Appendix E, Attachment E – Geo-Environmental – Assessment of Alternatives

Environmental Statement
East-West Arterial Extension:
Section 2 (Woodland Drive – Lookout Road)
Section 3 (Lookout Road – Frank Sound Road)

Geo-Environmental FINAL

Assessment of Alternatives
Grand Cayman East-West Arterial Extension

NRA
NATIONAL ROADS AUTHORITY

February 21, 2024

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CMW	Central Mangrove Wetland
Cu yd	Cubic Yards
EIA	Environmental Impact Assessment
EWA	East West Arterial
Ha	Hectare
m^3	Cubic Metres
NRA	National Roads Authority
RDI	Richards and Dumbleton International
ToR	Terms of Reference
WebTAG	UK Department for Transport's Transport Analysis Guidance

1 Introduction

The East-West Arterial (EWA) Extension Environmental Impact Assessment (EIA) is proposed to evaluate an alternative east-west travel route on Grand Cayman. The Terms of Reference (ToR) for the proposed EWA Extension EIA was finalized on April 4, 2023. Applicable information from the ToR has been included within this document. Since then, five Build alternatives (B1, B2, B3, B4, and C1), in addition to the No-Build scenario were developed and assessed as part of the Longlist Evaluation. A separate Longlist Alternatives Evaluation Document has been prepared to document this analysis.

As a result of the Longlist Alternatives Evaluation, four Build alternatives (B1, B2, B3, and B4) and the No-Build scenario were advanced to the Shortlist Alternatives Evaluation. This report focuses on the assessment of geo-environmental impacts due to these identified alternatives. Information from this report will be incorporated within the Shortlist Alternatives Evaluation Document and Environmental Statement.

2 Shortlist of Alternatives

Geo-environmental processes on Grand Cayman and within the EWA EIA study area contribute to sourcing potable water to residents and support natural resources. Applicable governmental standards were reviewed, and the baseline conditions were assessed for the island's geo-environmental processes.

This analysis evaluates the anticipated effects of the shortlisted alternatives on Geo-Environmental features, including the Lower Valley Freshwater Lens, North Side Freshwater Lens, brackish groundwater, and peat. The Shortlist Evaluation specifically concentrates on analysing direct impacts, where applicable, since these impacts can more accurately be assessed and quantified based on the project's level of design. The potential for possible indirect and cumulative effects has been discussed where applicable; however, since these impacts are less defined due to numerous variables outside of the project's design process, they have only been noted and qualitatively described. Further evaluation of indirect and cumulative effects will occur as part of the studies for the Preferred Alternative.

The shortlist of alternatives includes the No-Build scenario and four Build alternatives (B1, B2, B3, and B4) as depicted in **Figure 1**. As shown in **Figure 1**, the four Build alternatives all share the same common section beginning at the western terminus, near Woodland Drive, and continuing east to near Lookout Road. They also share the same common improvements to the local roadway network referred to as the Will T Connector. Additional details describing the shortlist of alternatives including full descriptions of each alternative along with typical design sections can be found in the Shortlist Evaluation Document.

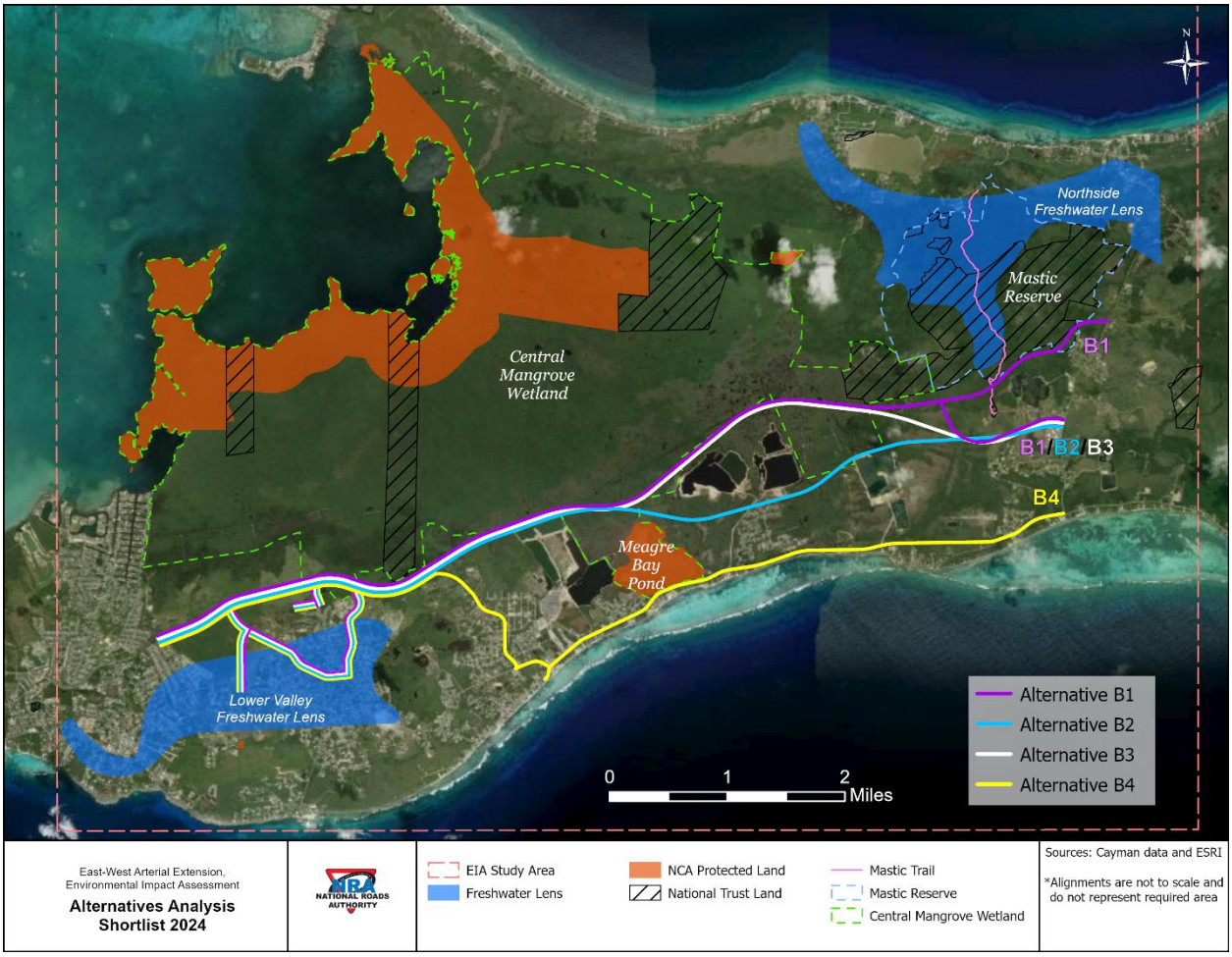

Figure 1: Shortlist of Build Alternatives

3 Baseline Conditions

3.1 Data Sources Evaluated

A source of geological and hydrogeological information for this assessment was the 2022 book by Dr. Brian Jones titled, Geology of the Cayman Islands. Also, the Water Authority Cayman provided two reports prepared for the Cayman Islands Government by Richards and Dumbleton International (RDI), dated August 1975 and November 1980, which contain data on the depth and areal extent of the freshwater lenses. The Hydrogeological Survey of Grand Cayman by the Water Authority (a 1:50,000-scale map) contains data that was also evaluated. All data sources utilized are listed in the References section of this document.

On December 13, 2023, the Water Authority provided information related to groundwater conditions in the vicinity of the Lower Valley Freshwater Lens and the North Side Freshwater Lens. This consisted of monitoring data from various periods within the overall time of 1982 to 2013, including water level data, electrical resistivity profiles, maps of monitoring wells and domestic wells, a technical paper about the Lower Valley reverse osmosis plant, and several case studies in which well owners were assisted by the Water Authority with recommendations regarding development of private groundwater supplies. The groundwater information from the Water Authority primarily concerns salinity levels in regard to maintaining water supply for potable and non-potable purposes.

A field assessment was conducted in July 2023 to observe exposed bedrock formations and peat as well as visit an active quarry within the EIA study area (Section 3.8.4 Field Assessment). Desktop studies were conducted, including a freshwater lens assessment and historical canal impact assessment on the freshwater lenses (Section 3.8). The project team qualitatively assessed the reported locations of freshwater lenses and assessed potential unconfined aquifer impacts associated with the development of canals based on literature review.

3.2 Review of Applicable Standards and Regulations

The Water Authority, under the Water Authority Act (2022) Revision, is charged with the management, control, and protection of water resources. Water Authority Act (2022 Revision) states in Section 19 that groundwater vests in the name of the Crown and appoints the Water Authority as the custodian of groundwater in the name of, and on behalf of, the Crown.

The Water Authority in the Cayman Islands is a utility and a regulatory agency that operates a central sewerage system and regulates onsite wastewater treatment systems. The Water Authority also operates a central water supply system that uses reverse osmosis treatment of saline groundwater. The Water Authority also regulates the construction and use of water supply wells.

The Water Authority Law, passed in 1982, placed controls on extraction from freshwater lenses. Three large, exploitable freshwater lenses occur on Grand Cayman. Formerly widespread was the pumping and trucking of water from such lenses, and some trucking of water continues. Historically some other (smaller) freshwater lenses on Grand Cayman have been lost due to excessive pumping and/or groundwater contamination.

Section 19, part (2) of the Development and Planning Regulations of the Cayman Islands (2020 Revision) indicates that, "Strict conditions shall be imposed to ensure that the water in the lens shall not be contaminated by the development or by the effluent therefrom and that the quantity of water used will not deplete the lens to the disadvantage of the existing users."

The Water Authority operates four reverse osmosis plants on Grand Cayman. The Cayman Water Company also operates several reverse osmosis plants to supply users in the western part of Grand Cayman.

The Water Authority regulates the treatment and disposal of wastewater. There is no central sewage system in the project area and wastewater in the project area is treated by septic tanks for small developments and aerobic treatment units for larger developments. Treated effluent is discharged into effluent disposal wells. The Water Authority issues the specifications for effluent disposal wells. The NRA manages stormwater disposal, typically excess stormwater is disposed via stormwater drainage wells. In the Cayman Islands the term effluent is typically used for disposal wells for the disposal of treated effluent and stormwater wells for the disposal of stormwater.

The qualitative assessment for Geo-Environmental resources was based on the UK Department for Transport's "Transport Analysis Guidance Unit A3: Environmental Impact Appraisal" (WebTAG) and incorporates the March 2020 Design Manual for Roads and Bridges LA 113 as appropriate. The most applicable category for Geo-Environmental impacts is "Impacts to Water Environment".

3.3 Water Authority Coordination

Coordination with the Water Authority has occurred to obtain relevant information regarding available geo-environmental information for Grand Cayman, including collected data, soil mapping, and technical reports for the Lower Valley and North Side fresh groundwater lenses. Additional coordination with the Water Authority and applicable agencies will continue with the Preferred Alternative.

3.4 Geology

Grand Cayman is generally low-lying. A recent estimate of the maximum land surface elevation at Grand Cayman is approximately 56 feet (17 metres) above sea level, from the book "Geology of the Cayman Islands" by Dr. Jones, which was published by Springer on November 14, 2022.

Grand Cayman is located on the Cayman Ridge, which forms the southern margin of the North American plate. The Cayman Ridge is a block uplifted above the surrounding seafloor, which is bounded by dipping fault planes. The region is tectonically active because the Cayman Islands are near the Oriente Transform Fault and the Mid-Cayman Rise. A map of the Caribbean area and a cross section showing the Cayman Ridge are in **Figures 2 and 3**, respectively. **Figure 2** is from Ren (2017) . **Figure 3** is from Jones (1994).

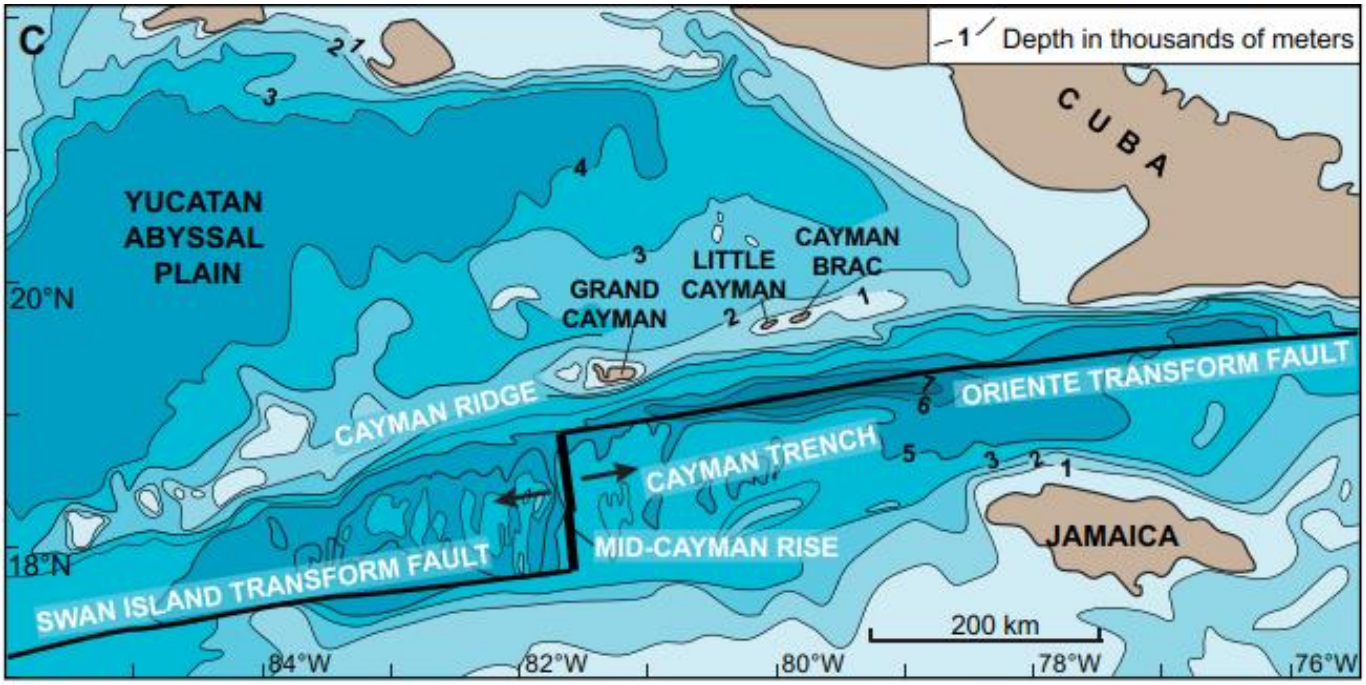

Figure 2: Map of the Caribbean Area
Source: Ren (2017)

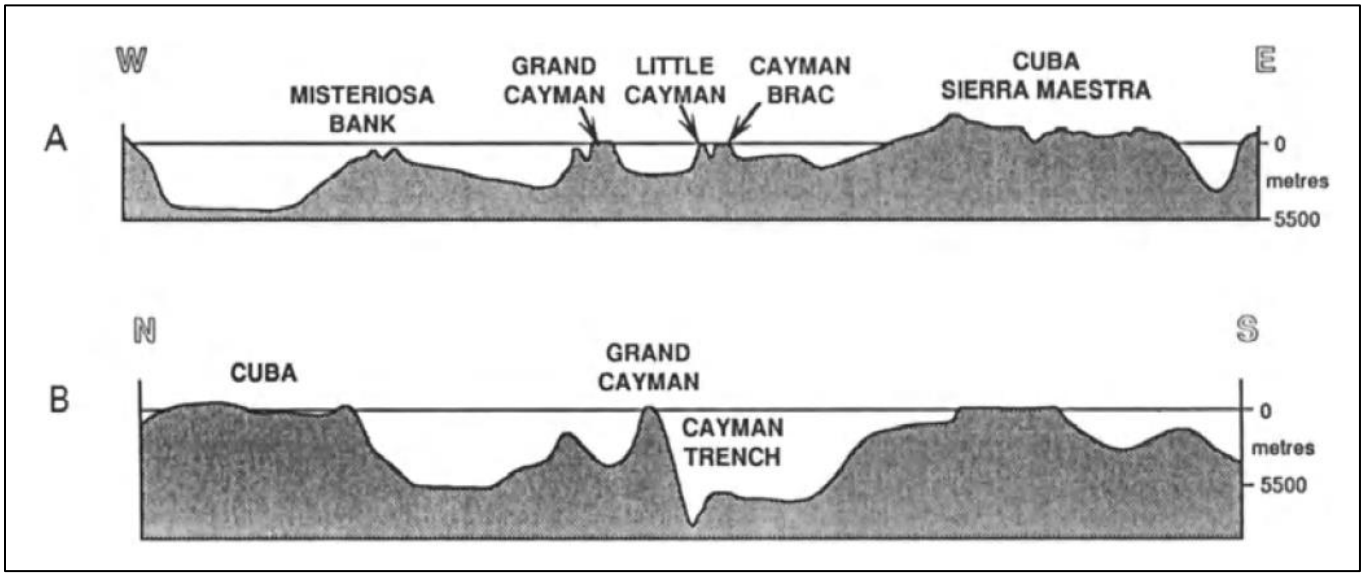

Figure 3: Cross section of Cayman Ridge. (A) Location of Grand Cayman on Cayman Ridge (B) Cayman Trench
Source: Jones (1994)

Carbonate rock up to 30 million years old is exposed on Grand Cayman. The carbonate thickness is at least 1,316 ft (401 metres) based on deep well data described in the book "Geology of the Cayman Islands" (2022) by Dr. Jones. The carbonates rest on older bedrock, and they formed during cycles of sea level change. During high stands of sea level, carbonate deposition occurred. In low stands of sea level, previously formed carbonates were eroded and weathered. The strata

dip toward the west at up to five degrees. Unconformities occur between the mapped formations, which represent periods of erosion.

The Bluff Group is a stratigraphic name that includes the following geologic units, from deepest (oldest) to youngest (shallowest): the Brac Formation, the Cayman Formation, and the Pedro Castle Formation. Although the Brac Formation is stratigraphically within the Bluff Group beneath the Cayman Islands, the Brac Formation specifically is not exposed at the island of Grand Cayman. (Jones, 2022)

The Cayman Formation underlies the EIA study area. It consists of relatively hard, microcrystalline dolostone containing the mineral dolomite (calcium magnesium carbonate). Dolostone in the Cayman Islands is dolomitized limestone in which magnesium ions from seawater have replaced calcium ions. The calcium percentage in the rock increases from the peripheral part of Grand Cayman to the interior-most areas of the island. The gradual dolomitization by seawater occurred during the Miocene, Pliocene, and Pleistocene Epochs.

The thickness of the Cayman Formation is up to 492 ft (150 m) thick. Exposed Cayman Formation may have an irregular surface from karst landscape development, and it commonly has caves. The rock is extensively jointed, and many joints are solution-widened. Further, joints and other openings may be filled with breccia composed of carbonate rock fragments.

The Pedro Castle Formation overlies the Cayman Formation. The Pedro Castle Formation outcrops mainly in the southernmost part of Grand Cayman, which is called Lower Valley. The Pedro Castle Formation is up to 70.5 ft (21.5 m) thick in the western part of Grand Cayman. he Pedro Castle Formation may be relatively soft close to its stratigraphic contact with the underlying hard Cayman Formation.

Surrounding and partially onlapping the Bluff Group is the Ironshore Formation. Its thickness ranges from a thin veneer to 29 ft (9 m). The Ironshore Formation consists of friable, poorly consolidated reef limestone, calcarenite, and oolitic limestone. The Ironshore Formation is the surficial geologic unit in most of western Grand Cayman.

A geologic map also showing the roadway alternatives is included in **Figure 4**.

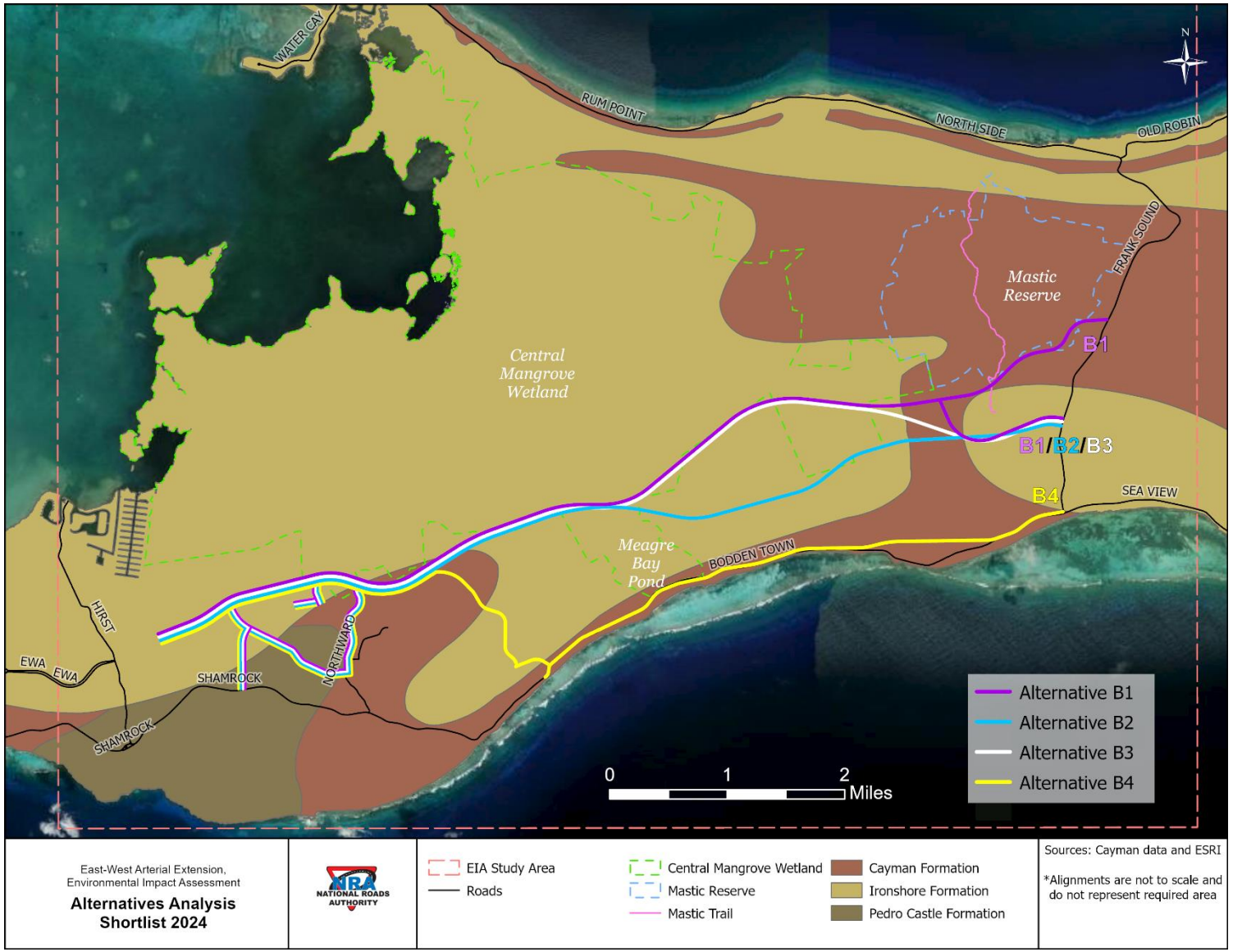

Figure 4: Geologic Map of the Study Area

3.5 Soils

Soils are generally thin on Grand Cayman. The sediments in the extensive mangrove wetlands have a particular sequence, which is described as transgressive by Woodroffe (1981). The sequence records the gradual submergence of the island in the Holocene Epoch.

The basal unit is a crust that formed on rock during subaerial conditions predating the marine transgression. Overlying the crusts is plastic mud deposited in seasonal floods. On top of the mud is peat formed from mangrove vegetation in an intertidal environment. The organic content of the peat ranges from 50 to 80 percent, and it is 80 to 90 percent water as a percentage of wet weight.

The National Roads Authority (NRA) provided plans and a subsurface profile for Section 2 of the East-West Extension (dated 2008). NRA provided similar information for a portion of Section 3 (dated 2014). The subsurface profiles trial pit data is included in **Attachment A – NRA Trial Pit Data – 2008 and 2014**. The spacing between trial pits was mostly 300 ft (91 m), although the spacing was smaller in some areas. The trial pits measured the depth to rock, and soil and peat thicknesses. In places, rock was at the land surface.

At its deepest, the top of rock was approximately 14 ft (4 m) below the land surface. Some trial pits encountered a layer of soil up to about 1 ft (0.3 m) thick on top of bedrock. Resting on this thin soil (or directly on top of bedrock) was a peat layer. The thickness of peat ranged from about 1 ft (0.3 m) to 14 ft (4 m). Several trial pits encountered the water table at, or just below the land surface.

For this assessment it was anticipated that the subsurface area would be excavated below the limits of weak materials, such as peat and carbonate-derived residuum, and then filled with load bearing materials to construct the highway. Karst landscape conditions including voids may also influence the project designs and construction, especially in areas where proposed bridge or structure foundations are bearing on rock. Liquefaction of soils is another consideration that may occur due to tectonic activity.

3.6 Peat

Peat has historically been connected to climate change as it has been determined to sequester greenhouse gases. Peat is mainly composed of organic remains from the mangroves themselves, principally from the two mangrove species *Rhizophora mangle* and *Avicennia germinans*. Peat deposits are fibrous, with abundant roots and rootlets. The peat does not have carbonate minerals, and molluscs are rare.

