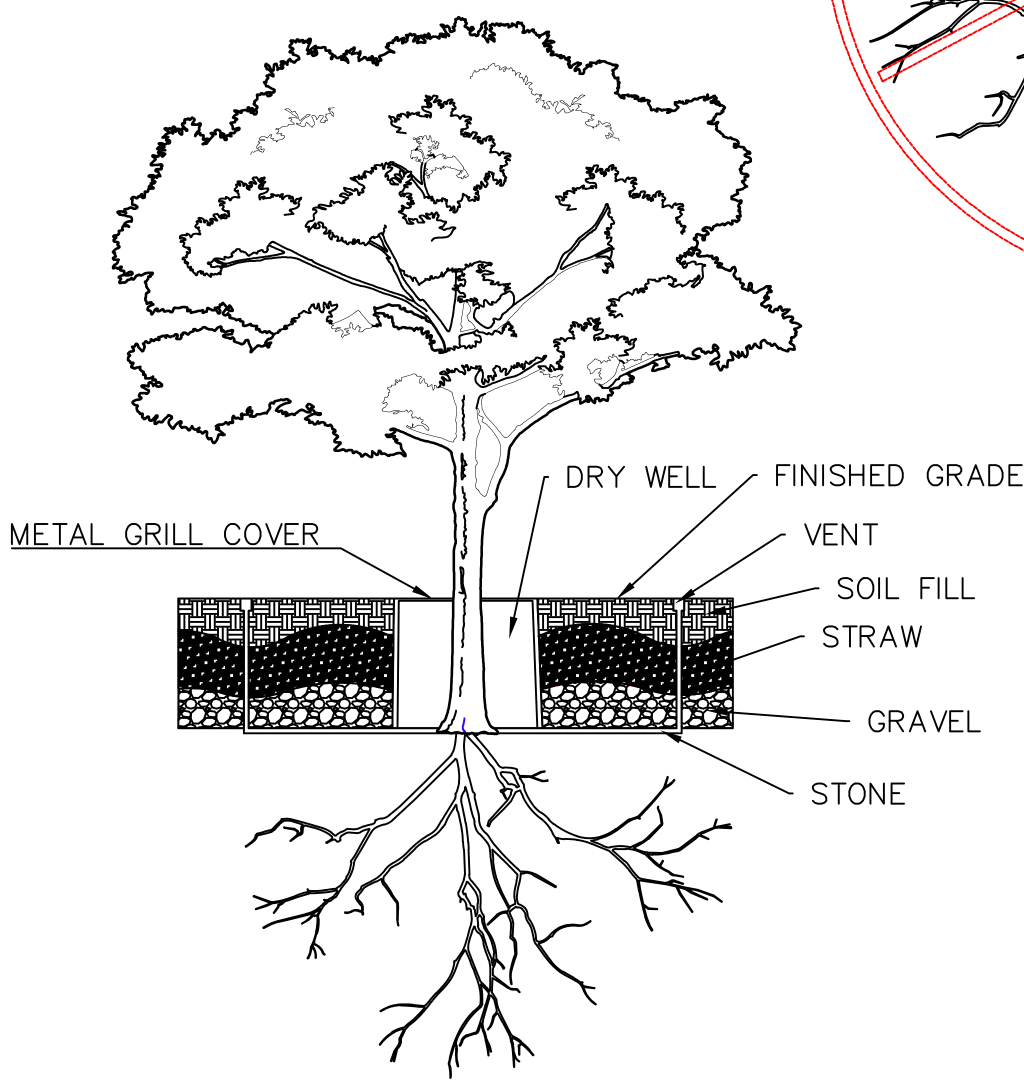
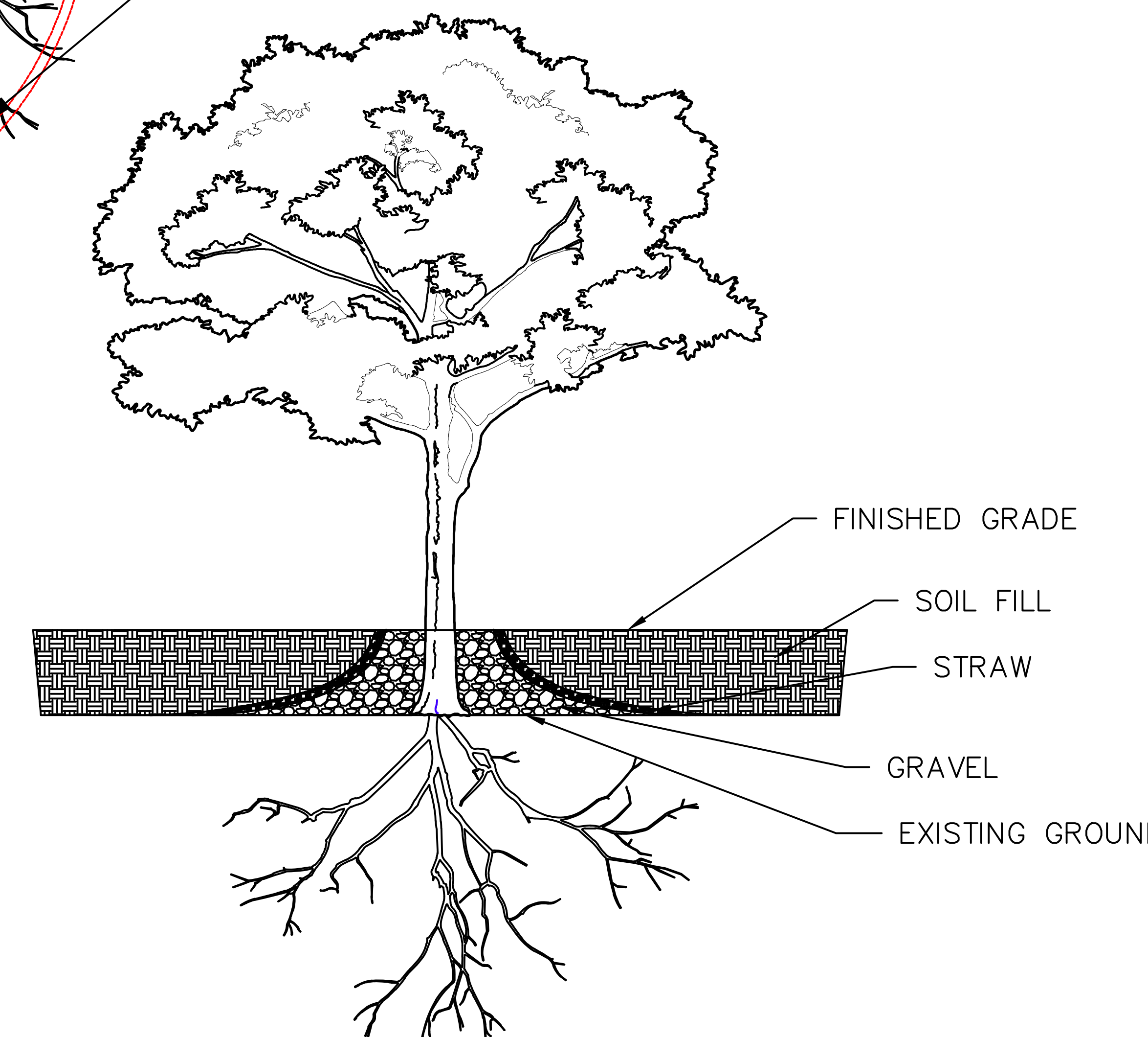
A11

WELL AND DRAINAGE DETAIL – PLAN VIEW (NTS)





PROCEDURE FOR GRADE INCREASE OF 0.6M OR MORE (NTS)



PROCEDURE FOR GRADE INCREASE OF 0.6M OR LESS (NTS)

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DRAWING TITLE
TREE DETAILS

SCALE
NTS

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H. CLARK

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M. MARSHALL

DATE
11 NOV 2021

JOB NO.
2021-001

DRAWING NO.
A12