Mangrove-derived peat deposits underlie most of the mangrove swamps and cover the bedrock in many areas of Grand Cayman. Much of the peat is less than 3 ft (1 m) thick, but locally may be as thick as 20 ft (6 m). It is anticipated that peat underlies a portion of the proposed roadway alignments based on the plans and a subsurface profile for Section 2 of the East-West Extension (dated 2008) and a portion of Section 3 (dated 2014). The thickness of peat in the 2008 and 2014 trial pits ranged from about 1 ft (0.3 m) to 14 ft (4 m). It should be noted that the 2008 and 2014 subsurface profiles do not encompass the entire EIA study area and assumptions had to be made in estimation of peat volumes for the Shortlist Evaluation. Methodology is provided in Section

4.1.2 below and additional subsurface studies will be conducted as needed for the Preferred Alternative.

For the roadway construction, peat and other unsuitable material may need to be removed and replaced with aggregate to create a firm foundation. The aggregate material will need to be mined from the existing authorised commercial quarries. In August 2018, the Water Authority estimated that there are approximately 32 million cubic yards (yd^3) (24.3 million cubic metres) of aggregate in the authorised commercial quarries. An alternative to removing peat and replacing with aggregate is to elevate the proposed roadway using bridges and other design options.

3.7 Hydrogeology

The three largest, usable freshwater lenses on Grand Cayman are the Lower Valley Lens, the North Side Lens, and the East End Lens. Of these, the Lower Valley Lens is the smallest and the East End Lens is the largest. The main freshwater lenses currently existing within the EIA study area are the Lower Valley Lens and the North Side Lens. The No-Build scenario, specifically Shamrock Road and Northward Rd, and the four Build alternatives (Alternatives B1, B2, B3 and B4) overlay the Lower Valley Lens. The North Side Lens is located north of the eastern extent of the No-Build scenario and the four Build alternatives (B1 to B4). A geologic map depicting the freshwater lenses as well as showing the roadway alternatives, is included in **Figure 5**. The freshwater lens assessment is in Section 3.8.

The source of the natural freshwater on Grand Cayman is almost entirely precipitation that contains a chloride concentration of 7 to 13.5 mg/l, based on information from the book, "Geology of the Cayman Islands" (2022) by Dr. Jones. Precipitation recharges the lenses by rapid flow through discontinuities in the bedrock during rainstorms. Recharge also occurs by slow infiltration through the unsaturated zone.

Freshwater occurs in lens-shaped bodies beneath topographic highs in the Bluff Group as an unconfined aquifer in the fractured carbonate rock. The unconfined aquifer is hydraulically connected with the ocean, and the water table elevation is typically less than 1.5 ft (0.5 m) above mean sea level. Because of the high permeability of the karst rock, surface streams are absent, and the water table gradient is low. Underneath the freshwater zone is a thick, brackish water zone that transitions from fresh to saline water. The freshwater zone has a chloride concentration less than or equal to 600 milligrams per litre (mg/l). In the brackish zone it is 600 to 19,000 mg/l. The saline zone has a chloride concentration of at least 19,000 mg/l. Tidal oscillations generate mixing of brackish and fresh water. The semi-diurnal tide range is 0.2 m, and the seasonal fluctuation is 0.5 m.

Based on the Ghyben–Herzberg ratio, for each metre of fresh water in an unconfined aquifer above sea level, there is 40 metres of fresh water in the aquifer below sea level. In the Cayman Islands, an idealized lens configuration is not completely met because the extensively fractured bedrock aquifers cause the shapes of the lenses to change.

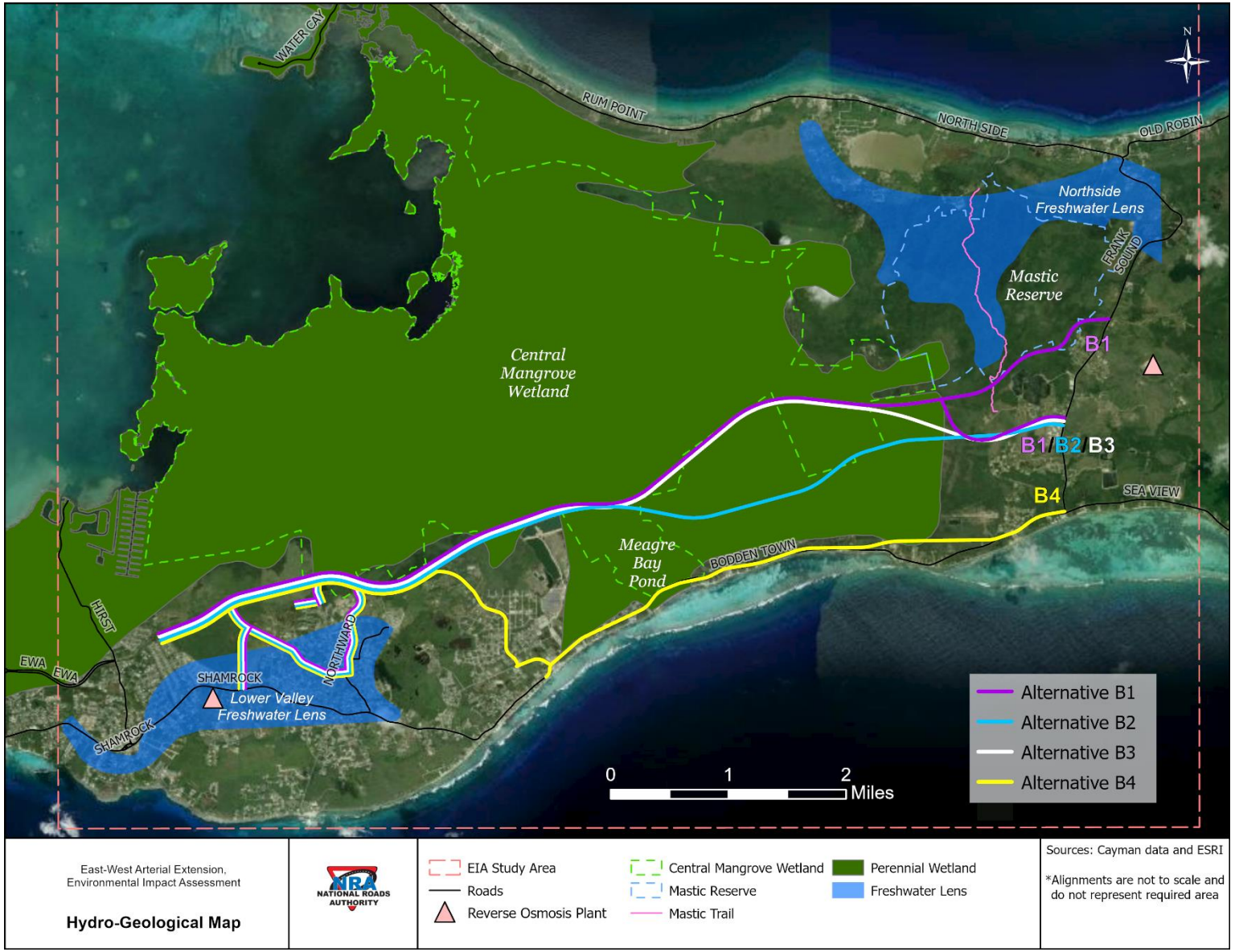

Figure 5: Hydro-Geological Map of the Study Area

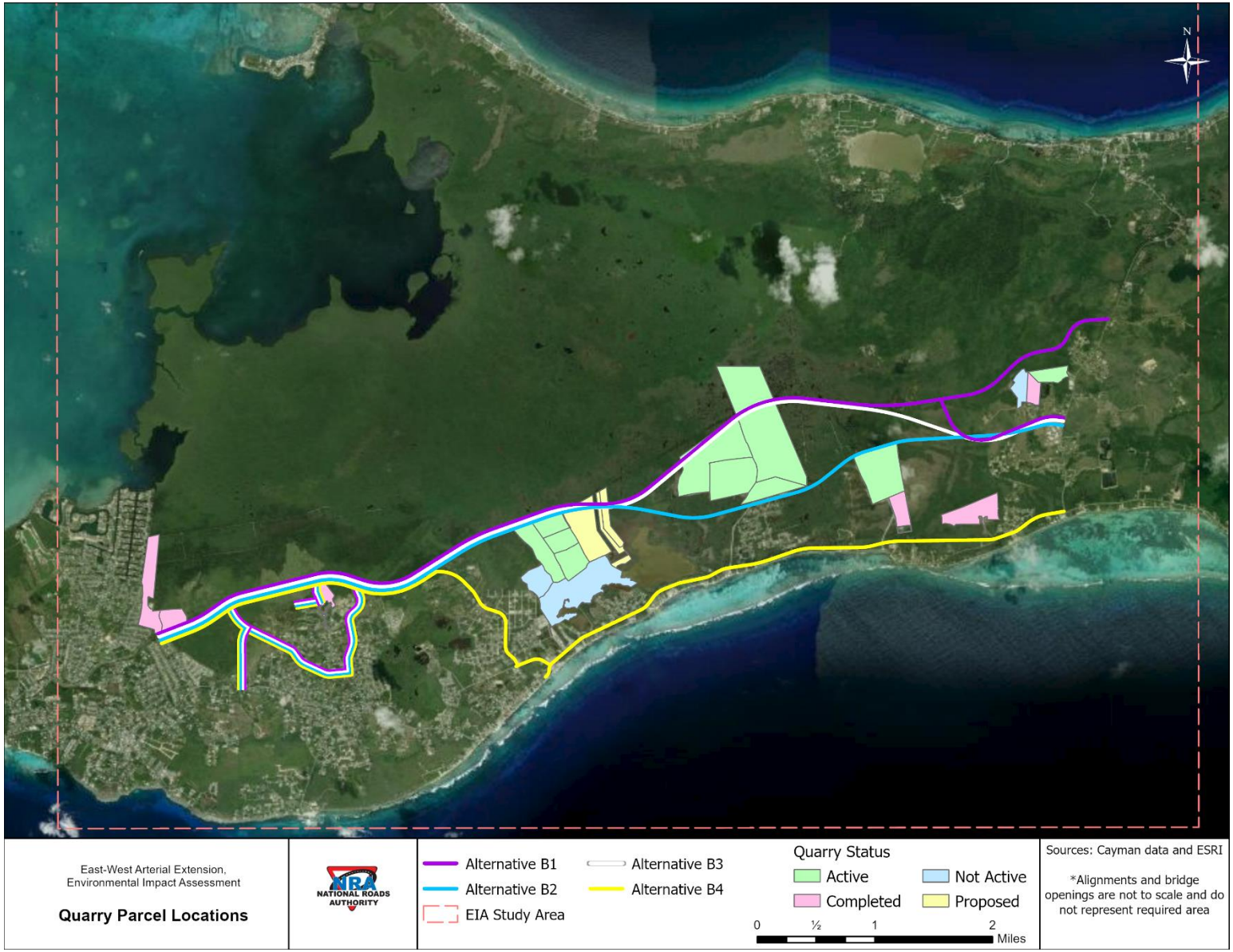

Figure 6: Quarry Locations Within the EIA Study Area

3.8 Quarries

Based on coordination with the NRA, Water Authority, and Department of the Environment (DoE), there are a total of 17 quarries within the EIA study area, including 6 active, 6 completed, 3 not active, and 2 proposed quarries, encompassing a total of 22 parcels. Alternatives B1, B2, and B3 are located directly adjacent to existing water-filled, rock quarries and cross through two proposed quarries. In addition, Alternatives B1 and B3 cross through two active quarries. An active quarry was visited during the 2023 field assessment (see Section 3.8.4). Quarry locations are included in **Figure 6**.

Quarries represent potentially more direct pathways into the karst aquifer, especially where karst voids may have been connected to the surface as a result of mining or hydrogeologic processes. In this sense, the saturated quarries are broadly similar to natural ponds, wells, or sinkholes with respect to vulnerability. In addition, the planned land use and possible mineral rights at the quarries will be further investigated for the areas along the Preferred Alternative.

3.9 Studies and Field Survey

3.9.1 Lower Valley Freshwater Lens

The Lower Valley Lens underlies the No-Build scenario and all four Build alternatives (Alternatives B1, B2, B3 and B4). The lens covers an area of 960 acres (388 hectares) and is elongated in a generally east-west orientation (**Figure 1** and **Figure 5**). Cap rock in the upper part of the Cayman Formation acts as a barrier to upward movement of groundwater from the deeper part of the Cayman Formation. The Lower Valley Lens overlies northwest-trending photolineaments that represent bedrock fractures likely connected with the ocean. In general, a lineament is a linear feature on the surface of the earth associated with geologic aspects such as discontinuities in bedrock. Lineaments may represent zones with relatively greater groundwater flow.

The freshwater table in the Lower Valley Lens is up to 2 feet (0.6 metres) above sea level. The bottom of the freshwater lens is at 26 feet (8 metres) below sea level. The transition zone between fresh and saline water extends from 26 feet (8 metres) below sea level to 66 feet (20 metres) below sea level. Seawater is present 66 feet (20 metres) below sea level and lower.

The Lower Valley Lens has historically been a water supply source. Since 1998 the Water Authority has operated a reverse osmosis plant located over the Lower Valley freshwater lens (**Figure 5**). The Water Authority had previously operated the Lower Valley wellfield and reservoir from 1984 to 1994, pumping fresh groundwater at low abstraction rates. Currently the Water Authority pumps and treats only saline water (below the Lower Valley Freshwater Lens). This approach preserves the Lower Valley Lens for local water users.

The reverse osmosis plant disposes of brine in a zone deeper than the abstraction zone. At the Lower Valley reverse osmosis plant, the abstraction zone is approximately 150 to 220 feet (45-67 metres) deep, the disposal zone is approximately 280 to 330 feet deep, and the distance between the abstraction well and the disposal well is approximately 330 feet (100 metres) (**Figure 7**). Note that **Figure 7** indicates the brine disposal depth in 2001; however, in 2005 it was deepened to the

depth stated in this report, because the production capacity of the reverse osmosis plant had increased. Disposal in the ocean is undesirable from an environmental standpoint.

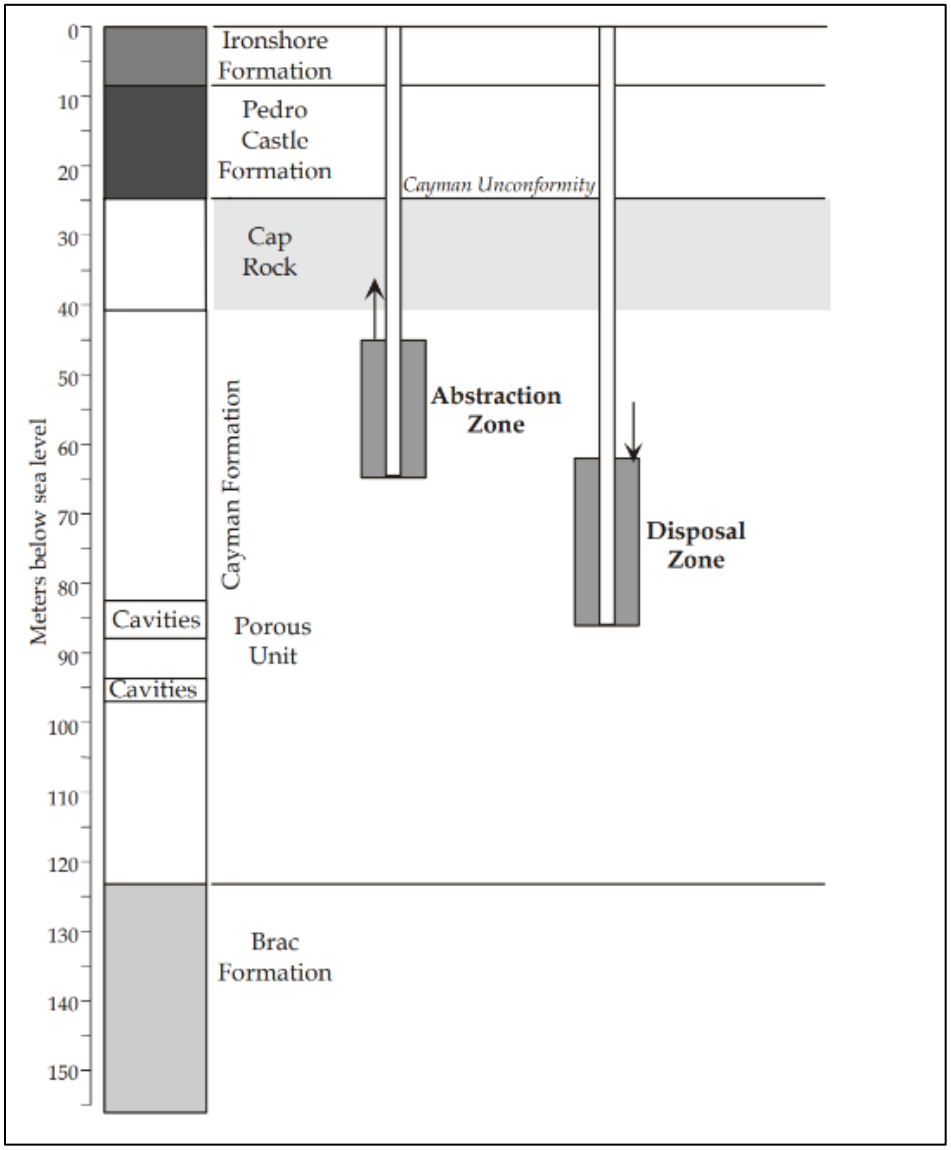

Figure 7: Lower Valley abstraction and disposal zones in relation to the geological succession

Source: Jones, B., van Genderen, H. J., & van Zanten, T. (2001)

3.9.2 North Side Freshwater Lens

The North Side Lens is adjacent to (and slightly north of) Alternatives B1, B2 and B3. The lens covers an area of 1,536 acres (622 hectares) and is located south of Old Man Bay. The lens is centred on the topographic feature called "The Mountain", which refers to the area on Grand Cayman where the land surface elevation is the highest on the island. The fresh water exists in coarse white marl, gravel, and limestone. The North Side Lens overlies north- and northwest-trending bedrock lineaments.

The Water Authority does not have detailed water level data for the North Side Lens, but the expected water table elevation is 1.5 to 2 ft (0.5 to 0.6 m) above sea level. The bottom of the freshwater lens is 43 feet (13 metres) below sea level, and seawater is present at 82 feet (25 metres) below sea level. The Water Authority's North Side reverse osmosis plant (in the central part of Grand Cayman) is located outside the limits of the North Side Freshwater Lens (**Figure 5**).

3.9.3 Canal Impacts on Freshwater Lenses

Canalization for mosquito control in mangrove wetlands occurred on Grand Cayman beginning in the 1970s in order to drain water quicker and reduce mosquito breeding. Canals in the 7-to-9-foot depth range (2 to 3 metres) were cut through the shallow aquifer cap rock that serves as a confining bed. As a result, the breaching of the confining layer facilitated the hydraulic connection between freshwater lenses and the sea and the water table was lowered closer to sea level in the freshwater lens discharge areas.

Three hydrogeologic studies performed for the Cayman Islands Government in the 1970s and 1980s concluded that canals had caused adverse impacts by reducing the thicknesses of the freshwater lenses. [Bermes, B. J. (1983); RDI (August 1975); RDI (November 1980)]. In addition, in a 1995 Technical Memorandum, the Water Authority determined that canals had adversely affected the lenses [Genderen, H.-J. van. (1995)]. Since that time, the development of canals has been discouraged and/or prohibited. In addition, some existing canals on Grand Cayman have been blocked under direction from the Water Authority.

Within the project area, the four Build alternatives cross the central mangrove wetlands in the vicinity of the Lower Valley Lens and the North Side Lens; therefore, it is important to take into account the impact of canalization when assessing potential stormwater management approaches. For example, swales in mangrove areas may have a similar impact as the canals.

Figure 8: Blocked canal (July 2023)

3.9.4 Field Assessment

A site visit of the EIA study area was conducted in July 2023 to assess the existing conditions. Exposed bedrock formations were found in the CMW area (**Figure 9**), EWA western terminus (**Figure 10**), and Mastic Trail area (**Figures 11 to 14**). Peat was observed in the mangrove areas.

Access was provided by the NRA to the quarry just east of the Meagre Bay Pond during the field assessment. Observations were made around the perimeter of the quarry up to the northern most point of the quarry where it borders the CMW. The quarry contained large excavators that were actively being used for excavation in the quarries (**Figure 15**). The NRA personnel also indicated that blasting was being utilized in the excavation process. Limestone is actively being excavated from the quarry for use in construction (**Figure 16**). The term "limestone" is used widely for rock that is quarried in the Cayman Islands, although technically the quarried rock is limestone or dolostone.

The excavation areas were filled with groundwater almost up to the existing ground level. The depth below the water table of the quarries varies. The older quarries were excavated in the 12 to 14 ft (3.7 to 4.3 m) range, and the commercial quarries reach depths up to 50 ft (15.2 m). The portion of the CMW that could be observed from the north end of the quarry was mostly covered with pools of water at the surface level and was populated with mangrove trees. Please see the Terrestrial Ecology Assessment of Alternatives Document for further details regarding the CMW and low-density mangrove areas. Peat was found in conjunction with the mangroves (**Figure 17**).

Figure 9: Bedrock outcrop in the CMW area (July 2023)

Figure 10: Bedrock outcrop within western terminus of the EWA (July 2023)

Figure 11: Limestone pit along the Mastic Trail (July 2023)

Figure 12: Exposed bedrock along Mastic Trail (July 2023)

Figure 13: Large bedrock outcrop along the Mastic trail (July 2023)

Figure 14: Crevice in the bedrock along the Mastic Trail (July 2023)

Figure 15: Active Quarry (July 2023)

Figure 16: Quarried rock (July 2023)

Figure 17: Peat in mangroves north of the quarry (July 2023)

4 Impact Assessment

The following section describes potential impacts from the proposed shortlist of alternatives that may include changes to the quantity and quality of freshwater lenses, brackish groundwater, and peat.

4.1 Quantitative

4.1.1 Freshwater Lenses and Brackish Groundwater

Freshwater lenses are critically important water supplies on Grand Cayman. Potential impacts to freshwater lenses include the addition of impermeable surfaces that could diminish groundwater recharge or redirect stormwater away from the freshwater lenses. The term "groundwater" in the context of this assessment refers to underground water throughout the whole project study area, which is mostly brackish (not fresh) water with a chloride concentration ranging from 60 to 19,000 milligrams per litre. Certain changes in recharge could negatively influence hydraulic conditions in and around freshwater lenses or degrade the quality of recharging water. In addition, changes in drainage patterns also have the potential to impact the freshwater lenses. Changes in groundwater quality could theoretically follow mixing of the existing groundwater with stormwater infiltrating off new roadway. Changes in the unconfined aquifer water level could result in a rise in the water table where stormwater is newly infiltrated, or the water table could drop locally if infiltration were reduced due to new impermeable surfaces.

The freshwater lenses can also be damaged as potential sources of potable supply if the groundwater flow system supporting the lens undergoes changes that diminish the volume of

freshwater. This may result in eventual salt-water contamination of all but the shallowest wells used to extract fresh groundwater.

In the Lower Valley and North Side areas, the freshwater lens is primarily used for residential use, agriculture, and horticulture, where farming takes place and residences have fruit trees and other crops that can be grown because there is fresh groundwater. The fresh groundwater also supports the presence of specific naturally occurring vegetation that could be impacted by changes in the presence of fresh groundwater.

The Water Authority operates a reverse osmosis plant at the Lower Valley Water Works, and this plant abstracts saline groundwater from below the shallow fresh groundwater. The saline brine from the plant is disposed below the abstraction zone. The fresh water produced at Lower Valley Water Works is distributed via the public water supply system.

The construction of the new road may involve deep foundations such as piers, columns, or piles. The specific types, sizes and locations of necessary bridge and other roadway structure foundations will be assessed later in the design phase of the project. Drilling for deep foundations can also potentially increase hydraulic connections between layers containing groundwaters of different quality (e.g., fresh or saline) thus leading to contamination.

The use of disposal wells adjacent to roadways is a current practice for the disposal of stormwater in Grand Cayman, and they may also be implemented as part of the EWA project. Depths and locations of existing stormwater disposal wells were provided by the NRA on August 4, 2023. The provided well data indicates that the stormwater is typically drained into the subsurface at levels that are stratigraphically underneath freshwater lenses, to minimize mixing of the stormwater with fresh groundwater. The stormwater disposal wells are generally deeper than the lower limits of freshwater lenses at Grand Cayman, based on stormwater disposal well data provided by the Water Authority. Therefore, the water in the stormwater disposal wells is entering the unconfined aquifer where the aquifer is brackish.

Stormwater drainage patterns and recharge rates may be impacted if the project requires construction of stormwater disposal wells or other means for the conveyance or discharge of stormwater. Changes in groundwater quality could theoretically follow mixing of the existing groundwater with stormwater infiltrating off new roadway. Changes in the unconfined aquifer water level could be a rise in the water table where stormwater is newly infiltrated, or the water table could drop locally if infiltration were reduced due to new impermeable surfaces.

The potential release of contaminants may also impact groundwater, including the freshwater lenses. Due to the karst geology of the Cayman Islands and the absence of shallow low permeability confining zones, contaminants released directly (e.g., spillages) or indirectly (via surface water runoff) from the proposed EWA have the potential to migrate into the underlying aquifers leading to deterioration in groundwater quality. The amount of possible impact from the EWA would be related to the facility location in either a lens recharge or discharge area. The lens recharge areas are depicted in **Figure 1 and Figure 5**. The lens discharge areas begin at the limits of the recharge area and are not delineated.

Theoretically, a circular freshwater lens is recharged in its centre (where it is thickest) by precipitation, and the lens discharges fresh groundwater at the edges of the hypothetical circle. The lenses on Grand Cayman have non-circular shapes, primarily due to the configuration of the underlying geology. The Cayman Islands Government mapped areas of the freshwater lenses (on the hydrogeologic map) show the lens recharge areas. The lens discharge areas are the areas outside the lenses, including wetlands. Specifically, the discharge areas include the wetlands generally located north of the Lower Valley lens, and south-east of the North Side lens.

Construction in the lens recharge areas would result in direct impacts on the lenses. In addition, if the discharge areas are disrupted, then the lenses might have their configurations and discharge flow directions changed. Generally, groundwater moves from areas of higher groundwater elevation to areas of lower groundwater elevation. In this sense the edges of the freshwater lenses on the hydrogeologic map are the edges of discharge areas. Based on Water Authority data, the freshwater lens recharge areas are the zones within the 600-milligram per litre chloride contours. At increasing distance away from the freshwater lens boundaries, the role of the swampy area as mainly a receiving zone for migrating freshwater will tend to diminish. For example, areas closer to the Atlantic Ocean will tend to be zones of mixing with seawater. In terms of potential impact, impacts within the lens recharge area are considered higher than impacts within the lens discharge area.

Furthermore, soil compaction and the increased impervious surfaces (pavement) may result in reduced infiltration, which may impact the recharge rate and water level in the Lower Valley and North Side freshwater lenses, as well as groundwater.

During the construction of the proposed EWA roadway, temporary dewatering of foundations may result in localised and temporary decline in groundwater levels and deterioration in groundwater quality via induced saline intrusion.

These potential impacts of the shortlisted alternatives have been assessed individually for the Lower Valley Freshwater Lens, the North Side Freshwater Lens, and brackish groundwater. The impact of the project on the change of drainage patterns and the potable supply of the freshwater lenses have been assessed by the distance from the proposed roadway to the freshwater lenses recharge area, as these are the only formally delineated boundaries. Reduced infiltration capacity of the freshwater lenses and groundwater have been assessed by measuring the increase of impervious surface area assuming that no sustainable drainage solutions be employed during the design. The temporary dewatering impact of the project was assessed along the length of the proposed roadway through the CMW. See **Table 1** for the quantified values for distance from the freshwater lenses, the amount of impervious surface area, and the length of roadway through the CMW.

4.1.2 Peat

Peat may potentially be removed, covered over, compacted, or contaminated during construction, which may impact the CMW. The peat substrate is necessary to provide new growth for many species of flora, including but not limited to mangrove species. Peat is a vital component of a healthy wetland ecosystem and sequesters and purifies toxins from the surrounding groundwater.

The removal of peat and potential for the release of greenhouse gases is discussed further in the Greenhouse Gas Assessment of Alternatives. The impact to peat was assessed by the overall quantity of peat removal anticipated for each alternative.

The methodology for determining the total quantity of peat removal for each alternative is based on the trial pit data supplied by NRA from 2008 and 2014 discussed in Section 3.5 of this document. The data included depths and locations of peat, which were translated to a profile/alignment in which an engineer design template was applied to calculate the volume of excavation based on the width of the corridor, the length along the alignment, and the depth provided by the trial pit data.

The original trial pit locations mostly line up with the current Alternative B1 corridor (**Attachment A**) and so were able to be applied along the entire alignment for the available data set. Missing pieces of data between trial pit locations were interpolated. For Alternatives B2, B3, and B4, this same trial pit data was applied to the portions of the alignment that followed or most closely followed the existing trial pit data. In some cases, where the trial pit locations were somewhat removed from the alignment, this data was projected to the alignment. In other locations that were far removed from the data, aerial imagery and context of location were used to best approximate additional peat removal areas (for example, if aerial imagery showed a densely vegetated area with pockets of water, similar to known peat areas).

Additional information regarding peat quantities is provided within the Engineering Evaluation Document. See **Table 1** for the quantified values of volume of peat removal and the length of roadway through the CMW.

Table 1: Summary of Geo-Environmental Quantitative Impact Assessment by Alternative

Resource	Potential Impact	Assessment Method	No-Build	B1	B2	B3	B4
Lower Valley Lens	Impact on lens recharge area	Acreage of roadway construction within the mapped recharge area	N/A*	10.1 acres 4.1 ha	10.1 acres 4.1 ha	10.1 acres 4.1 ha	10.1 acres 4.1 ha
North Side Lens	Impact on lens recharge area	Distance of additional roadway from the mapped recharge area	N/A*	0.1 mile; 0.2 km	0.5 mile; 0.8 km	0.6 mile; 0.9 km	1.3 miles; 2.1 km
Brackish Ground-water	Contamination of groundwater due to contaminant spills and infiltration of road runoff	Increase of impervious surface area**	0 acre; 0 ha	161 acres; 65 ha	132 acres; 53 ha	135 acres; 55 ha	98 acres; 40 ha
Peat	Peat impact on CMW	Additional length of roadway thru CMW	0 mile; 0 km	2.8 miles; 4.5 km	2.1 miles; 3.4 km	2.8 miles; 4.5 km	0.7 mile; 1.1 km
		Total volume of peat removal; *cubic yards (Cu yd); cubic metres (m^3)*	0 Cu yd; 0 m^3	550,994 Cu yd; 421,265 m^3	223,811 Cu yd; 171,116 m^3	454,153 Cu yd; 347,225 m^3	118,895 Cu yd; 90,902 m^3

*The No-Build scenario is considered the baseline for comparison for the Build alternatives in terms of roadway infrastructure. Therefore, is it considered to include no additional roadway (expressed as N/A).
**Impervious surface area was calculated based on the 2074 cross-sections and corridor lengths. See the Engineering Evaluation Document for additional details.

4.2 Qualitative

4.2.1 Qualitative Assessment Methodology

The following qualitative assessment for Geo-Environmental resources was based on the UK Department for Transport's "Transport Analysis Guidance Unit A3: Environmental Impact Appraisal" (WebTAG). The most applicable category for Geo-Environmental impacts is "Impacts to Water Environment". Therefore, this qualitative assessment incorporates WebTAG Section 10 of the Unit A3; Environmental Impact Appraisal as appropriate. The qualitative assessment also incorporates the March 2020 Design Manual for Roads and Bridges LA 113 as appropriate.

A variation from WebTAG Unit A3 is that this assessment did not include the "Very Large Adverse Impact" category since it is inconsistent with the 7-point qualitative scale assigned in the Appraisal Summary Table.

The **first step** of the qualitative assessment was to determine the importance (or value) of features based on the guidance table below:

Table 2: Estimating the Importance of Water Environment Features

Importance	Criteria	Examples
Very high	• Feature with a high quality and rarity, regional or national scale and limited potential for substitution	• Aquifer providing potable water to a large population (groundwater) • Important fish population (surface water) • Floodplain or defence protecting more than 100 residential properties (flood risk)
High	• Feature with a high quality and rarity, local scale and limited potential for substitution • Feature with a medium quality and rarity, regional or national scale and limited potential for substitution	• High status water body (surface water) • Aquifer providing potable water to a small population (groundwater) • Notable fish population (surface water) • Floodplain or defence protecting up to 100 residential properties or industrial premises (flood risk)
Medium	• Feature with a medium quality and rarity, local scale and limited potential for substitution • Feature with a low quality and rarity, regional or national scale and limited potential for substitution	• Good status water body (surface water) • Aquifer providing abstraction water for agricultural or industrial use (groundwater) • Floodplain or defence protecting up to 10 industrial premises (flood risk)
Low	• Feature with a low quality and rarity, local scale and limited potential for substitution	• Less than good status (surface water) • Unproductive strata (groundwater) • Floodplain with limited existing development (flood risk)

Source: WebTAG Unit A3, Environmental Impact Appraisal, Table 13, November 2023

The **second step** of the qualitative assessment was to determine the magnitude of impact (positive or negative). This is based on Table 14 from WebTAG Unit A3 as depicted in **Table 3**. Please note that the ranking system and criteria from WebTAG were followed, but that some of the terminology within the magnitude of impact section was modified to ease document consistency

and reader understanding. Because the subsequent step (the **third step**) in the evaluation uses the terms "Adverse" and "Beneficial," those terms in **Table 3** were changed to "Negative" and "Positive." This change in terminology is consistent with other sections of WebTAG Unit A3.

Table 3: Estimating the Magnitude of Impact

Magnitude	Criteria	Example
Major Negative	• Results in loss of feature	• Loss of important fishery • Change in water quality status • Compromise employment source • Loss of flood storage/increased flood risk • Pollution of potable source of abstraction
Moderate Negative	• Results in adverse impact on integrity of feature or loss of part of feature	• Loss in productivity of a fishery • Contribution of a significant proportion of the effluent in the receiving water body • Reduction in the economic value of the feature
Minor Negative	• Results in minor adverse impact on feature	• Measurable changes in feature, but of limited size and/or proportion
Negligible	• Results in an impact on feature but of insufficient magnitude to affect the use/integrity	• Discharges to watercourse but no significant loss in quality, fishery productivity or biodiversity • No significant impact on the economic value of the feature • No increase in flood risk
Minor Positive	• Results in minor beneficial impact on feature or a reduced risk of adverse effect occurring.	• Measurable changes in feature, but of limited size and/or proportion
Moderate Positive	• Results in moderate improvement of feature	• Enhanced productivity of a fishery • Reduction in a significant proportion of the effluent in a receiving water body • Moderate reduction in flood risk
Major Positive	• Results in major improvement of feature	• Removal of major existing polluting discharge to a watercourse • Major reduction in flood risk

Source: WebTAG Unit A3, Environmental Impact Appraisal, Table 14, November 2023

The **third step** of the qualitative assessment was to determine the assessment scores based on the results of Steps 1 and 2. As shown in **Table 4** the assessment scores are based on the magnitude of impact and the importance of the water environment feature. **Table 4** is the matrix that was used to define the scores of the selected features which are presented in **Table 7**.

This step is a streamlined version of determining the Overall Assessment Score of the water resource per WebTAG Unit A3 (see paragraph 10.2.15). To reduce confusion, the terminology in **Table 4** was updated to match the terms used in Unit A3's Table 16. However, the process for

using the matrix was not changed. This allows for an assessment score per *resource* to be determined.

Table 4: Assessment Score by Resource

Magnitude of Impact*	Importance of Water Environment Features			
	Very High	High	Medium	Low
Major Negative	Large adverse**	Large adverse	Moderate adverse	Slight adverse
Moderate Negative	Large adverse	Moderate adverse	Slight adverse	Neutral
Minor Negative	Moderate adverse	Slight adverse	Neutral	Neutral
Negligible	Slight adverse	Neutral	Neutral	Neutral

**All identified impacts were adverse, therefore beneficial impacts are not shown within the table*
***Very Large and Large Adverse were merged to be consistent with the 7-point qualitative scale for the Appraisal Summary Table*

Source: WebTAG Unit A3, Environmental Impact Appraisal, Table 15, November 2023

Finally, an Overall Assessment Score of each alternative that takes into account the individual assessment score for each resource is evaluated and determined (**Table 5**). WebTAG guides project teams to also consider the number of key water resources affected by a scheme when determining the Overall Assessment Score. Therefore, both the assessment score by resource as well as the number of impacted resources were taken into account when determining the Overall Assessment Score per alternative.

Table 5: Definitions of Overall Assessment Score

Score	Comment
Large Beneficial Impact	It is extremely unlikely that any scheme incorporating the construction of a new transport route (road or rail) would fit into this category. However, a scheme could have a large positive impact if it is predicted that it will result in a 'very' or 'highly' significant improvement to a water feature(s), with insignificant adverse impacts on other water features.
Moderate Beneficial Impact	Where the scheme provides an opportunity to enhance the water environment features, because it results in predicted: • Significant improvements for at least one water feature, with insignificant adverse impacts on other features; • Very or highly significant improvements, but with some adverse impacts of a much lower significance. The predicted improvements achieved by the scheme should greatly outweigh any potential negative impacts.
Slight Beneficial Impact	Where the scheme provides an opportunity to enhance the water environment, because it provides improvements in water features which are of greater significance than the adverse effects.

Score	Comment
Neutral	Where the net impact of the scheme is neutral, because: • It has no appreciable effect, either positive or negative, on the identified water environment features; • The scheme would result in a combination of effects, some positive and some negative, which balance to give an overall neutral impact. In most cases, these will be slight or moderate positive and negative impacts. It may be possible to balance impacts of greater significance; however, in these cases great care will be required to ensure that the impacts are comparable in terms of their potential environmental impacts and the perception of these impacts.
Slight Adverse Impacts	Where the scheme may result in a degradation of the water environment because the predicted adverse impacts are of greater significance than the predicted improvements.
Moderate Adverse Impacts	Where the scheme may result in a degradation of the water environment, because it results in predicted: • Significant adverse impacts on at least one feature, with insignificant predicted improvements to other features; • Very or highly significant adverse impacts but with some improvements which are of a much lower significance and are insufficient positive impacts to offset the negative impacts of the scheme.
Large Adverse Impact	Where the scheme may result in a degradation of the water environment, because it results in predicted: • Highly significant adverse impacts on a water environment feature; • Significant adverse impacts on several water environment features
**Very Large Adverse Impact was not included for consistency with the 7-point qualitative scale for the Appraisal Summary Table*	

Source: TAG Unit A3, Environmental Impact Appraisal, Table 16*, November 2023

4.2.2 Importance of Water Environment Features

The first step in the qualitative assessment was to determine the importance of each water environmental feature (resource) based on **Table 2**.

4.2.2.1 Lower Valley Freshwater Lens

As described in Section 2.2.1, the Lower Valley Freshwater Lens is an existing water supply source for potable water for a localized population. Fresh groundwater also supports agriculture and horticulture, including farming and residences with fruit trees and other crops, and the presence of specific naturally occurring vegetation.

While there is also a population that obtains treated public water from the Water Authority's desalination plant, there are domestic well owners that directly rely on the freshwater lens as a supply of water. While connection to the existing public water system is possible as a substitution, consumers who previously used private wells might have a new cost if they needed to switch to desalinated, public water for their supply. The Lower Valley Freshwater Lens receives a **"Very High"** rating on the Importance of Water Environment Features scale due to the high freshwater quality, its localized use as a fresh water supply, and limited potential for substitution.

4.2.2.2 North Side Freshwater Lens

As described in Section 2.2.2, the North Side Freshwater Lens is an existing water supply source for potable water for a localized population. Fresh groundwater also supports agriculture and horticulture, including farming and residences with fruit trees and other crops, and the presence of specific naturally occurring vegetation.

While there is also a population that obtains treated public water from the Water Authority's desalination plant, there are domestic well owners that directly rely on the freshwater lens as a supply of water. Consumers previously using only private wells would have a new cost if they needed to connect to public water, including situations where it was to be used for agriculture or horticulture.

While connection to the existing public water system is possible as a substitution, consumers who previously used private wells might have a new cost if they needed to switch to desalinated, public water for their supply. The North Side Freshwater Lens receives a **"Very High"** rating on the Importance of Water Environment Features scale due to the high freshwater quality, its localized use as a fresh water supply, and limited potential for substitution.

4.2.2.3 Brackish Groundwater

Brackish groundwater refers to the subsurface water located beneath the EIA study area, which is mostly brackish (a combination of salt water and fresh water). Brackish water is widely available though is unusable without treatment. Due to its generally non-potable water quality and wide availability, the brackish groundwater receives a **"Medium"** rating on the Importance of Water Environment Features scale.

4.2.2.4 Peat

The peat substrate, which is necessary to provide for new growth for many species of flora, is a vital component of a healthy wetland ecosystem, and sequesters and purifies toxins from the surrounding groundwater. Due to the direct connection of peat with ecosystems of high national priority with limited potential for substitution (CMW), peat receives a **"Very High"** rating on the Importance of Water Environment Features scale.

4.2.3 Magnitude of Impact

The second step in the qualitative assessment was to determine the magnitude of impact of each alternative on water environmental feature (resource) based on **Table 3**.

4.2.3.1 No-Build

The No-Build scenario is considered the baseline condition of comparison for the Build Alternatives (B1, B2, B3, and B4) regarding Geo-Environmental resources. Therefore, this scenario receives a **"Negligible"** rating on the Magnitude of Impact scale for all resources (Lower Valley Freshwater Lens, North Side Freshwater Lens, Brackish Groundwater, and Peat).

4.2.3.2 Alternative B1

Lower Valley Freshwater Lens: A portion of Alternative B1 extends across the recharge area of the Lower Vally Freshwater Lens and partially crosses the discharge area. Alternative B1 is anticipated to result in 10.1 acres (4.1 hectares) of roadway construction within the Lower Valley Freshwater Lens recharge area. This equates to approximately 1% of the identified overall recharge area. Potential impacts from construction within the recharge area include reduced infiltration and direct contamination during construction. Due to the potential for reduced infiltration and contamination, Alternative B1 is anticipated to have a negative impact on the Lower Vally Freshwater Lens. However, based upon the low area of impact (1% of recharge area) and amount of existing development within the Lower Valley Freshwater Lens recharge area, Alternative B1 is anticipated to have an insignificant impact on the overall waterbody quality. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

North Side Freshwater Lens: Alternative B1 is located approximately 0.1 mile (0.2 kilometre) south of the identified North Side Freshwater Lens recharge area. Due to the proximity, it is anticipated that a portion of Alternative B1 would be located within the North Side Freshwater Lens discharge area. As discussed in Section 4.1.1 above, the discharge areas are not formally delineated boundaries. Potential impacts from construction within the discharge area include disruption the natural discharge patterns and configuration of the freshwater portion of the lens. Due to the overall size of the resource and lack of direct impact on the recharge area, Alternative B1 is anticipated to have a measurable but insignificant impact on the North Side Freshwater Lens. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

Brackish Groundwater: Alternative B1 extends across an area underlain by brackish groundwater. While the brackish groundwater is mostly non-potable, it is ultimately hydrologically connected with freshwater. Potential impacts include decrease in infiltration due to additional impervious surface area and disruption to natural flow patterns beneath the roadway fill materials. Although Alternative B1 is anticipated to have a negative impact to the adjacent groundwater, it is anticipated to be limited in size/proportion due to the abundance of brackish groundwater throughout the EIA study area. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

Peat: Alternative B1 is anticipated to require approximately 550,994 Cu yd (421,265 m^3) of peat removal for construction. Alternative B1 is also anticipated to result in the construction of approximately 2.8 miles (4.5 km) of new roadway within the CMW. Due to the volume of peat removal required and dependence of the CMW system on peat for both substrate and water quality, peat removal is anticipated to have a negative, measurable impact on the CMW system. However, based on the overall size of the CMW system (**Figure 1**), Alternative B1 is not anticipated to result in a degraded quality or loss of the overall CMW system due to peat removal. Therefore, it receives a **"Moderate Negative"** rating on the Magnitude of Impact scale.

4.2.3.3 Alternative B2

Lower Valley Freshwater Lens: A portion of Alternative B2 extends across the recharge area of the Lower Vally Freshwater Lens and partially crosses the discharge area. Alternative B2 is anticipated to result in 10.1 acres (4.1 hectares) of roadway construction within the Lower Valley Freshwater Lens recharge area. This equates to approximately 1% of the identified overall recharge area. Potential impacts from construction within the recharge area include reduced infiltration and direct contamination during construction. Due to the potential for reduced infiltration and contamination, Alternative B2 is anticipated to have a negative impact on the Lower Vally Freshwater Lens. However, based upon the low area of impact (1% of recharge area) and amount of existing development within the Lower Vally Freshwater Lens recharge area, Alternative B2 is anticipated to have an insignificant impact on the overall waterbody quality. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

North Side Freshwater Lens: Alternative B2 is located approximately 0.5 mile (0.8 kilometre) south of the mapped North Side Freshwater Lens recharge area. Due to the distance, it is unclear whether the alternative is located within the North Side Freshwater Lens discharge area. Therefore, Alternative B2 is anticipated to have an immeasurable impact on the North Side Freshwater Lens. Therefore, it receives a **"Negligible"** rating on the Magnitude of Impact scale.

Brackish Groundwater: Alternative B2 extends across area underlain by brackish groundwater. While the brackish groundwater is mostly non-potable, it is ultimately hydrologically connected with freshwater. Potential impacts include decrease in infiltration due to additional impervious surface area and disruption to natural flow patterns beneath the roadway fill materials. Although Alternative B2 is anticipated to have a negative impact to the adjacent groundwater, it is anticipated to be limited in size/proportion due to the abundance of brackish groundwater throughout the EIA study area. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

Peat: Alternative B2 is anticipated to require approximately 223,811 Cu yd (171,116 m^3) of peat removal for construction. Alternative B2 is also anticipated to result in the construction of approximately 2.1 miles (3.4 km) of new roadway within the CMW. Due to the volume of peat removal required and dependence of the CMW system on peat for both substrate and water quality, peat removal is anticipated to have a negative, measurable impact on the CMW system. However, based on the overall size of the CMW system **(Figure 1)**, Alternative B2 is not anticipated to result in a degraded quality or loss of the overall CMW system due to peat removal. Therefore, it receives an **"Moderate Negative"** rating on the Magnitude of Impact scale.

4.2.3.4 Alternative B3

Lower Valley Freshwater Lens: A portion of Alternative B3 extends across the recharge area of the Lower Vally Freshwater Lens and partially crosses the discharge area. Alternative B3 is anticipated to result in 10.1 acres (4.1 hectares) of roadway construction within the Lower Valley Freshwater Lens recharge area. This equates to approximately 1%

of the identified overall recharge area. Potential impacts from construction within the recharge area include reduced infiltration and direct contamination during construction. Due to the potential for reduced infiltration and contamination, Alternative B3 is anticipated to have a negative impact on the Lower Vally Freshwater Lens. However, based upon the low area of impact (1% of recharge area) and amount of existing development within the Lower Vally Freshwater Lens recharge area, Alternative B3 is anticipated to have an insignificant impact on the overall waterbody quality. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

North Side Freshwater Lens: Alternative B3 is located approximately 0.5 mile (0.9 kilometre) south of the identified North Side Freshwater Lens recharge area. Due to the distance, it is unclear whether the alternative is located within the North Side Freshwater Lens discharge area. Therefore, Alternative B3 is anticipated to have an immeasurable impact on the North Side Freshwater Lens. Therefore, it receives a **"Negligible"** rating on the Magnitude of Impact scale.

Brackish Groundwater: Alternative B3 extends across area underlain by brackish groundwater. While the brackish groundwater is mostly non-potable, it is ultimately hydrologically connected with freshwater. Potential impacts include decrease in infiltration due to additional impervious surface area and disruption to natural flow patterns beneath the roadway fill materials. Although Alternative B3 is anticipated to have a negative impact to the adjacent groundwater, it is anticipated to be limited in size/proportion due to the abundance of brackish groundwater throughout the EIA study area. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

Peat: Alternative B3 is anticipated to require approximately 454,153 Cu yd (347,225 m^3) of peat removal for construction. Alternative B3 is also anticipated to result in the construction of approximately 2.8 miles (4.5 km) of new roadway within the CMW. Due to the volume of peat removal required and dependence of the CMW system on peat for both substrate and water quality, peat removal is anticipated to have a negative, measurable impact on the CMW system; however, based on the overall size of the CMW system **(Figure 1)**, Alternative B3 is not anticipated to result in a degraded quality to the overall CMW system due to peat removal. Therefore, it receives a **"Moderate Negative"** rating on the Magnitude of Impact scale.

4.2.3.5 Alternative B4

Lower Valley Freshwater Lens: A portion of Alternative B4 extends across the recharge area of the Lower Vally Freshwater Lens and partially crosses the discharge area. Alternative B4 is anticipated to result in 10.1 acres (4.1 hectares) of roadway construction within the Lower Valley Freshwater Lens recharge area. This equates to approximately 1% of the identified overall recharge area. Potential impacts from construction within the recharge area include reduced infiltration and direct contamination during construction. Due to the potential for reduced infiltration and contamination, Alternative B4 is anticipated to have a negative impact on the Lower Vally Freshwater Lens. However, based upon the low area of impact (1% of recharge area) and amount of existing development

within the Lower Vally Freshwater Lens recharge area, Alternative B4 is anticipated to have an insignificant impact on the overall waterbody quality. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

North Side Freshwater Lens: Alternative B4 is located approximately 1.2 miles (2.0 kilometres) south of the identified North Side Freshwater Lens recharge area. Due to the distance, it is unclear whether the alternative is located within the North Side Freshwater Lens discharge area. Therefore, Alternative B4 is anticipated to have an immeasurable impact on the North Side Freshwater Lens. Therefore, it receives a **"Negligible"** rating on the Magnitude of Impact scale.

Brackish Groundwater: Alternative B4 extends across area underlain by brackish groundwater. While the brackish groundwater is mostly non-potable, it is ultimately hydrologically connected with freshwater. Potential impacts include decrease in infiltration due to additional impervious surface area and disruption to natural flow patterns beneath the roadway fill materials. Although Alternative B4 is anticipated to have a negative impact to the adjacent groundwater, it is anticipated to be limited in size/proportion due to the abundance of brackish groundwater throughout the EIA study area. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

Peat: Alternative B4 is anticipated to require approximately 118,895 Cu yd (90,902 m^3) of peat removal for construction. Alternative B4 is also anticipated to result in the construction of approximately 0.7 mile (1.1 km) of new roadway within the **CMW**. Due to the volume of peat removal required and dependence of the CMW system on peat for both substrate and water quality, peat removal is anticipated to have a negative, measurable impact on the CMW system; however, based on the overall size of the CMW system (**Figure 1**) and limited disturbance through the CMW, Alternative B4 is anticipated to result in a negative impact of limited size/proportion due to peat removal. Therefore, it receives a **"Minor Negative"** rating on the Magnitude of Impact scale.

4.2.4 Overall Assessment Scores

Table 6 provides an overview of the Importance and Magnitude of Impact by resource and alternative.

Table 6: Summary Table of Importance and Magnitude of Impact by Resource and Alternative

Resource	Importance	Anticipated Magnitude of Impact by Alternative				
		No-Build	B1	B2	B3	B4
Lower Valley Freshwater Lens	Very High	Negligible	Minor Negative	Minor Negative	Minor Negative	Minor Negative
North Side Freshwater Lens	Very High	Negligible	Minor Negative	Negligible	Negligible	Negligible
Brackish Ground-water	Medium	Negligible	Minor Negative	Minor Negative	Minor Negative	Minor Negative
Peat	Very High	Negligible	Moderate Negative	Moderate Negative	Moderate Negative	Minor Negative

Table 7 provides an overall summary of the qualitative rating by resource and overall. As discussed in Section 4.2.1 above, the qualitative rating by resource is based on the importance of the resource and magnitude of impact as show in **Table 4**. For example, the Lower Valley Freshwater Lens has an importance of "Very High," and B1 is anticipated to have a "Minor Negative" impact on the resource; therefore, per **Table 4**, the anticipated impact of B1 on the Lower Valley Freshwater Lens is "Moderate Adverse." The overall qualitative rating for each Build alternative is based on the definition of assessment score guidance shown in **Table 5**. The following describes the overall qualitative impacts determined for each of the shortlisted alternatives.

No-Build: The No-Build scenario is anticipated to have a Slight Adverse or Neutral impact on the identified features. Therefore, it results in an overall "Slight Adverse" rating based on **Table 5**.

Alternatives B1, B2, and B3: Alternatives B1, B2, and B3 are anticipated to have a significant adverse impact on one feature (large adverse impact on peat) with moderate or slight impacts on the other identified features. Therefore, these alternatives result in an overall "Large Adverse" rating based on **Table 5**.

Alternative B4: Alternative B4 is anticipated to have moderate impacts on two features (moderate adverse impact on the Lower Valley Freshwater Lens and Peat) with a Slight Adverse or Neutral impact on the other identified features. Therefore, it results in an overall "Moderate Adverse" rating based on **Table 5**.

Table 7: Summary Table of Qualitative Impacts on Geo-Environmental Resources

Resource	No-Build	B1	B2	B3	B4
Lower Valley Freshwater Lens	Slight Adverse	Moderate Adverse	Moderate Adverse	Moderate Adverse	Moderate Adverse
North Side Freshwater Lens	Slight Adverse	Moderate Adverse	Slight Adverse	Slight Adverse	Slight Adverse
Brackish Groundwater	Neutral	Neutral	Neutral	Neutral	Neutral
Peat	Slight Adverse	Large Adverse	Large Adverse	Large Adverse	Moderate Adverse
Overall Qualitative Rating	**Slight Adverse**	**Large Adverse**	**Large Adverse**	**Large Adverse**	**Moderate Adverse**

4.3 Monetary

Not applicable per the UK Department for Transport "Transport Analysis Guidance".

5 Shortlist Evaluation Summary

The Shortlist Evaluation included a quantitative analysis (Section 4.1), a qualitative analysis (Section 4.2), and a monetary valuation (Section 4.3) for each of the shortlisted Build alternatives along with the No-Build scenario. As noted in Section 4.3, a monetary valuation is not applicable per the UK Department for Transport "Transport Analysis Guidance". The listed evaluations have been compiled into **Table 8** below.

For the unavoidable impacts reported, mitigation measures to aid in offsetting impacts may be possible. Mitigation measures have not been considered as part of this Shortlist Evaluation but will be investigated and identified for the Preferred Alternative and documented in the forthcoming Environmental Statement Document.

Table 8: Summary Table Geo-Environmental Shortlist Evaluation

Resource	No-Build	B1	B2	B3	B4
Lower Valley Freshwater Lens	Slight Adverse (0 acre; 0 ha of construction)	Moderate Adverse (10.1 acres; 4.1 ha of construction)	Moderate Adverse (10.1 acres; 4.1 ha of construction)	Moderate Adverse (10.1 acres; 4.1 ha of construction)	Moderate Adverse (10.1 acres; 4.1 ha of construction)
North Side Freshwater Lens	Slight Adverse (N/A)	Moderate Adverse (0.1 mile; 0.2 km distance)	Slight Adverse (0.5 mile; 0.8 km distance)	Slight Adverse (0.5 mile; 0.9 km distance)	Slight Adverse (1.2 miles; 2.0 km distance)
Brackish Groundwater	Neutral (0 acre; 0 ha)	Neutral (161 acres; 65 ha)	Neutral (132 acres; 53 ha)	Neutral (135 acres; 55 ha)	Neutral (98 acres; 40 ha)
Peat	Slight Adverse (0 mile; 0 km thru CMW) (0 Cu yd; 0 m^3)	Large Adverse (2.8 miles; 4.5 km thru CMW) (550,994 Cu yd; 421,265 m^3)	Large Adverse (2.1 miles; 3.4 km thru CMW) (223,811 Cu yd; 171,116 m^3)	Large Adverse (2.8 miles; 4.5 km thru CMW) (454,153 Cu yd; 347,225 m3)	Moderate Adverse (0.7 mile; 1.1 km thru CMW) (118,895 Cu yd; 90,902 m3)
Overall Qualitative Rating	**Slight Adverse**	**Large Adverse**	**Large Adverse**	**Large Adverse**	**Moderate Adverse**

The following summarizes the results of the analysis for the identified geo-environmental resources:

- *No-Build* – Based on the parameters of the evaluation, the No-Build scenario is not anticipated to have additional direct impacts on the identified geo-environmental resources

and considered the baseline of comparison. However, even a negligible impact on a resource of very high importance, such as the Freshwater Lenses and the peat, results in a "Slight Adverse" impact per WebTAG Unit A3. Therefore, it results in an overall **Slight Adverse** qualitative rating.

- *Alternative B4*– Based on the parameters of the evaluation, Alternative B4 would be the least impactful of the four Build alternatives since it is qualitatively ranked the lowest at **Moderate Adverse**, is the furthest from the North Side Freshwater Lens recharge area, requires the least acreage of additional impervious surface area, miles of roadway through the CMW, and volume of peat removal.

- *Alternative B2*– Based on the parameters of the evaluation, Alternative B2 would be the second least impactful of the four Build alternatives. While Alternative B2 has the same overall qualitative rating as Alternative B1 and Alternative B3 (**Large Adverse**), Alternative B2 results in less acreage of additional impervious surface area, miles of roadway through the CMW, and volume of peat removal than Alternative B1 or Alternative B3. Therefore, is it anticipated to be less impactful than Alternative B1 and Alternative B3 overall.

- *Alternative B3* – Based on the parameters of the evaluation, Alternative B3 would be the third least impactful of the four Build alternatives. Alternative B3 has the same overall qualitative rating as Alternative B1 and Alternative B2 (**Large Adverse**). However, as discussed in the Alternative B2 section above, Alternative B3 is anticipated to overall be more impactful than Alternative B2 based on the higher acreage of additional impervious surface area, miles of roadway through the CMW, and volume of peat removal.

- *Alternative B1* – Based on the parameters of the evaluation, Alternative B1 would be the most impactful of the four Build alternatives. While Alternative B1 has the same overall qualitative rating as Alternative B2 and Alternative B3 (**Large Adverse**), Alternative B1 is the closest of the Build alternatives to the North Side Freshwater Lens recharge area, requires the most acreage of additional impervious surface area, miles of roadway through the CMW, and volume of peat removal.

This Geo-Environmental Assessment is one in a series of Technical Reports that have been prepared for the Shortlist Evaluation. The level of impacts and the identification of the least impactful alternative will differ based on the resource/feature evaluated in each of the Technical Reports. Therefore, the least impactful alternative described in this evaluation summary and in each technical document **does not** move an alternative forward to the Preferred Evaluation nor does it constitute any special weighting or extra consideration in the Shortlist Evaluation Document. The comprehensive analysis of all the resources/features evaluated along with the rationale for the identification of the Preferred Alternative are presented in the Shortlist Evaluation Document.

6 References

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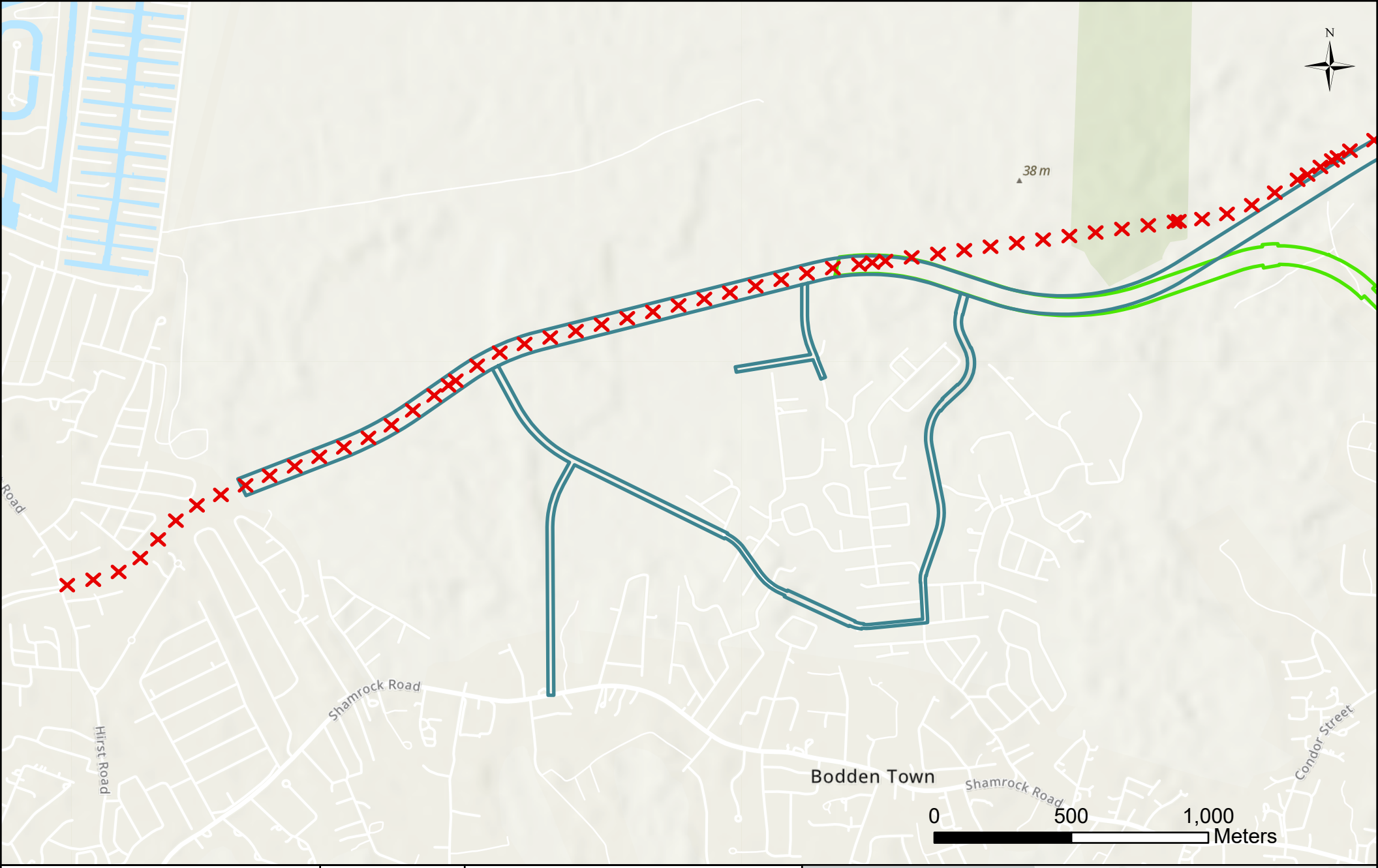
Attachment A

NRA Trial Pit Data – 2008 and 2014

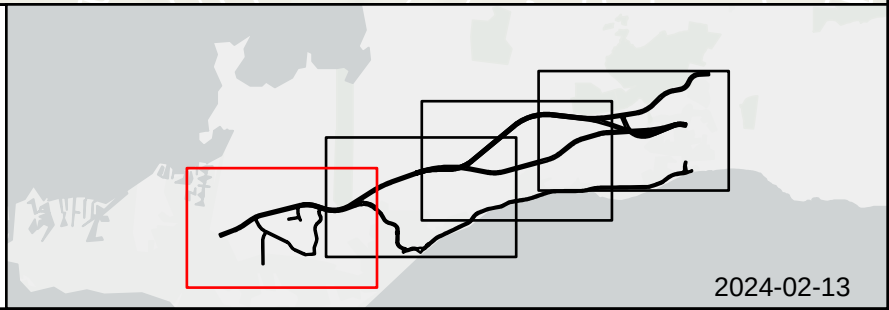


East-West Arterial Extension,
Environmental Impact Assessment

2008 and 2014
Trial Pit Locations
Map 1 of 4

NRA
NATIONAL ROADS AUTHORITY

- Section 2
- Alternative B1
- Alternative B2
- Alternative B3
- Alternative B4
- Trial Pit Locations



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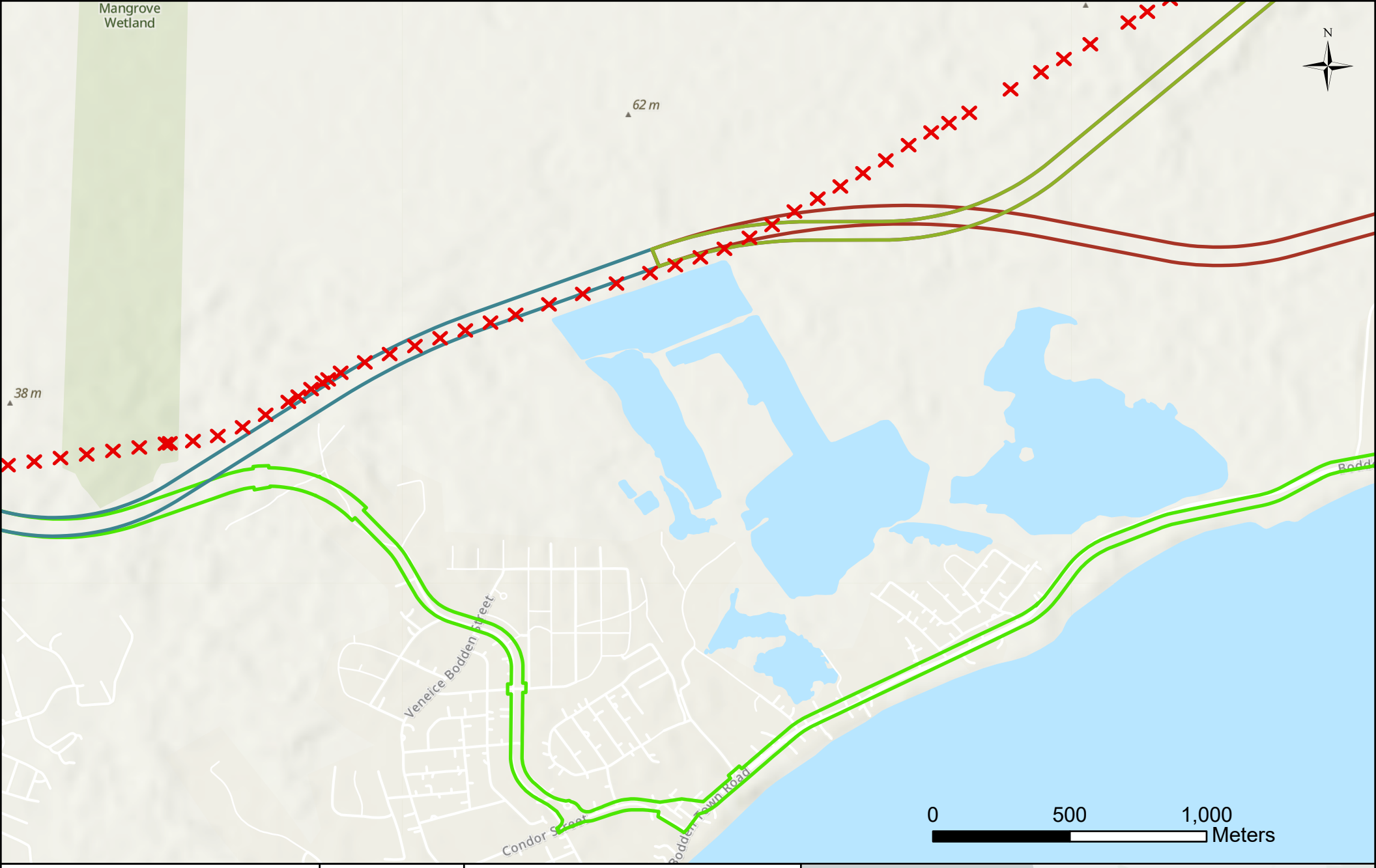
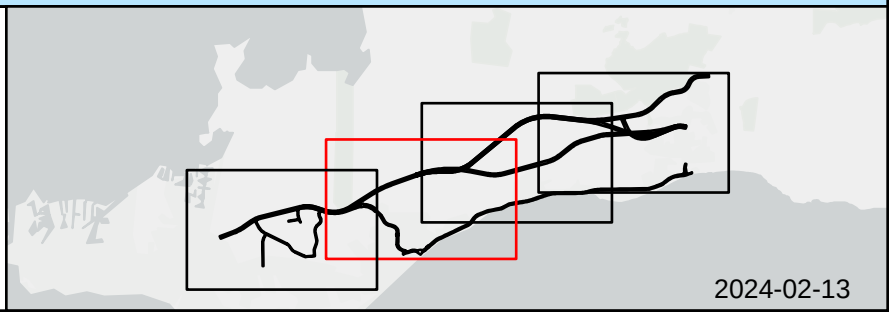


East-West Arterial Extension,
Environmental Impact Assessment

2008 and 2014
Trial Pit Locations
Map 2 of 4

NRA
NATIONAL ROADS AUTHORITY

- Section 2
- Alternative B1
- Alternative B2
- Alternative B3
- Alternative B4
- Trial Pit Locations



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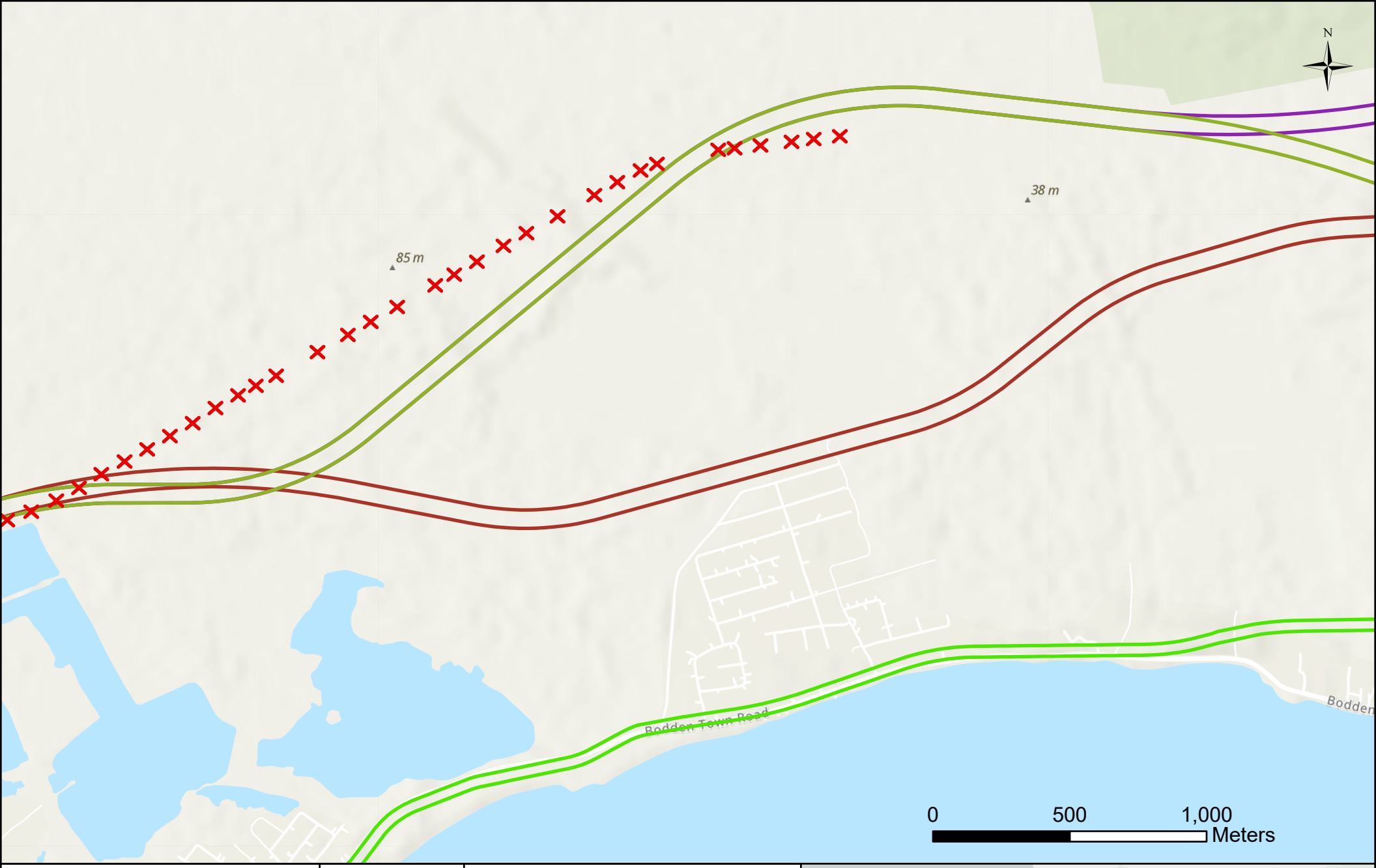
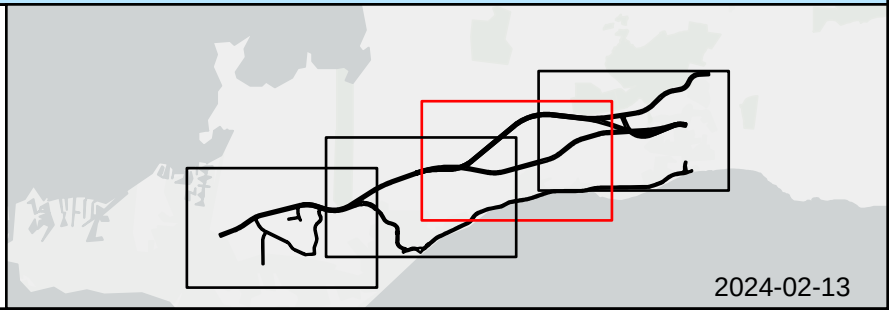


East-West Arterial Extension,
Environmental Impact Assessment

2008 and 2014
Trial Pit Locations
Map 3 of 4

NRA
NATIONAL ROADS AUTHORITY

- Section 2
- Alternative B1
- Alternative B2
- Alternative B3
- Alternative B4
- Trial Pit Locations



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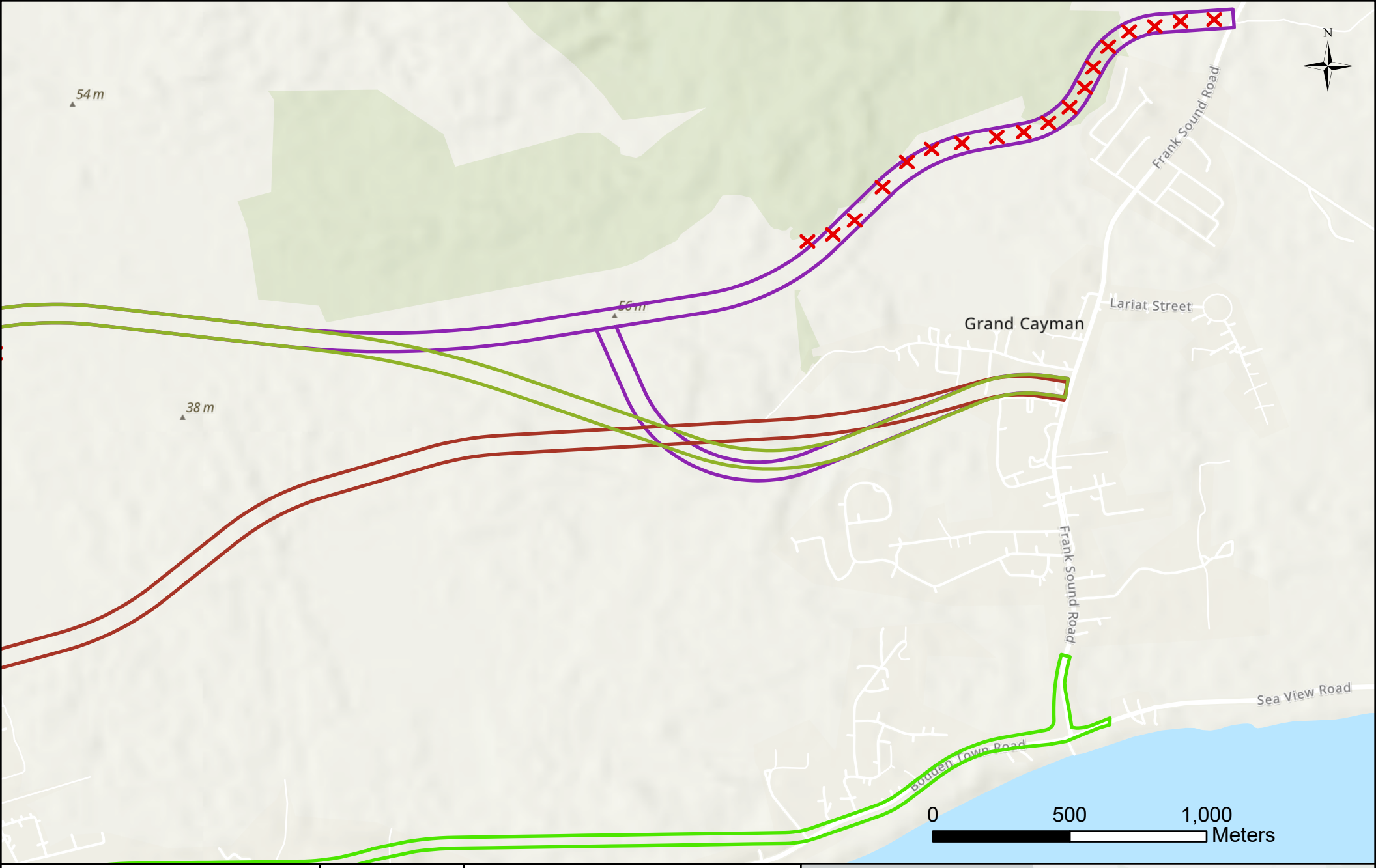
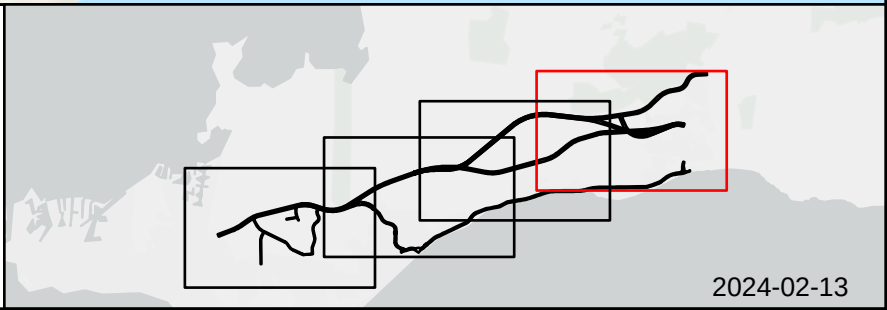


East-West Arterial Extension,
Environmental Impact Assessment

2008 and 2014
Trial Pit Locations
Map 4 of 4

NRA
NATIONAL ROADS AUTHORITY

- Section 2
- Alternative B1
- Alternative B2
- Alternative B3
- Alternative B4
- Trial Pit Locations



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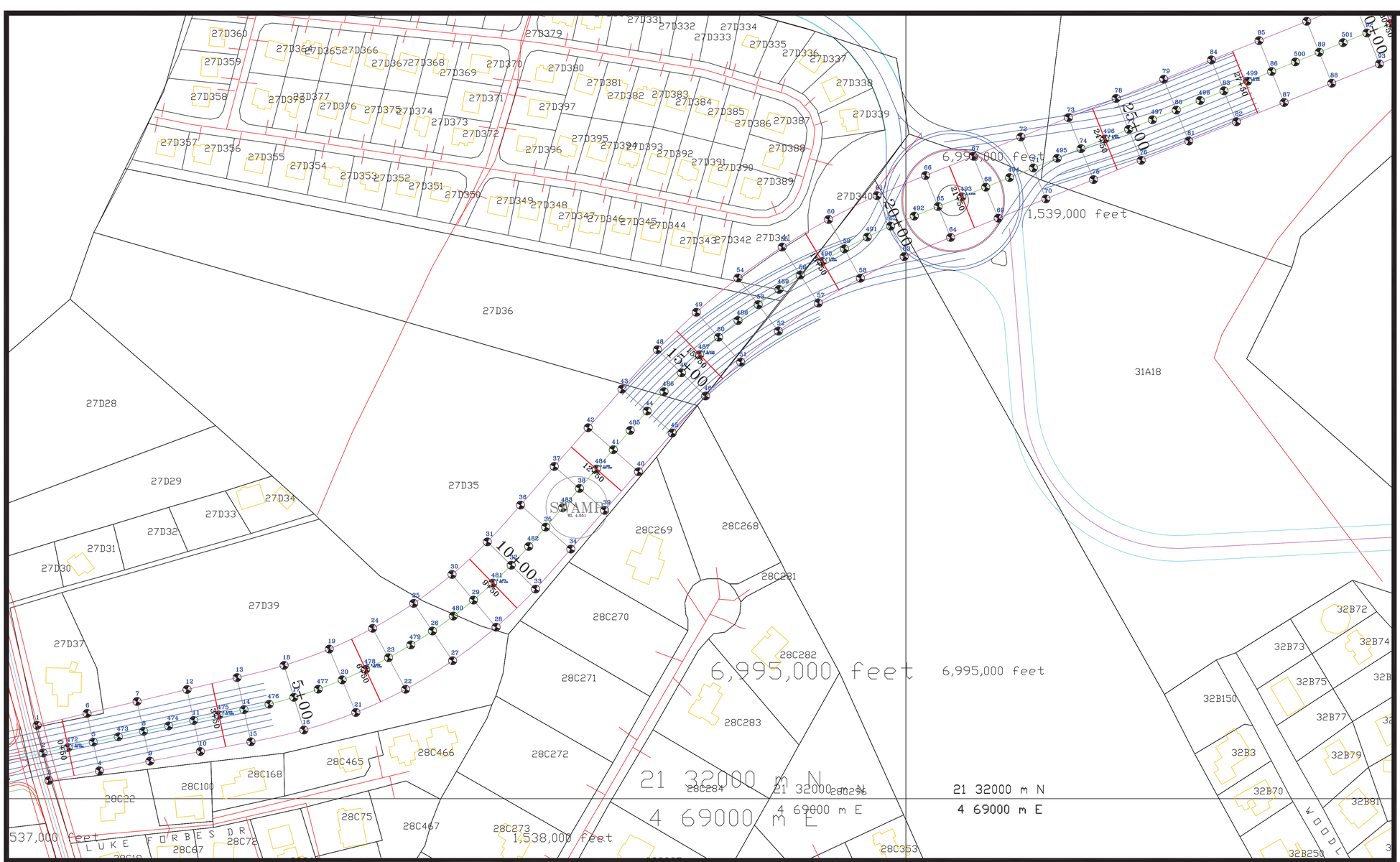

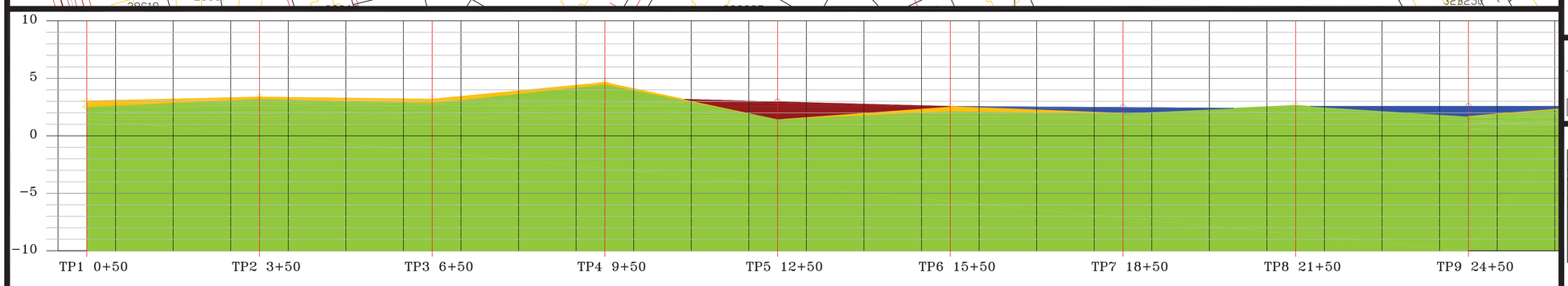

TYPICAL TRIAL PIT #2 STATION 3+50

TYPICAL TRIAL PIT #5 STATION 12+50

TYPICAL TRIAL PIT #6 STATION 15+50

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION HIRST ROAD TO LOOK OUT GARDENS GEOTECHNICAL SURVEY SEPTEMBER 2008

POINT #	TRIAL PIT NOS	STATION LOC	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
472	TP1	0+50	300'	3.033		3.033		2.533
475	TP2	3+50	300'	3.375		3.375		3.208
478	TP3	6+50	300'	3.192		3.192		2.859
481	TP4	9+50	300'	4.641		4.641		4.474
484	TP5	12+50	300'				2.956	1.456
487	TP6	15+50	300'	2.558		2.558		2.1414
490	TP7	18+50	300'		2.462			1.964
493	TP8	21+50	300'	2.646		2.646		2.646
496	TP9	24+50	300'		2.567			1.687

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Project ref. GC44

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC44EAST-WEST ALIGN

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Drawn	D. Myles
Checked	P. Parchment
Date:	22/10/08
Dwg.No.	1

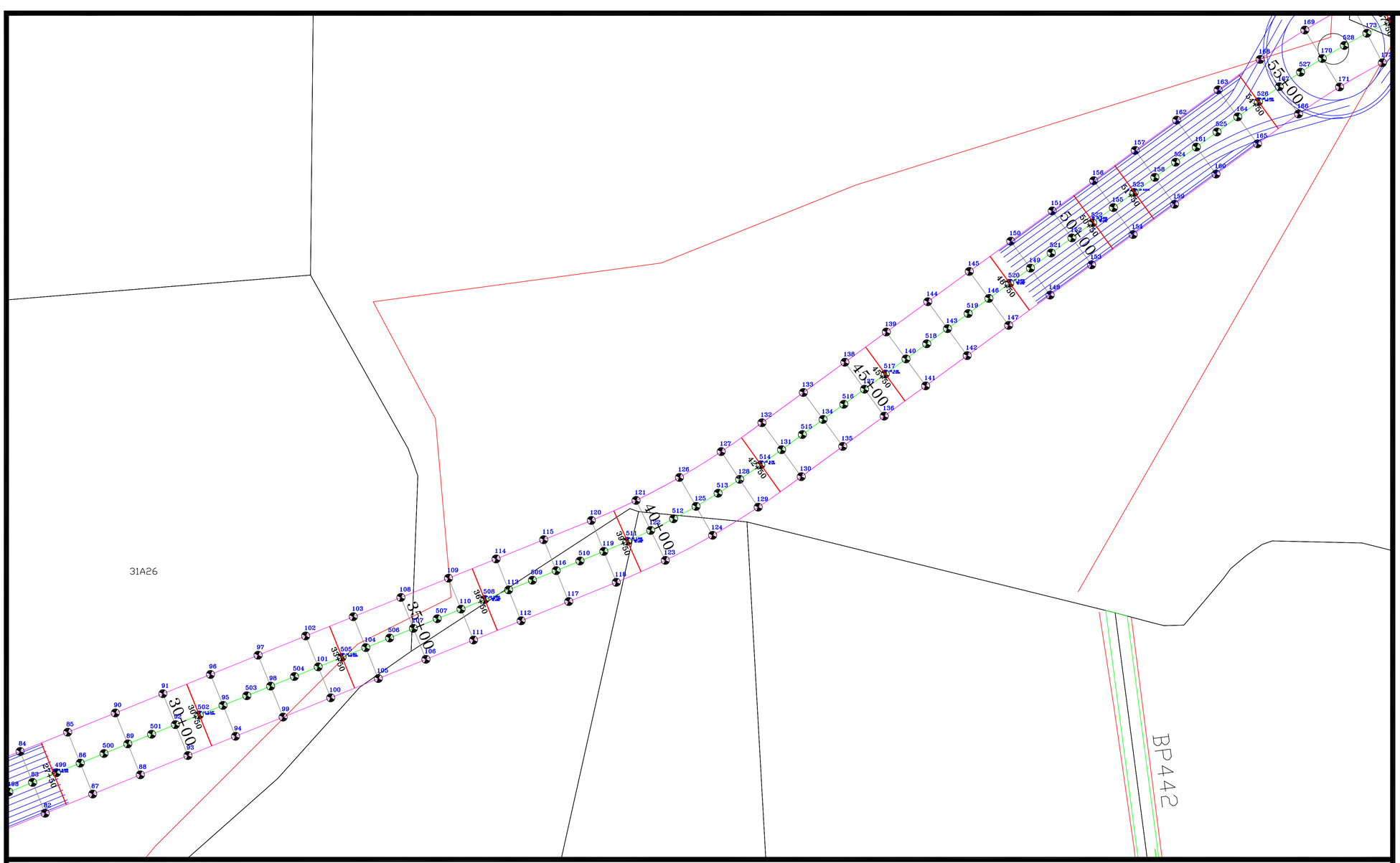
No.	Revisions	Date	By

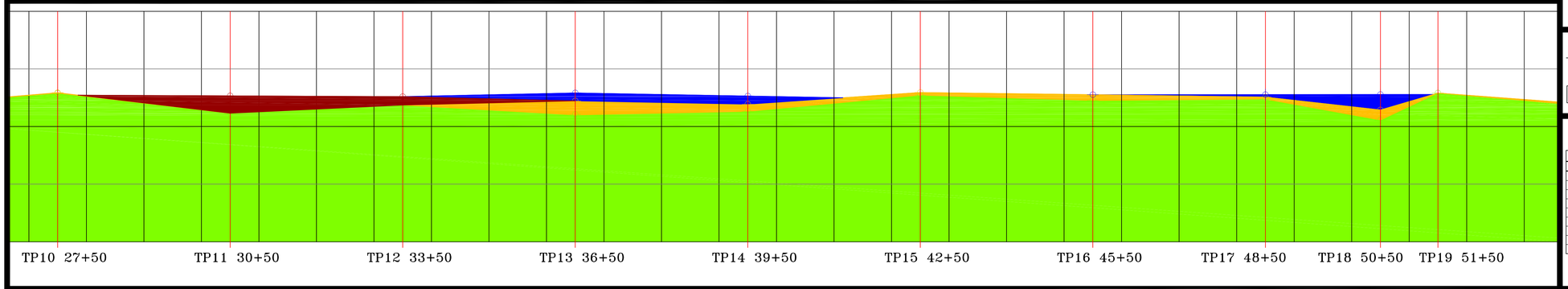
From sta. BOP
To sta. 27+50

Sheet 1 of 7

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST−WEST EXTENSION





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LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION HIRST ROAD TO LOOK OUT GARDENS GEOTECHNICAL SURVEY SEPTEMBER 2008

POINT #	TRIAL PIT NOS	STATION LOC	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
499	TP10	27+50	300'	2.94		2.94		2.896
502	TP11	30+50	300'	2.668			2.668	1.147
505	TP12	33+50	300'	2.599			2.599	1.861
508	TP13	36+50	300'	1.227	2.919	1.227		1.052
511	TP14	39+50	300'	1.936	2.649	1.936		1.305
514	TP15	42+50	300'	2.96		2.96		2.72
517	TP16	45+50	300'		2.766			2.26
520	TP17	48+50	200'	2.555	2.773	2.555		2.375
522	TP18	50+50	100'	1.438	2.781	1.438		0.563

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No.	Revisions	Date	By

From sta. 27+50
To sta. 55+00

Sheet 2 of 7

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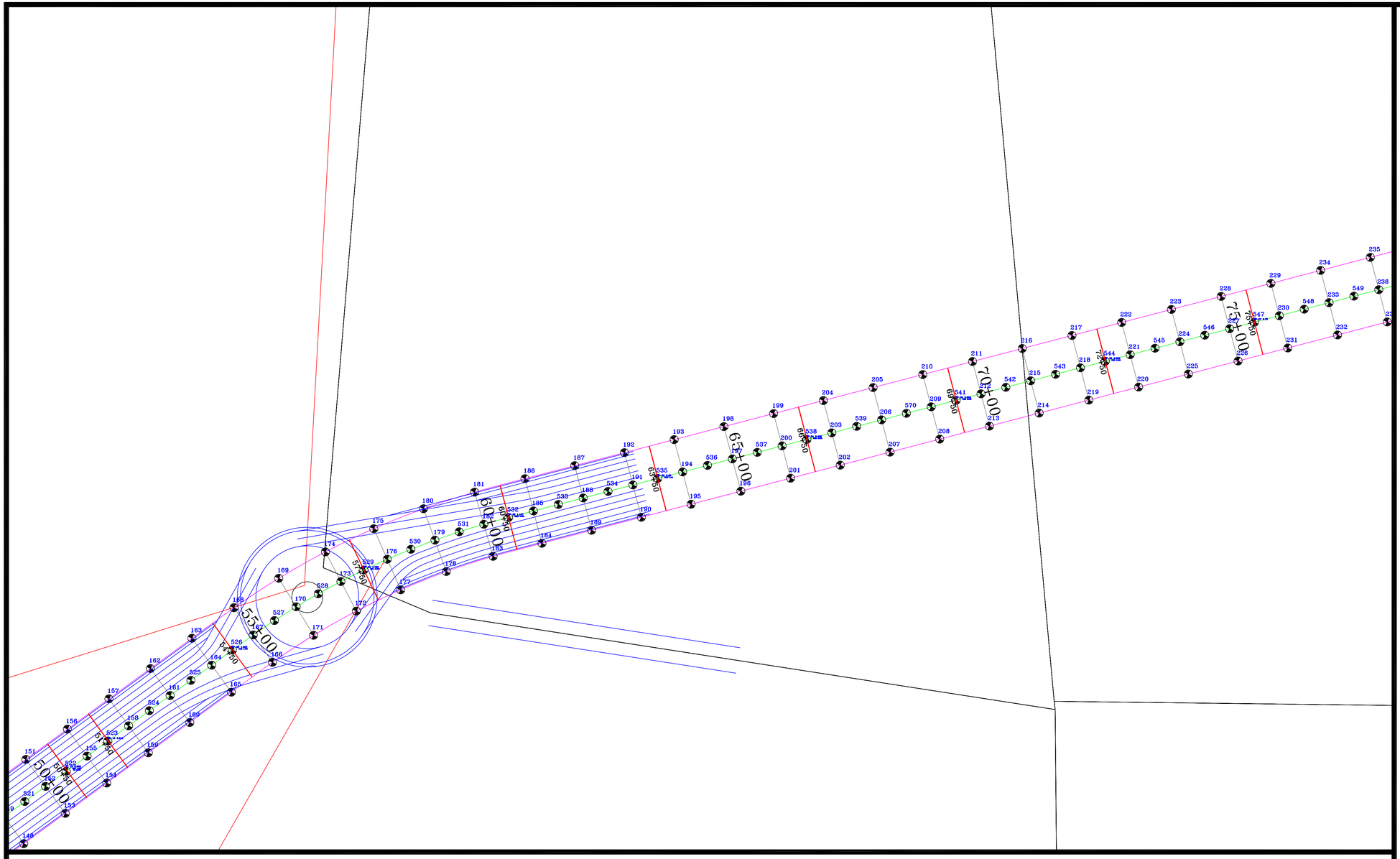
PLAN AND PROFILE LOCATIONS
FOR GEOTECHNICAL SURVEY
ON THE EAST-WEST EXTENSION



TYPICAL TRIAL PIT #21 STATION 57+50

TYPICAL TRIAL PIT #24 STATION 66+50

TYPICAL TRIAL PIT #26 STATION 72+50

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION HIRST ROAD TO LOOK OUT GARDENS GEOTECHNICAL SURVEY SEPTEMBER 2008

POINT #	TRIAL PIT NOS	STATION LOC	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
523	TP19	51+50	300'	2.912				2.912
526	TP20	54+50	300'	1.796		1.796		1.60
529	TP21	57+50	300'	2.239		2.239		1.729
532	TP22	60+50	300'	2.308			2.308	1.157
535	TP23	63+50	300'	2.42			2.42	2.22
538	TP24	66+50	300'	2.794		2.794		2.402
541	TP25	69+50	300'	3.507		3.507		3.234
544	TP26	72+50	300'	2.549		2.549		2.386
547	TP27	75+50	300'	2.75				2.75

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No.	Revisions	Date	By

From sta. 55+00
To sta. 75+00

Sheet 3 of 7

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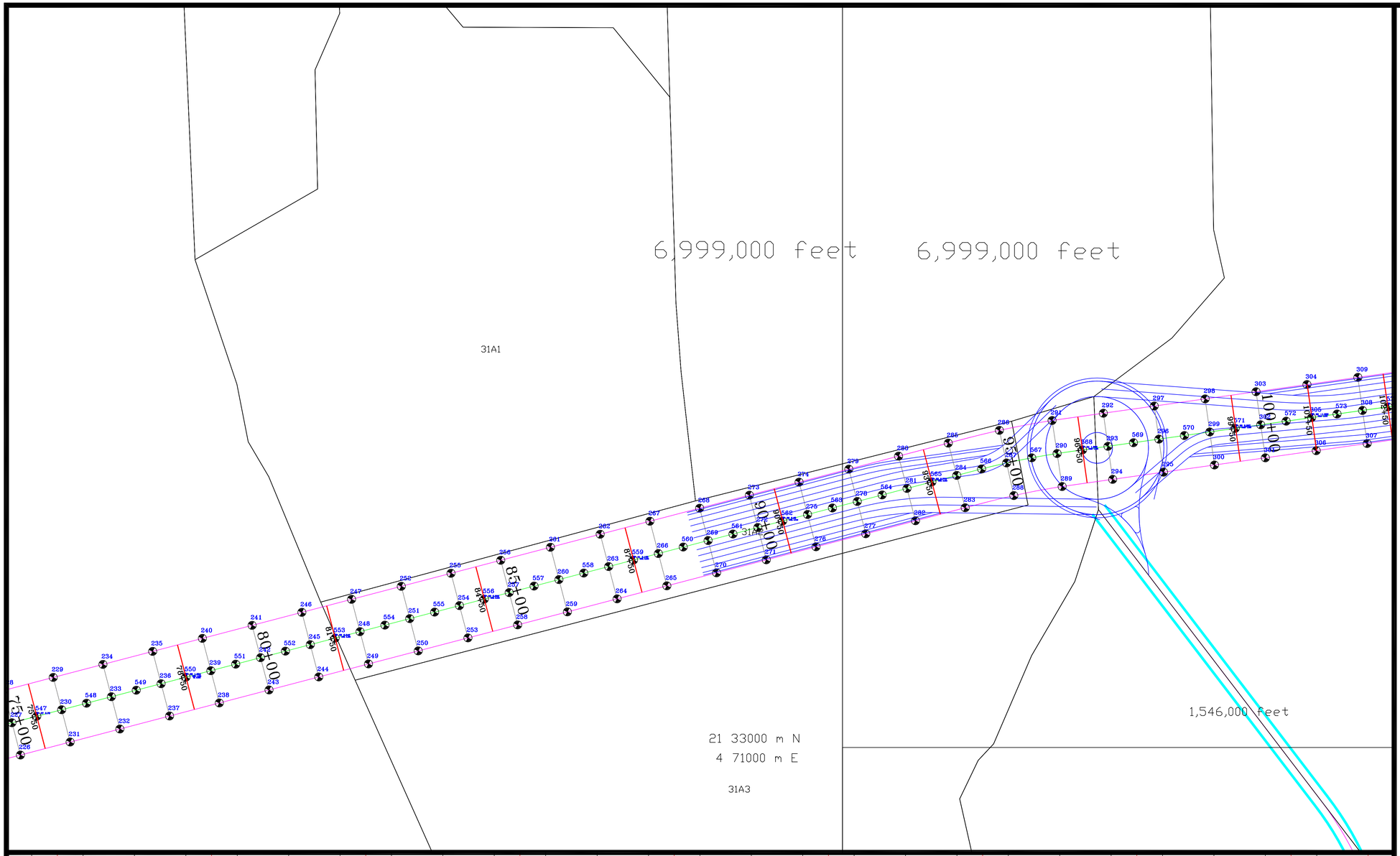
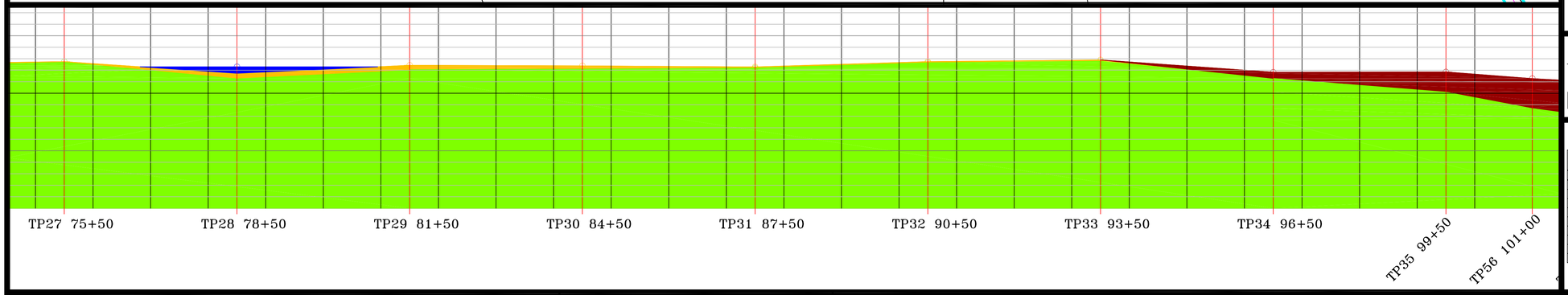
PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION



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LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION HIRST ROAD TO LOOK OUT GARDENS GEOTECHNICAL SURVEY SEPTEMBER 2008

POINT #	TRIAL PIT NOS	STATION LOC	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
550	TP28	78+50	300'	1.731	2.303	1.731		1.304
553	TP29	81+50	300'	2.433		2.433		2.046
556	TP30	84+50	300'	2.382		2.382		2.099
559	TP31	87+50	300'	2.295		2.295		2.195
562	TP32	90+50	300'	2.746		2.746		2.65
565	TP33	93+50	300'	2.896		2.896		2.779
568	TP34	96+50	300'	1.829			1.829	1.288
571	TP35	99+50	150'	1.855			1.855	0.057
305	TP56	101+00	150'	1.278			1.278	-1.322

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No.	Revisions	Date	By

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To sta. 100+00

Sheet 4 of 7

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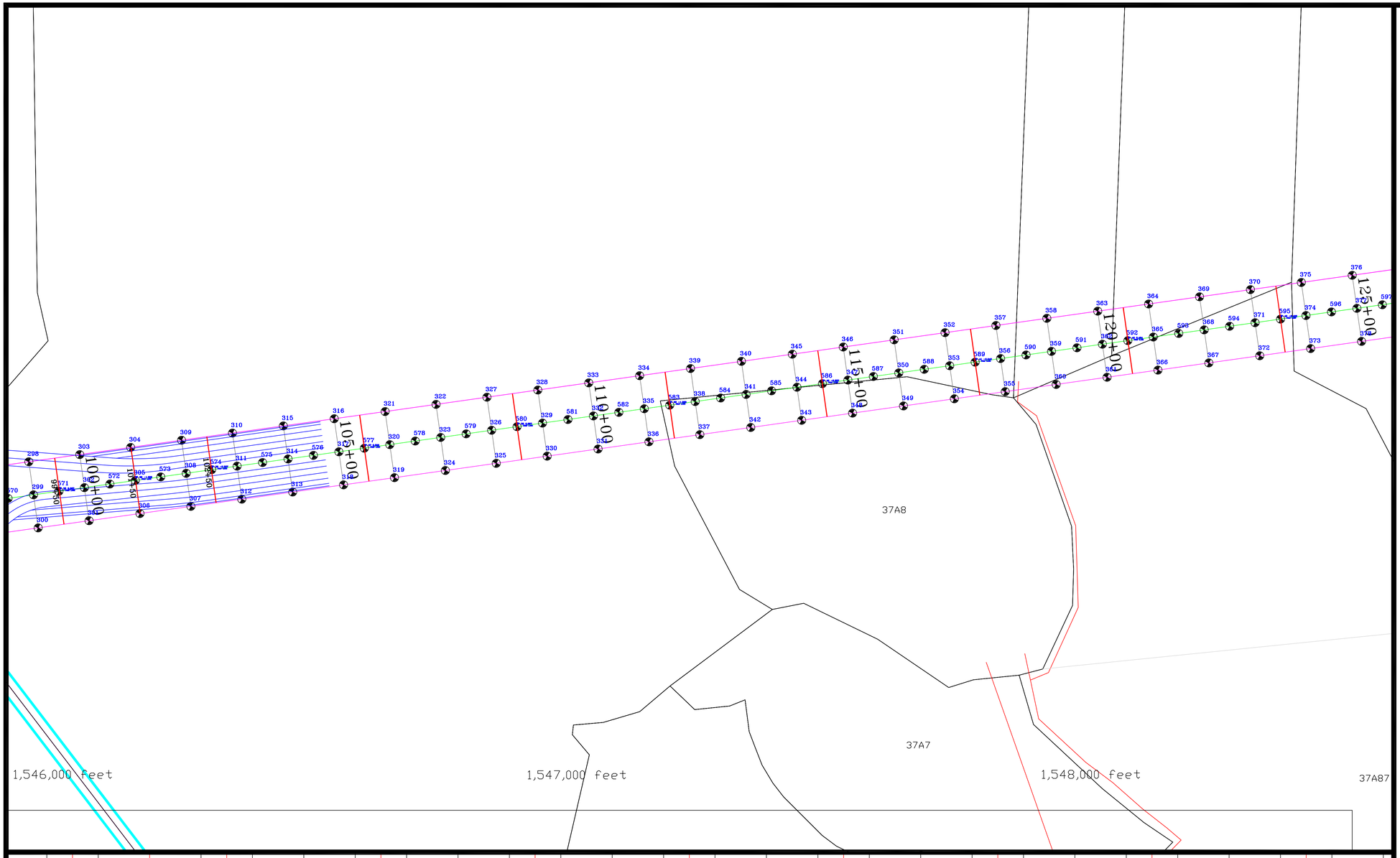

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TYPICAL TRIAL PIT #40 STATION 114+50

TYPICAL TRIAL PIT #43 STATION 123+50

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION HIRST ROAD TO LOOK OUT GARDENS GEOTECHNICAL SURVEY SEPTEMBER 2008

POINT #	TRIAL PIT NOS	STATION LOC	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
574	TP36	102+50	300'	0.563			0.863	-2.337
577	TP37	105+50	300'	1.319			1.319	0.588
580	TP38	108+50	300'	1.925			1.925	0.997
583	TP39	111+50	300'	1.859			1.859	-1.399
586	TP40	114+50	300'	2.237			2.237	-0.237
589	TP41	117+50	300'	2.151			2.151	-0.042
592	TP42	120+50	300'	2.128			2.128	0.494
595	TP43	123+50	300'	1.597			1.597	-6.403

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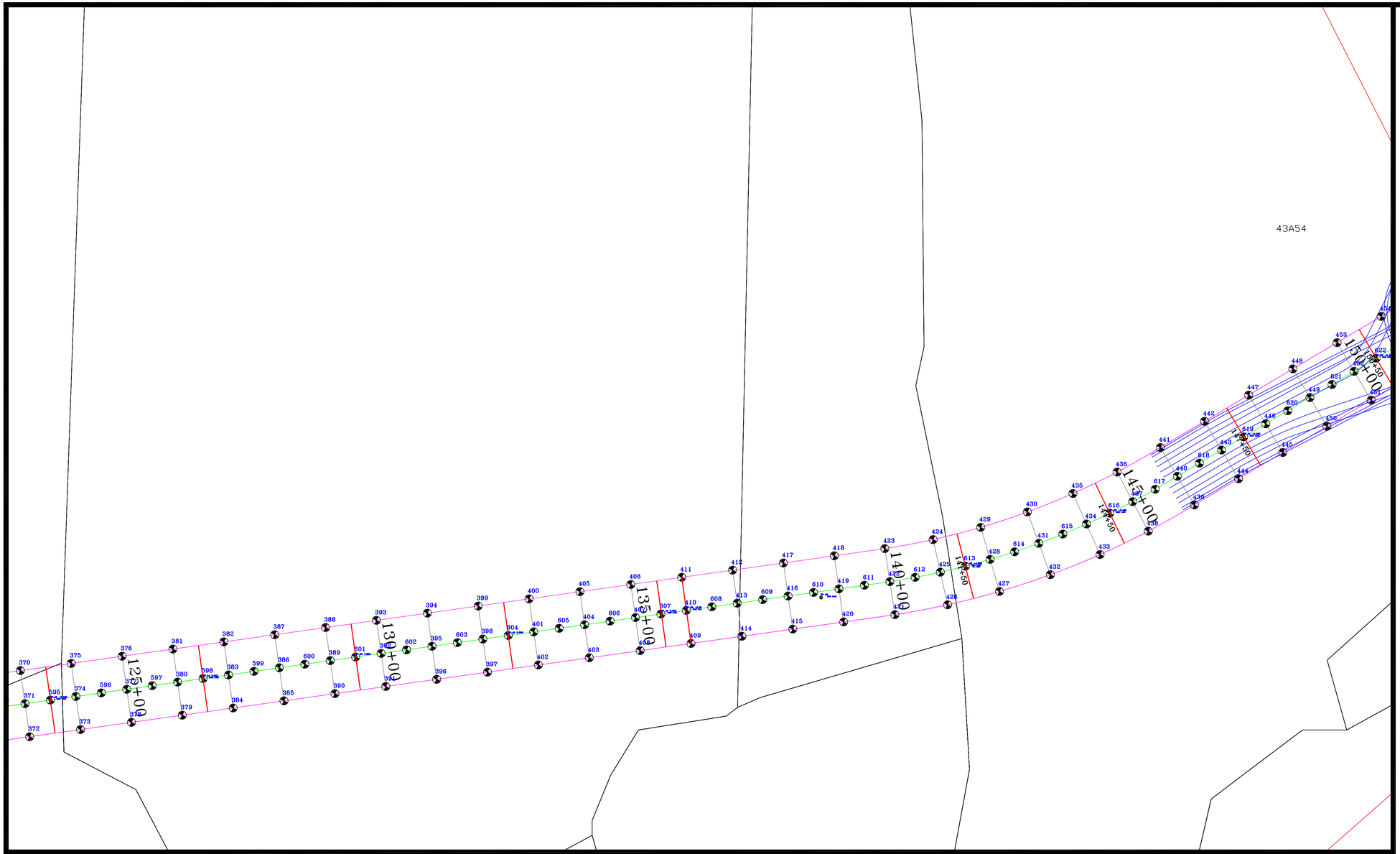
No.	Revisions	Date	By

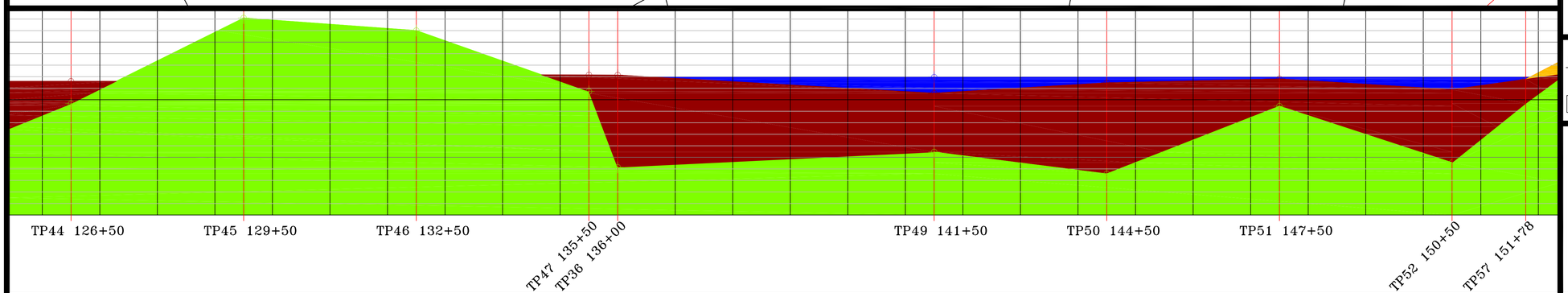
From sta. 100+00
To sta. 125+00

Sheet 5 of 7

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION





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TYPICAL TRIAL PIT #49 STATION 141+50

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION HIRST ROAD TO LOOK OUT GARDENS GEOTECHNICAL SURVEY SEPTEMBER 2008

POINT #	TRIAL PIT NOS	STATION LOC	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
598	TP44	126+50	300'	1.603			1.603	0.342
601	TP45	129+50	300'	7.096				7.096
604	TP46	132+50	300'	6.006				6.006
607	TP47	135+50	300'	2.151			2.151	0.723
610	TP58	136+00	50'	2.14			2.14	-5.86
610	TP48	138+50	300'	POND 550 FEET				
613	TP49	141+50	300'	0.565	1.958		0.565	-6.535
616	TP50	144+50	300'	1.468			1.468	-6.432
619	TP51	147+50	300'	1.812			1.812	-6.558
622	TP52	150+50	300'	0.873		0.873		-6.457

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Project ref. GC44

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Vert. 1" = 10'

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No.	Revisions	Date	By

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To sta. 150+00

Sheet 6 of 7

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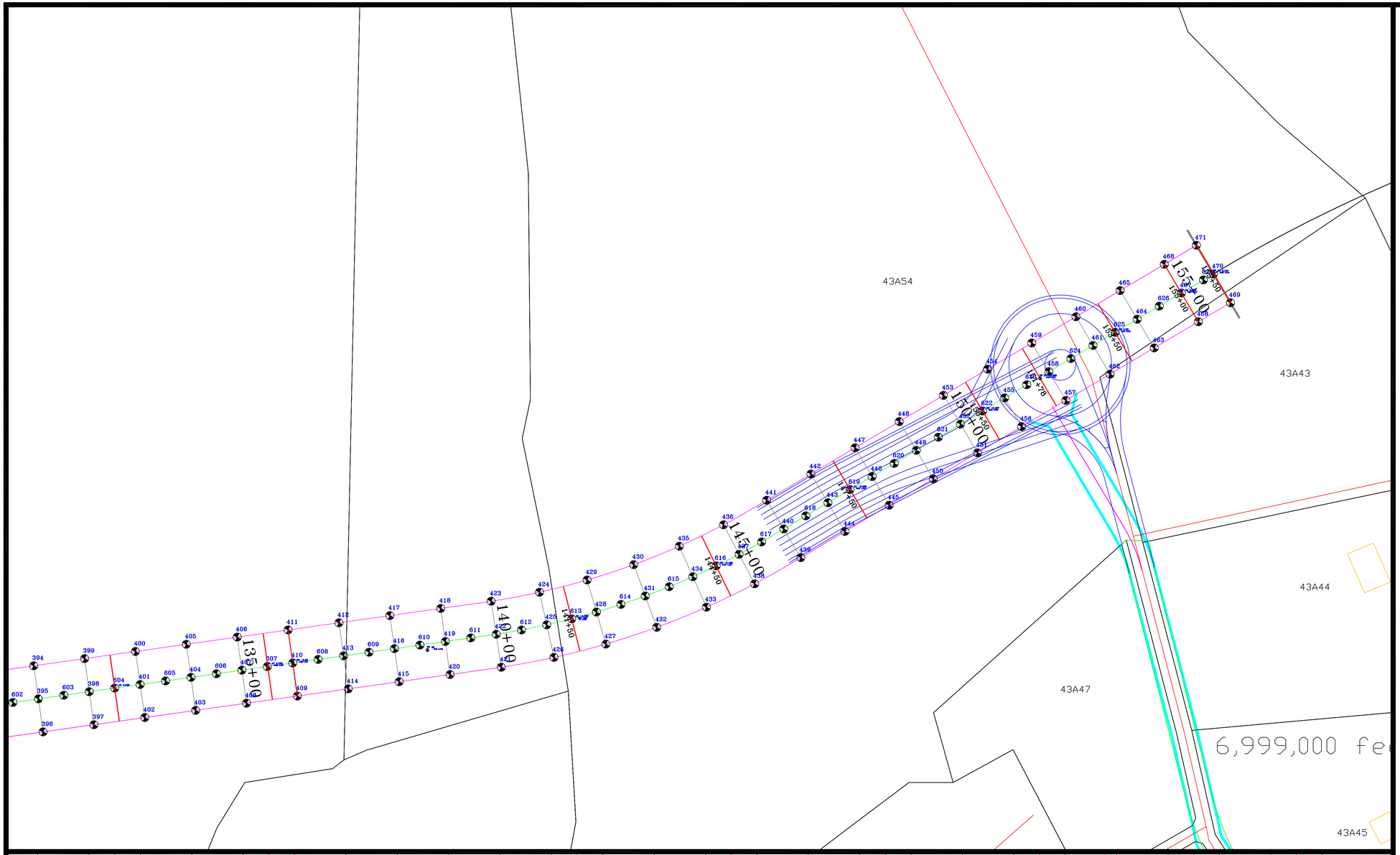
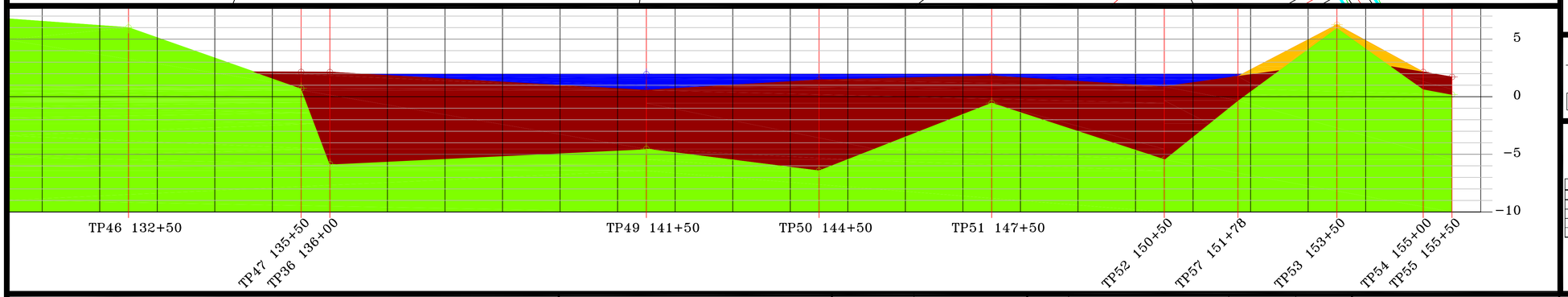
PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION





TYPICAL TRIAL PIT # 51 STATION 147+50

TYPICAL TRIAL PIT #52 STATION 150+50

TYPICAL TRIAL PIT #55 STATION 155+50

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION HIRST ROAD TO LOOK OUT GARDENS GEOTECHNICAL SURVEY SEPTEMBER 2008

POINT #	TRIAL PIT NOS	STATION LOC	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
NONE	TP57	151+78	28'	1.774		1.774		0.326
625	TP53	153+50	150'	6.248			6.248	6.06
467	TP54	155+00	50'	2.148			2.148	0.658
470	TP55	155+50		0.719			0.719	0.191

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC44

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC44-E/W ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	24/10/08
Dwg.No.	7

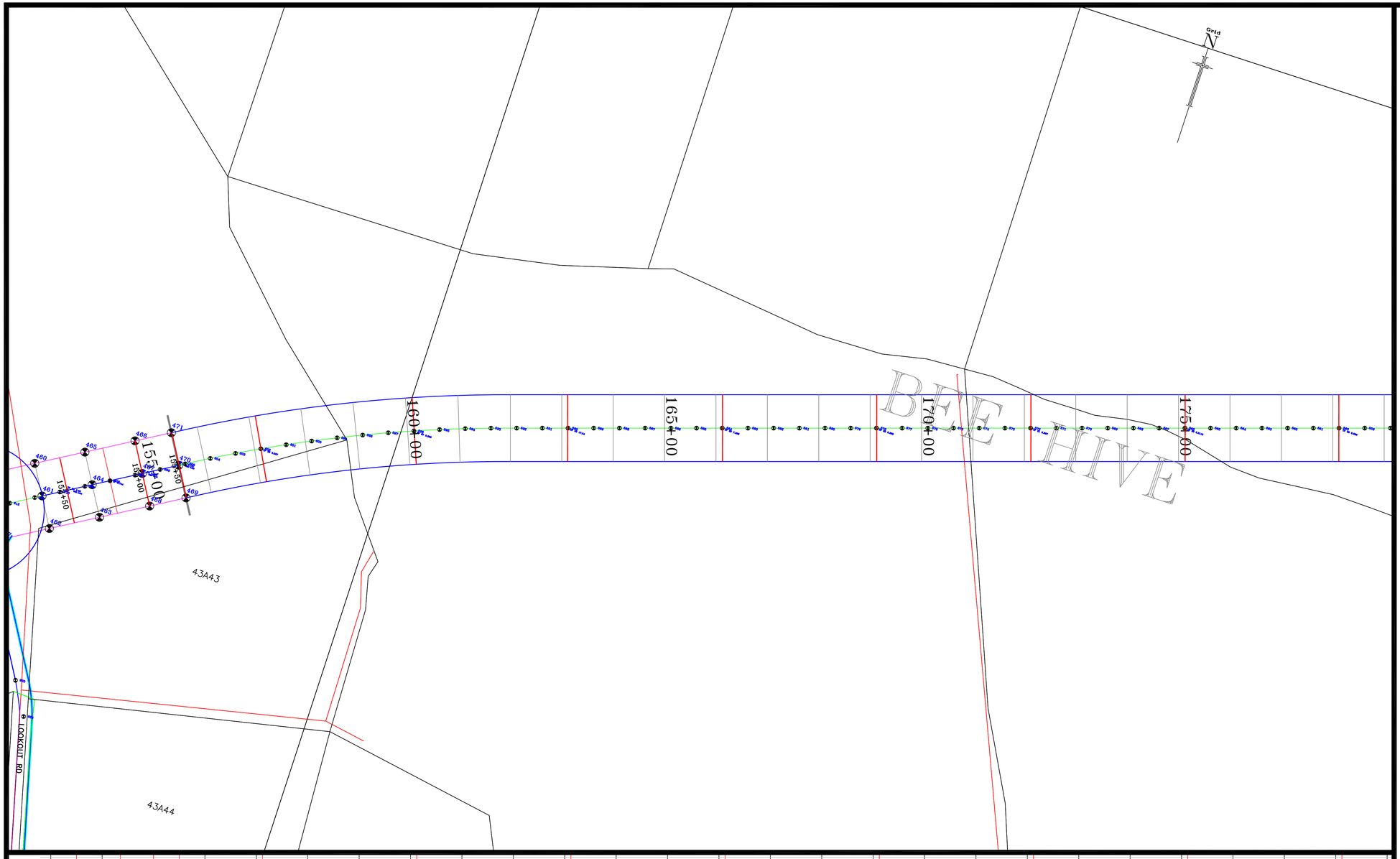
No.	Revisions	Date	By

From sta. 135+00
To sta. EOP

Sheet 7 of 7

TITLE

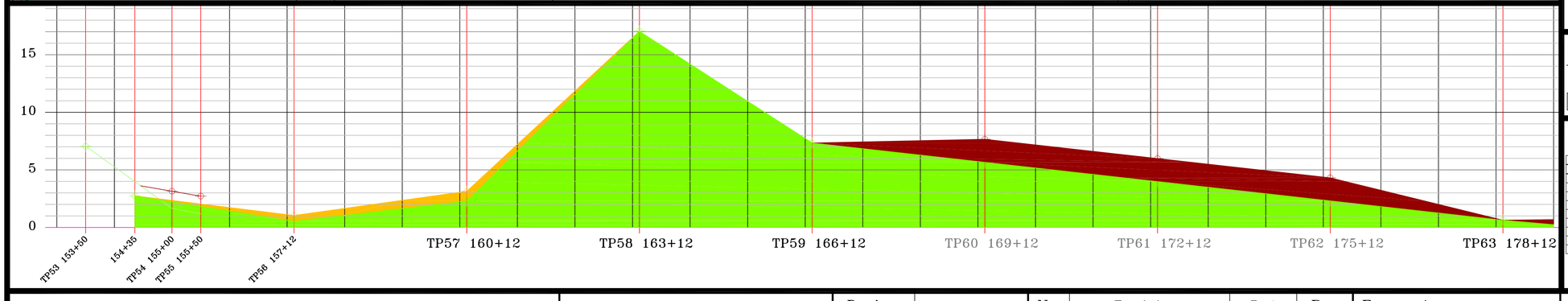
PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION



TYPICAL TRIAL PIT #56 STATION 157+12

TYPICAL TRIAL PIT #59 STATION 166+12

TYPICAL TRIAL PIT #63 STATION 178+12



LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER	
608	BOP	154+36	0			2.744			
602	TP56	157+12	276			1.037		0.537	
596	TP57	160+12	300				3.139	2.306	
590	TP58	163+12	300					17.04	
584	TP59	166+12	300					7.338	
578	TP60	169+12	300				7.6625	5.6625	ASSUMPTIONS
572	TP61	172+12	300				5.987	3.987	ASSUMPTIONS
566	TP62	175+12	300				4.3115	2.3115	ASSUMPTIONS
560	TP63	178+12	400					0.636	

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	22 AUG 14
Dwg.No.	8

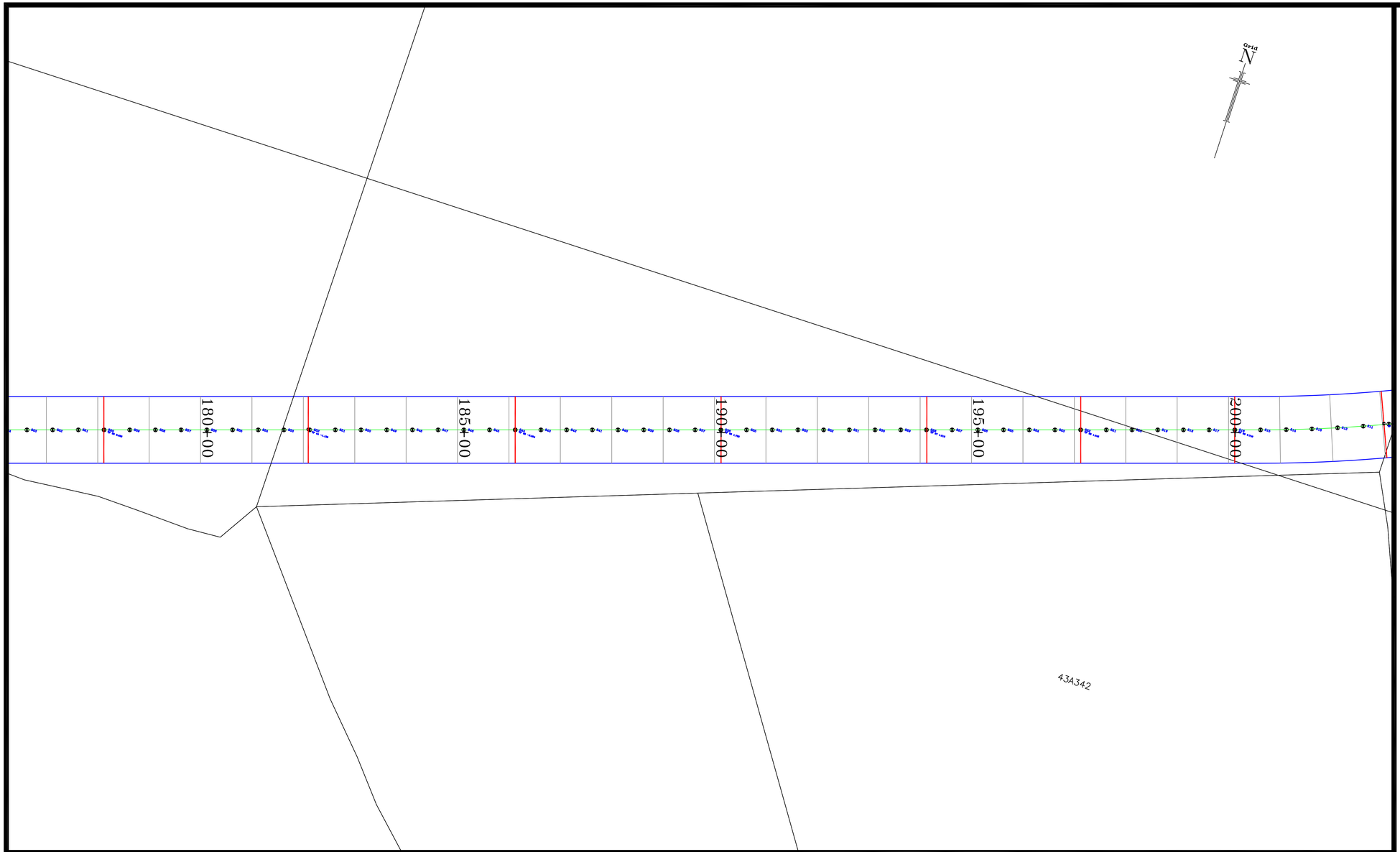
No.	Revisions	Date	By

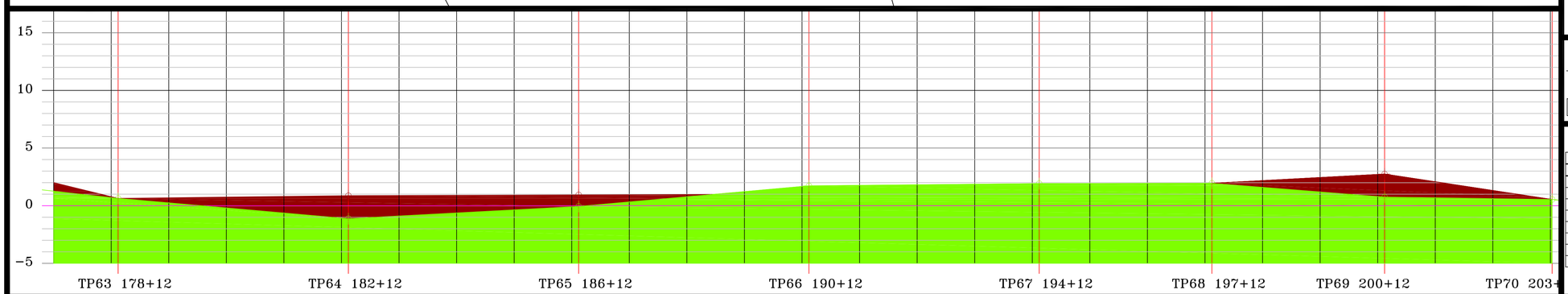
From sta. 153+50 BOP
To sta. 178+00

Sheet 8 of 20

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION





TYPICAL TRIAL PIT #63 STATION 178+12

TYPICAL TRIAL PIT #66 STATION 190+12

TYPICAL TRIAL PIT #69 STATION 200+12

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
560	TP63	178+12	400					0.636
552	TP64	182+12	400				0.874	-1.126
544	TP65	186+12	400				0.936	-0.064
536	TP66	190+12	400					1.723
528	TP67	194+12	400					1.918
522	TP68	197+12	300					1.945
516	TP69	200+12	300				2.749	0.749
510	TP70	203+03	300					0.541

NATIONAL ROADS AUTHORITY
C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	9

No.	Revisions	Date	By

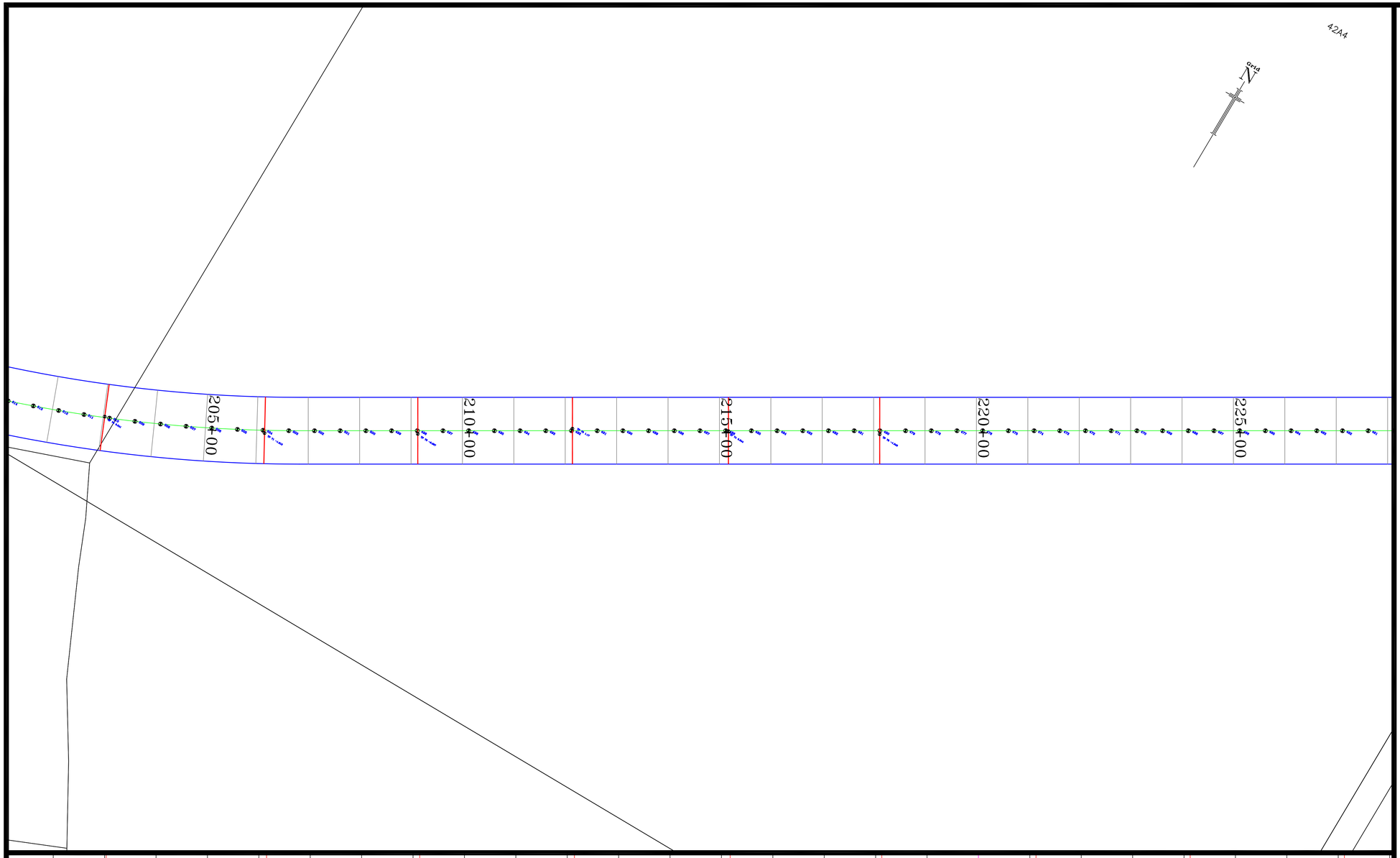
From sta. 178+00
To sta. 203+00

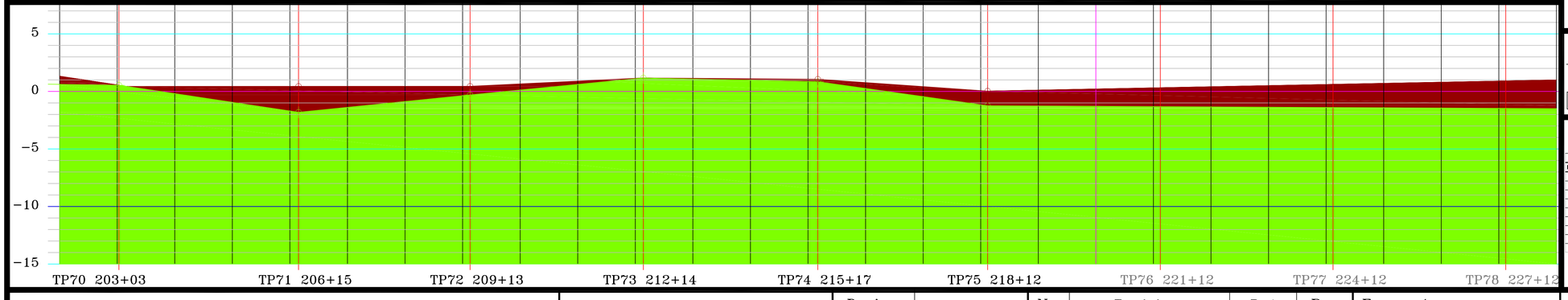
Sheet 9 of 20

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST−WEST EXTENSION

42A4





TYPICAL TRIAL PIT #70 STATION 203+03

TYPICAL TRIAL PIT #74 STATION 215+17

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER	
510	TP70	203+03	300					0.541	
504	TP71	206+15	300				0.441	-1.812	
498	TP72	209+13	300				0.447	-0.307	
492	TP73	212+14	300				2.719	1.17	
486	TP74	215+17	300				1.057	0.844	
480	TP75	218+12	300				0.027	-1.243	
	TP76	221+12	300				0.321	-1.32	ASSUMPTIONS
	TP77	224+12	300				0.616	-1.396	ASSUMPTIONS
	TP78	227+12	300				0.91	-1.473	ASSUMPTIONS

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	10

No.	Revisions	Date	By

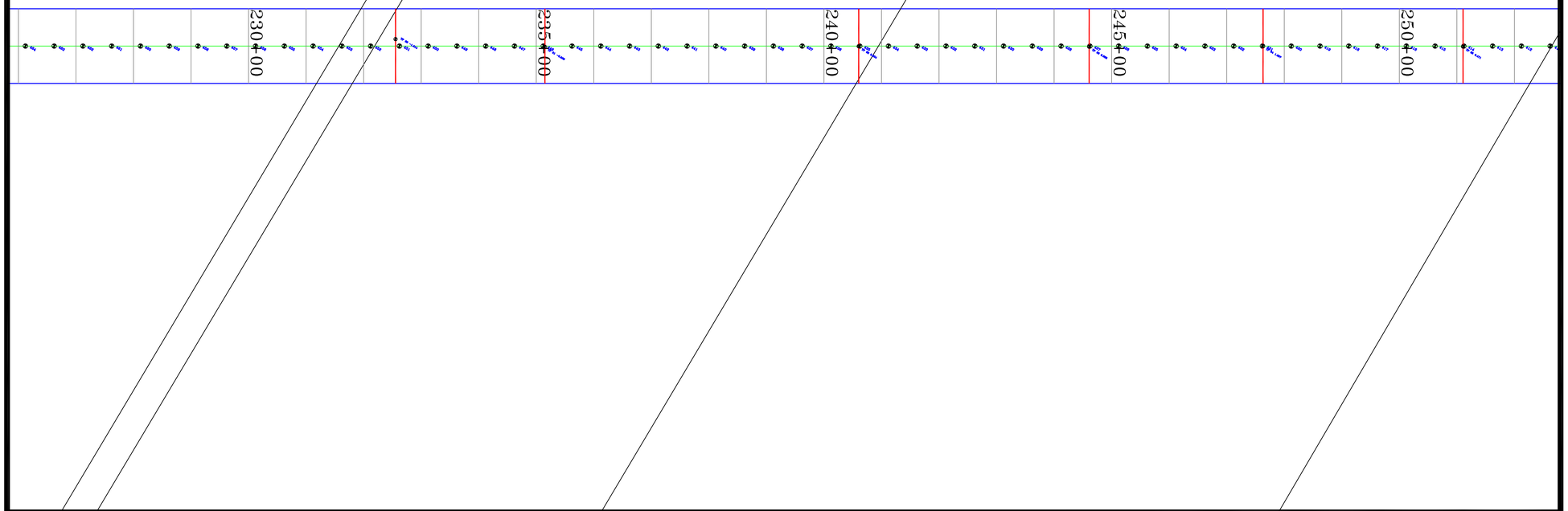
From sta. 202+00
To sta. 227+00

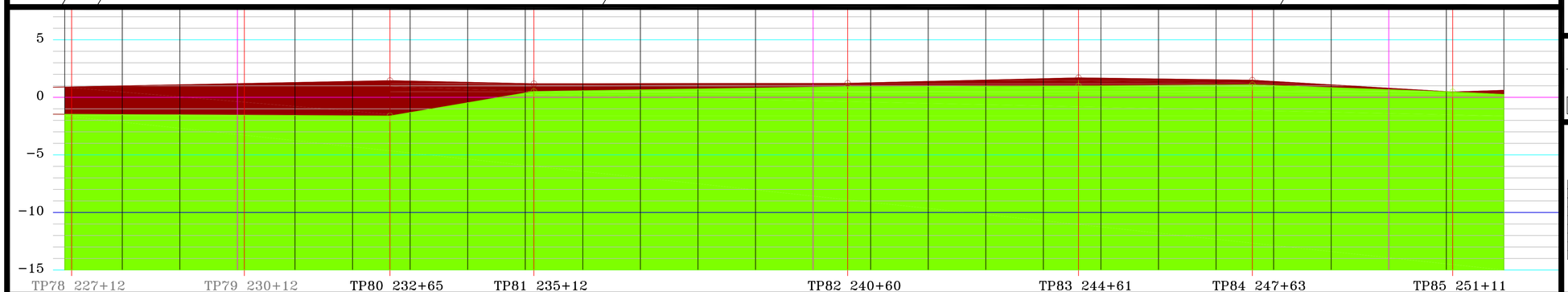
Sheet 10 of 20

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION

42A4





TYPICAL TRIAL PIT #82 STATION 240+60

TYPICAL TRIAL PIT #85 STATION 251+11

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014									
PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
	TP79	230+12	300				1.205	-1.549
451	TP80	232+65	300				1.453	-1.614
446	TP81	235+15	300				1.183	-0.509
435	TP82	240+60	545				1.223	0.934
427	TP83	244+61	400				1.695	0.983
421	TP84	247+63	300				1.49	1.097
414	TP85	251+11	500					0.471

ASSUMPTIONS

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	11

No.	Revisions	Date	By

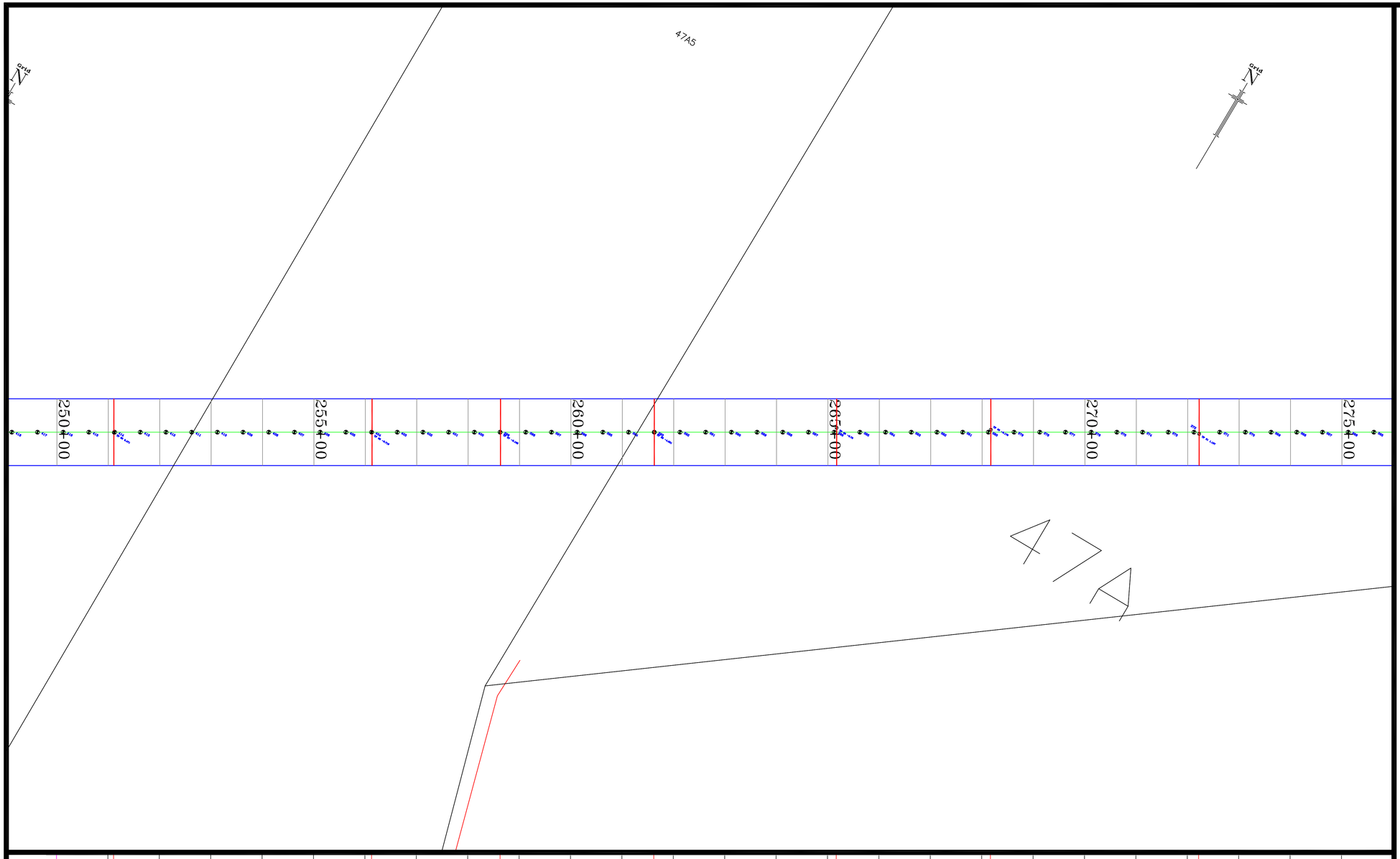
From sta. 230+00

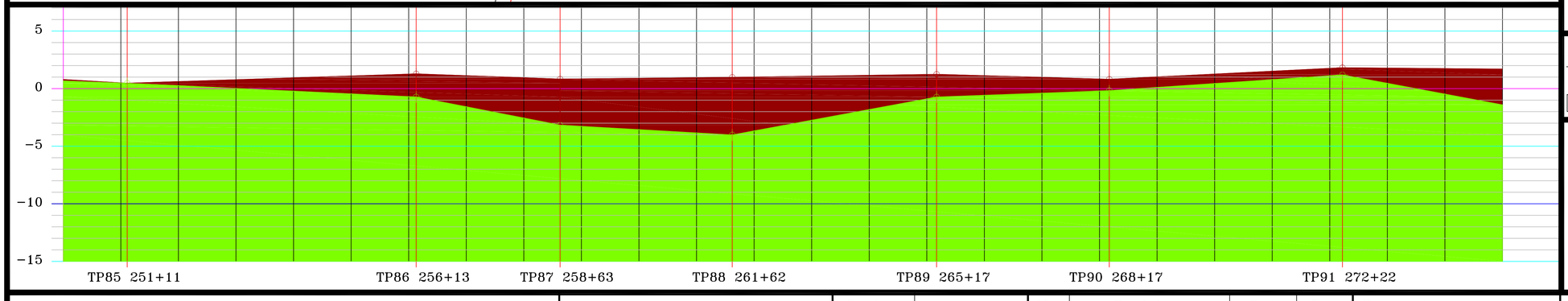
To sta. 251+00

Sheet 11 of 20

TITLE

PLAN AND PROFILE LOCATIONS
FOR GEOTECHNICAL SURVEY
ON THE EAST−WEST EXTENSION





TYPICAL TRIAL PIT #85 STATION 251+11

TYPICAL TRIAL PIT #88 STATION 261+62

TYPICAL TRIAL PIT #91 STATION 265+17

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
414	TP85	251+11	500					0.471
404	TP86	256+13	300				1.281	-0.719
399	TP87	258+63	300				0.832	-3.168
393	TP88	261+62	350				0.979	-4.021
386	TP89	265+17	300				1.244	-0.73
380	TP90	268+17	400				0.814	-0.175
372	TP91	272+22	300				1.816	1.197
362	TP92	277+11	500				1.613	-3.387

NATIONAL ROADS AUTHORITY
C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	12

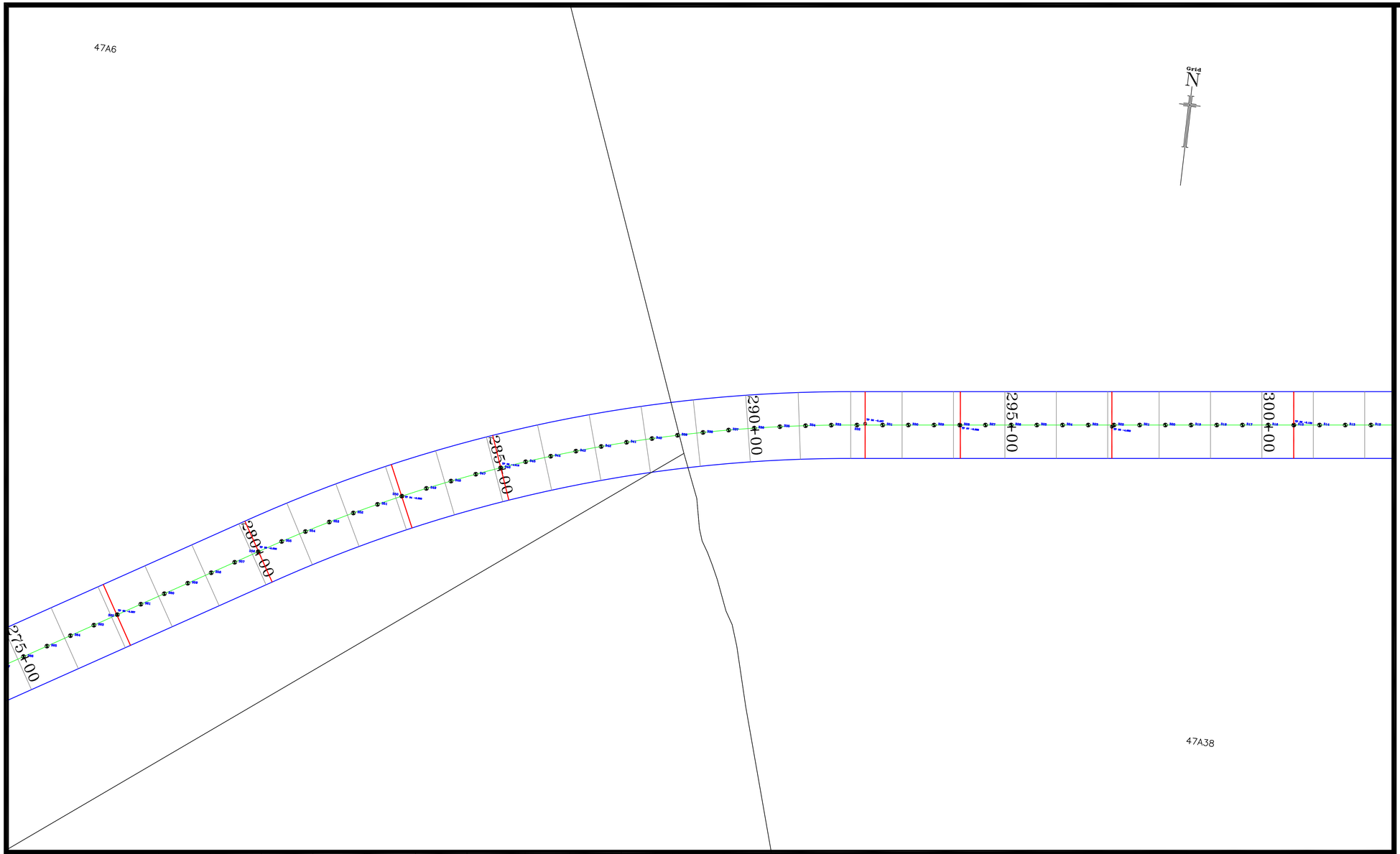
No.	Revisions	Date	By

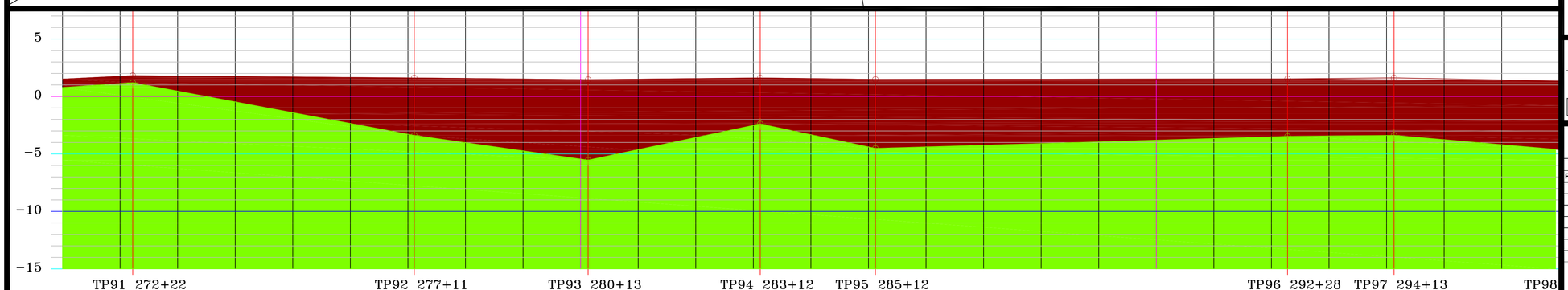
From sta. 251+00
To sta. 277+00

Sheet 12 of 20

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST−WEST EXTENSION





TYPICAL TRIAL PIT #92 STATION 277+11

TYPICAL TRIAL PIT #96 STATION 292+28

TYPICAL TRIAL PIT #99 STATION 300+62

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
372	TP91	272+22	300				1.816	1.197
362	TP92	277+11	500				1.613	-3.387
356	TP93	280+13	300				1.464	-5.536
350	TP94	283+12	300				1.612	-2.388
346	TP95	285+12	200				1.487	-4.513
332	TP96	292+28	700				1.533	-3.467
328	TP97	294+13	200				1.618	-3.382

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	13

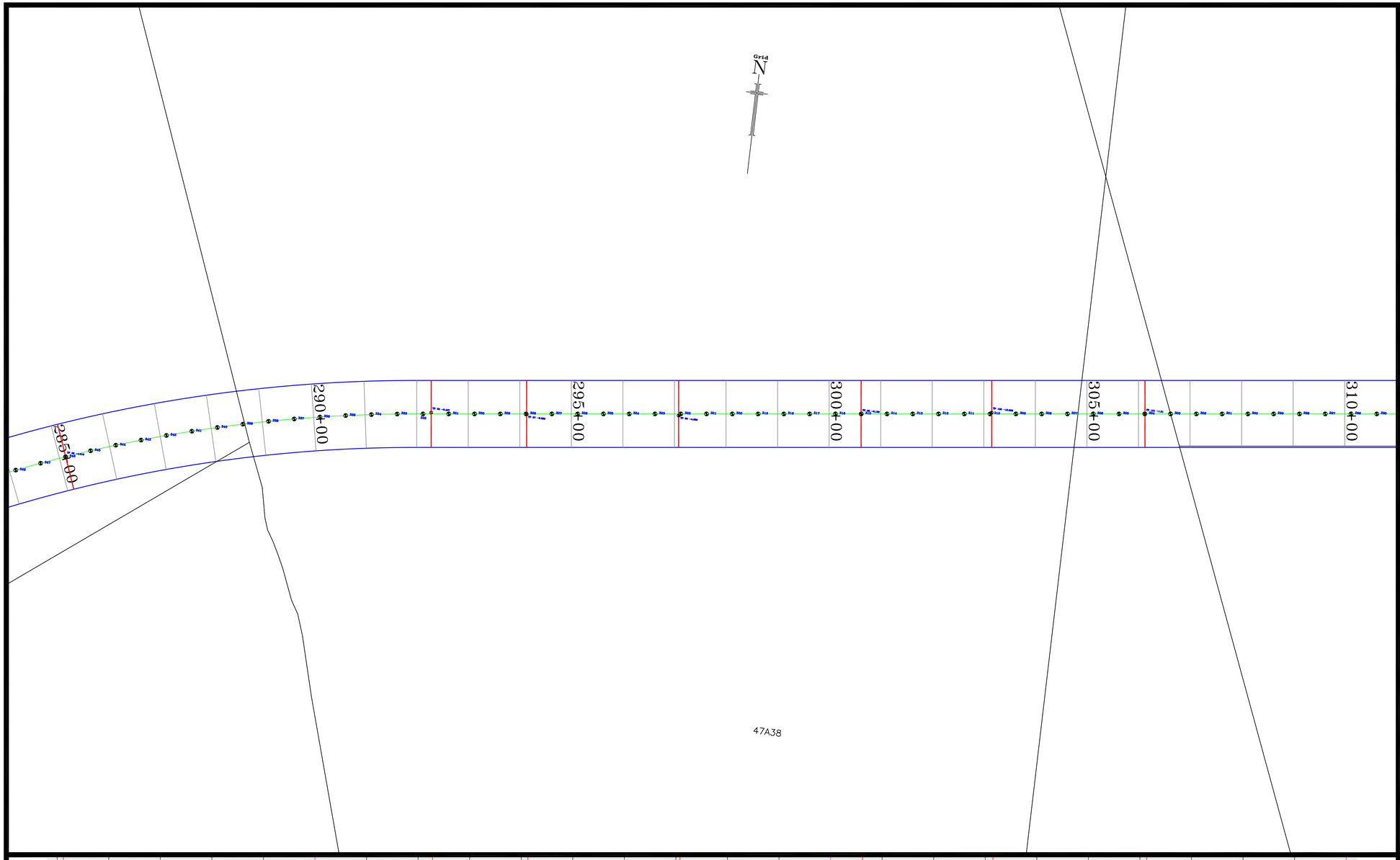
No.	Revisions	Date	By

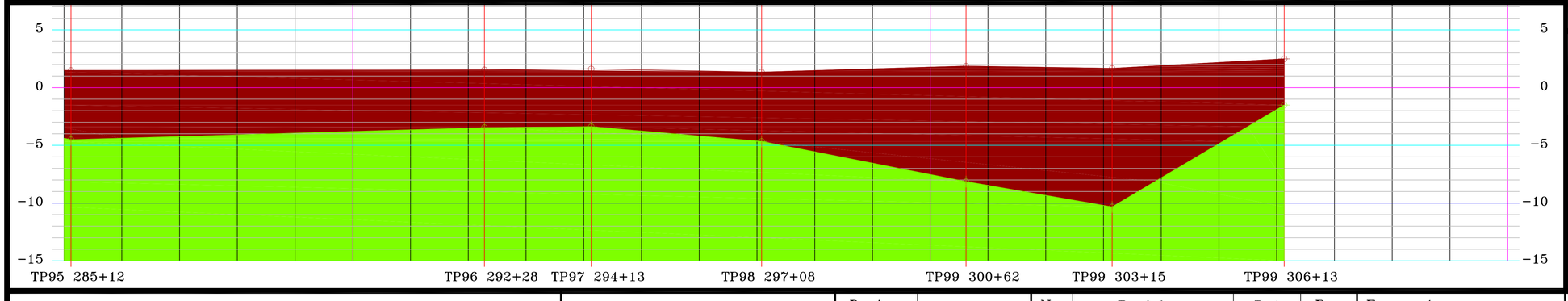
From sta. 272+00
To sta. 294+00

Sheet 13 of 20

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST−WEST EXTENSION





TYPICAL TRIAL PIT #99 STATION 300+62

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
346	TP95	285+12	200				1.487	-4.513
332	TP96	292+28	700				1.533	-3.467
328	TP97	294+13	200				1.618	-3.382
322	TP98	297+08	300				1.341	-4.659
315	TP99	300+62	300				1.861	-8.139
310	TP100	303+15	300				1.667	-10.333
304	TP101	306+13	300				2.49	-1.51

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	14

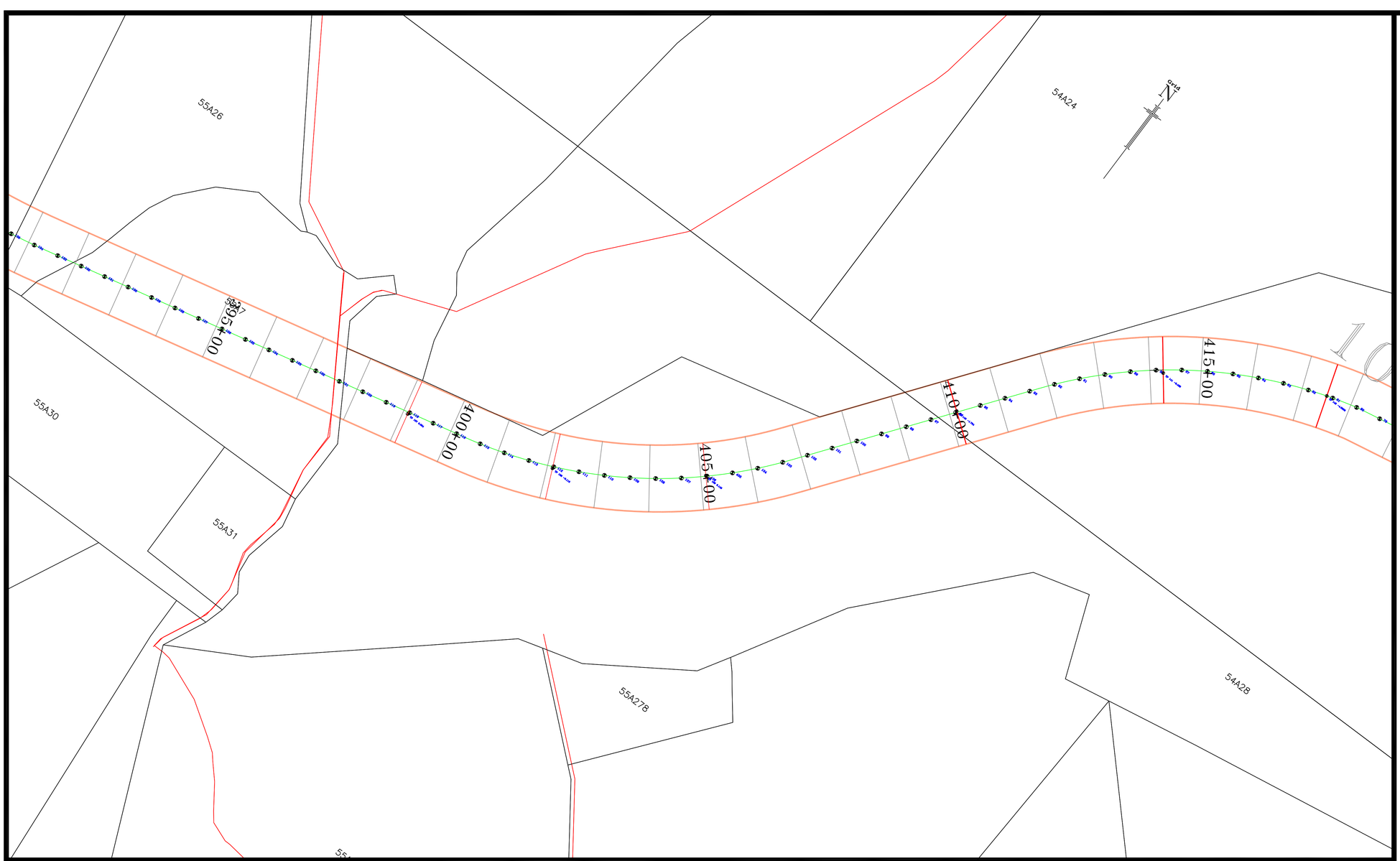
No.	Revisions	Date	By

From sta. 285+00
To sta. 306+00

Sheet 14 of 20

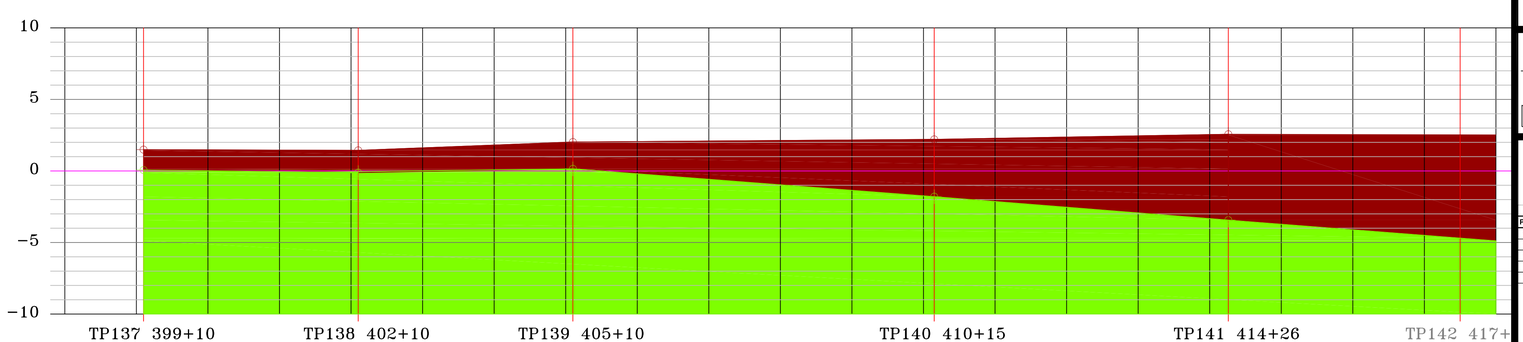
TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION



TYPICAL TRIAL PIT #137 STATION 399+10

TYPICAL TRIAL PIT #139 STATION 405+10



LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER
118	TP137	399+10	300				1.492	0.064
112	TP138	402+10	300				1.442	-0.115
106	TP139	405+10	500				2.026	0.148
96	TP140	410+15	500					-1.794
88	TP141	414+26	500				2.568	-3.432

MASTIC TRAIL WOODEN WALKWAY

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	18

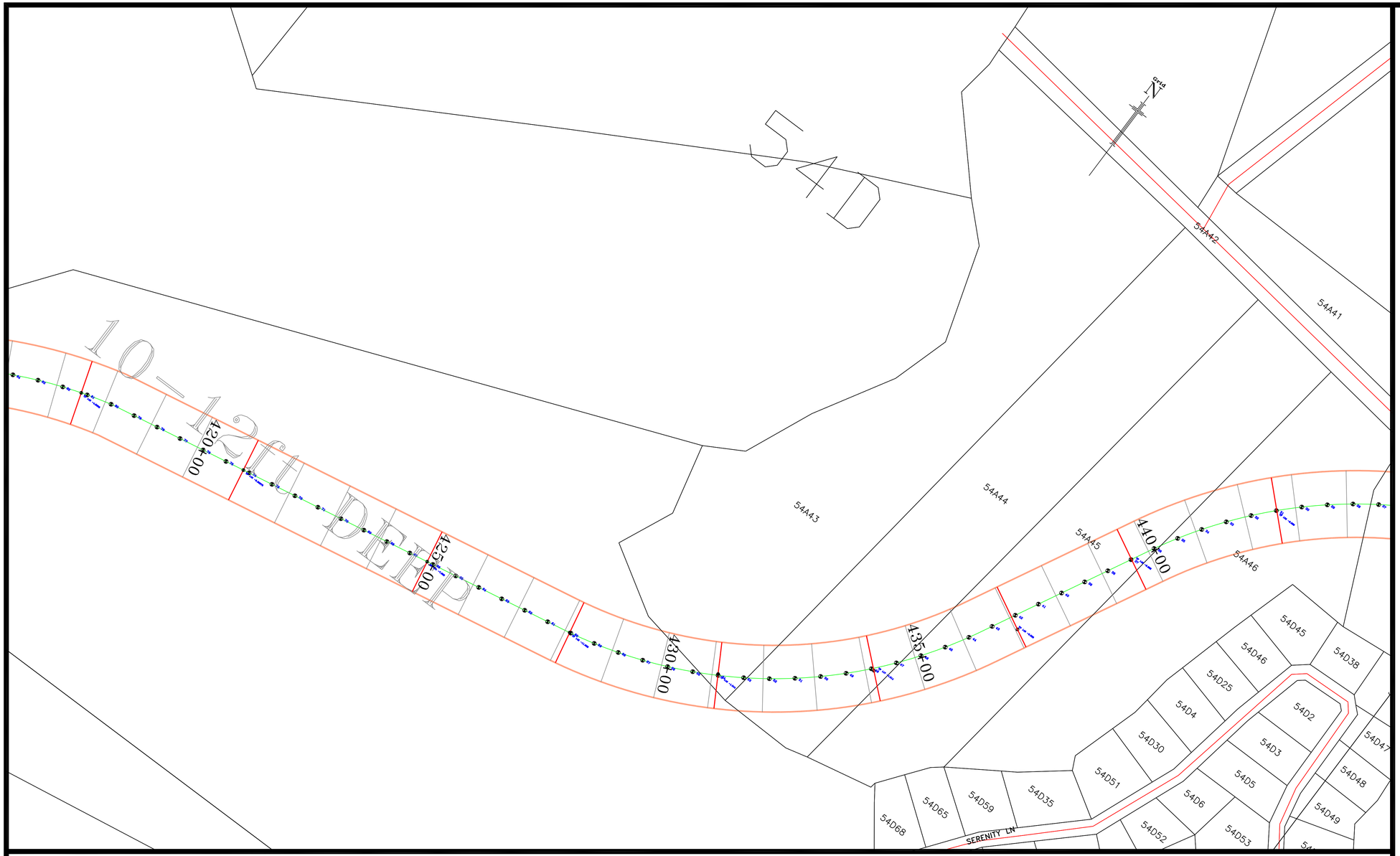
No.	Revisions	Date	By

From sta. 399+00
To sta. 414+00

Sheet 18 of 20

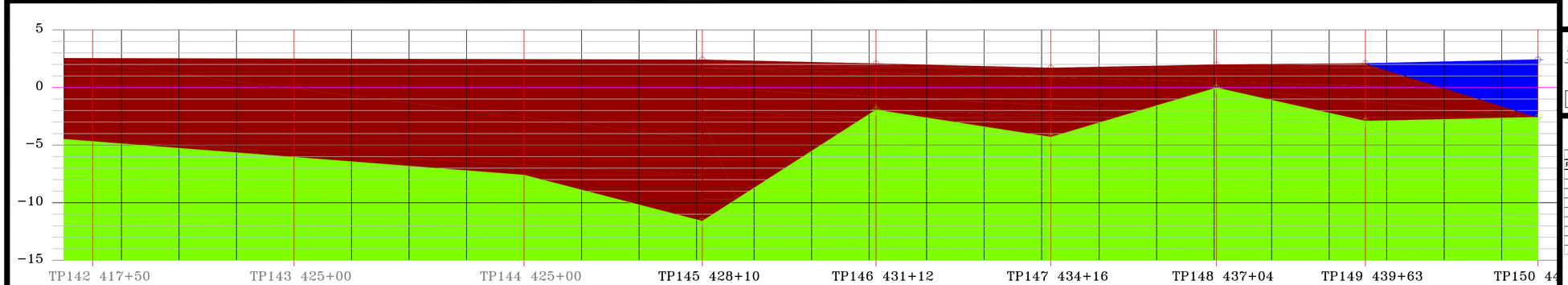
TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST−WEST EXTENSION



TYPICAL TRIAL PIT #146 STATION 135+50

TYPICAL TRIAL PIT #150 STATION 147+50



LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014									
PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER	
78	TP142	419+00	300				2.5282	-4.5303	
72	TP143	422+00	300				2.4851	-5.96375	ASSUMPTIONS
66	TP144	425+00	300				2.4361	-7.602	ASSUMPTIONS
60	TP145	428+10	300				2.398	-11.602	ASSUMPTIONS
54	TP146	431+12	300				2.056	-1.944	
48	TP147	434+16	300				1.686	-4.314	
42	TP148	437+04	300				1.967	-0.033	
37	TP149	439+63	300				2.078	-2.922	
31	TP150	442+63	300		2.411			-2.589	

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	19

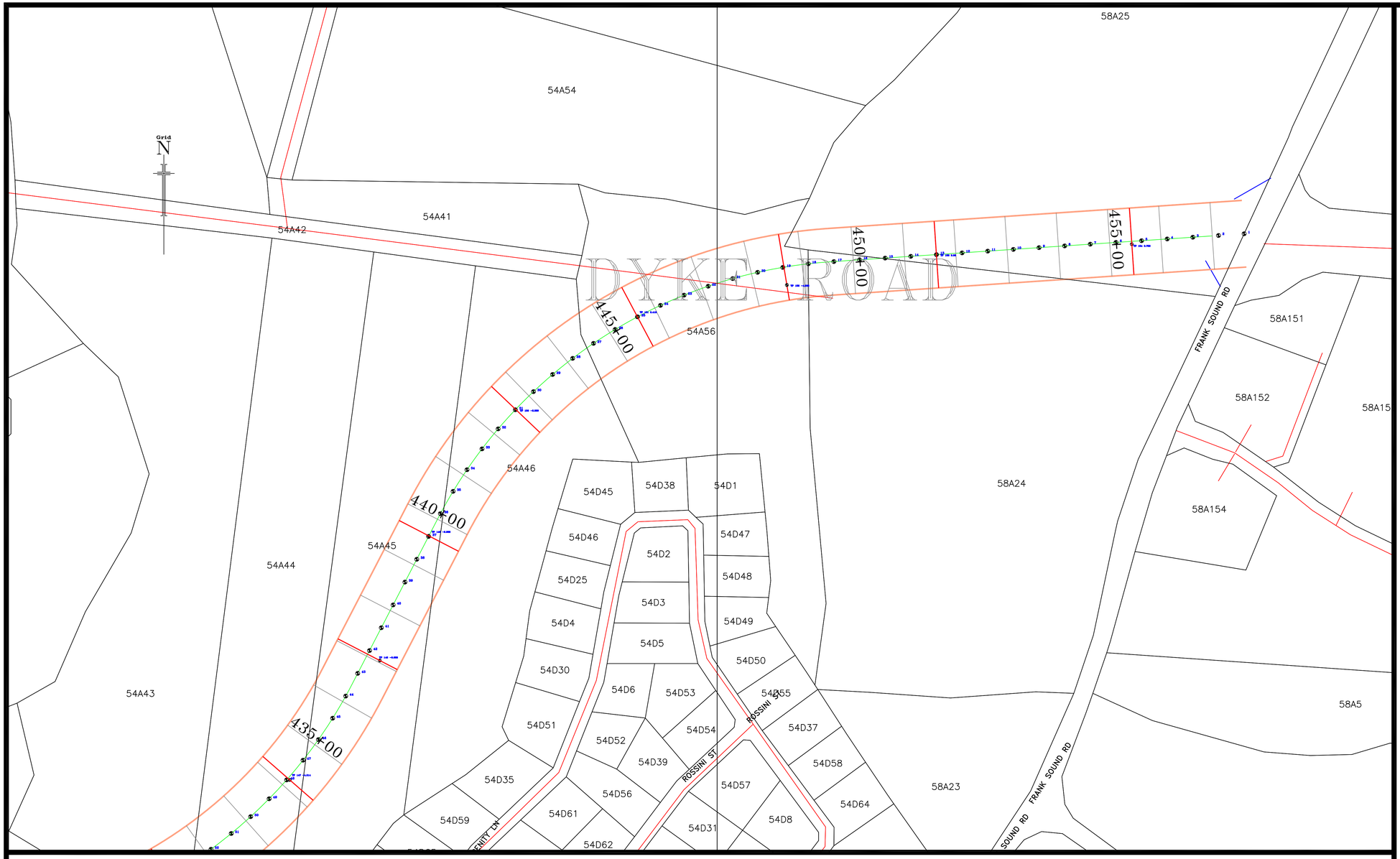
No.	Revisions	Date	By

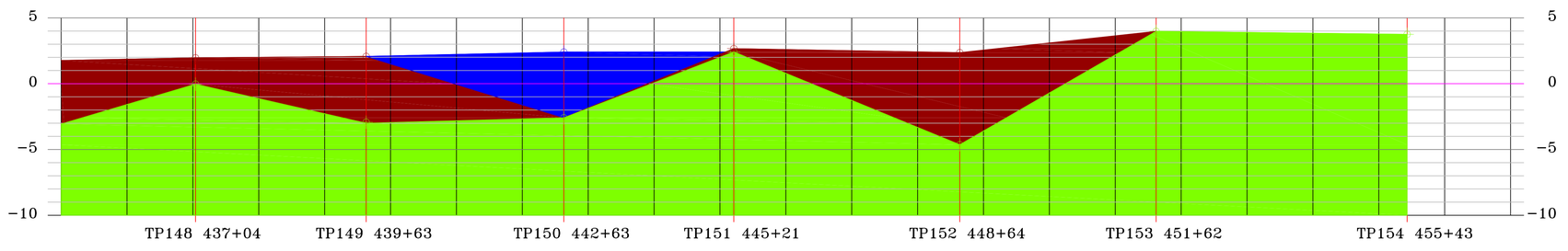
From sta. 419+00
To sta. 442+00

Sheet 19 of 20

TITLE

PLAN AND PROFILE LOCATIONS
FOR GEOTECHNICAL SURVEY
ON THE EAST−WEST EXTENSION





TYPICAL TRIAL PIT #148 STATION 141+50

TYPICAL TRIAL PIT #152 STATION 153+50

TYPICAL TRIAL PIT #154 STATION 155+50

LEGEND

PEAT | SOIL | ROCK | WATER LEVEL

EAST-WEST EXTENSION LOOKOUT GARDENS TO FRANK SOUND ROAD GEOTECHNICAL SURVEY AUGUST 2014

PNT #	TRIAL PIT NOS	STATION	DISTANCE (ft)	EXISTING LEVEL	WATER LEVEL	SOIL LAYER	PEAT LAYER	ROCK LAYER	
25	TP151	445+21	300				2.668	2.418	
19	TP152	448+64	300				2.365	-4.635	DYKE ROAD
13	TP153	451+62	300					3.98	
5	TP154	455+43	300					3.752	

NATIONAL ROADS AUTHORITY

C/O P. O. BOX # 10426 APO
370 NORTH SOUND ROAD, GEORGE TOWN
GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

Project ref. GC63

Scale Horiz. 1" = 100'
Vert. 1" = 10'

Drawing Name. GC63 EAST-WEST ALIGN

Design	N. R. A.
Drawn	D. Myles
Checked	P. Parchment
Date:	15 SEPT 14
Dwg.No.	20

No.	Revisions	Date	By

From sta. 455+00

To sta. 435+00

Sheet 20 of 20

TITLE

PLAN AND PROFILE LOCATIONS FOR GEOTECHNICAL SURVEY ON THE EAST-WEST EXTENSION