REPORT

FLOOD DETENTION DAMS - 2019 INTERMEDIATE DAM SAFETY REVIEW

PREPARED FOR HASTINGS DISTRICT COUNCIL

March 2020

Stantec

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Executive Summary

Hastings District Council operates a stormwater service to a number of areas within the Hastings District by utilising flood detention dams to attenuate flood flows from upstream catchment areas. These include four small dams in the coastal area of Clifton above the camping ground, two small dams in the Te Awanga catchment, and five larger, High Potential Impact Classification dams in the various catchments in the township of Havelock North.

Since 2000, HDC has engaged Stantec New Zealand to perform an Intermediate Dam Safety Review, completed annually, which includes inspections and assessment of dam safety issues associated with these flood detention dams.

In 2015 a Comprehensive Dam Safety Review was completed. These are completed on a five yearly basis. The summary and recommendations from the CDSR are included in this report.

The intent of the intermediate inspections and reporting is to detail the current conditions at each dam for dam safety deficiencies and review the operations information of the dams to assess the current safety performance. Relevant dam safety and dam maintenance recommendations are made. The status of previous recommendations from the 2018 IDSR have been reviewed and updated, and the status of the 2015 CDSR recommendations has also been summarised.

On the basis of the visual inspections, the flood detention dams appeared to be functioning adequately and safe performance is expected under normal operating conditions.

To ensure performance during small to medium flood events, the culverts, in particular the upstream channels and inlet structures, should be maintained and clear of vegetation.

To ensure safe discharge of large floods via the spillways, the spillway channels should be maintained clear of any obstructions such as fences and gates and vegetation removed.

Gates and fences across and within the spillways remain as live dam safety issues at all five Havelock North dams. Some gates across the spillway entrance have been modified to hinge in the direction of flow (School Stream and Te Kahika) although their effectiveness is unknown. If a gate or fence is required across a spillway, then alternative arrangements should be investigated that will not impede flow when it is required to operate in a flood event. For example, a fence could be constructed upstream of the spillway and below the level of the spillway crest. HDC now wish to manage the operation of gates across spillways as part of emergency management with the landowners and/or maintenance/emergency contractors.

HDC are planning to complete Operation, Maintenance, and Surveillance documentation in 2020, to cover all relevant aspects of dam safety across their portfolio of dams. This includes relationship with HDC contractors for maintenance and flood response, and with landowners around maintenance and dam safety requirements.

A number of the previous IDSR and CDSR recommendations are being progressed, with HDC prioritising these within existing and planned future budgets.

Abbreviations

AEP	Annual Exceedance Probability
CDSR	Comprehensive Dam Safety Review
DSMS	Dam Safety Management System
EAP	Emergency Action Plan
FSL	Full Supply Level
HDC	Hastings District Council
IDF	Inflow Design Flood
IDSR	Intermediate Dam Safety Review
NZSOLD	New Zealand Society on Large Dams
O&M	Operation and Maintenance
PAR	Population at Risk
PFM	Potential Failure Mode
PIC	Potential Impact Classification
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation

Hastings District Council

Flood Detention Dams - 2019 Intermediate Dam Safety Review

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1. Background Information

Hastings District Council (HDC) operates a stormwater service to a number of areas within the Hastings District by utilising flood detention dams to attenuate flood flows from upstream catchment areas. These include four small dams in the coastal area of Clifton above the camping ground, two small dams in the Te Awanga catchment, and five larger, High Potential Impact Classification dams in the various catchments in the township of Havelock North.

Until the late 1990's personnel from the Hawke's Bay Regional Council (HBRC) performed periodic inspections and carried out required maintenance. Based on the available information, these structures have successfully operated to date with only minor modifications and maintenance performed, and the emergency spillways have never operated.

Since 2000, HDC has engaged Stantec New Zealand (Stantec) to perform an Intermediate Dam Safety Review (IDSR), completed annually, which includes inspections and assessment of dam safety issues associated with these flood detention dams (refer to Figure 1 in Appendix A).

In 2015 a Comprehensive Dam Safety Review (CDSR) was completed. These are completed on a five yearly basis. The summary and recommendations from the CDSR are included in this report (Section 6.3).

1.1 Intermediate Dam Safety Reviews

The intent of the intermediate inspections and reporting is to detail the current conditions at each dam for dam safety deficiencies and review the operations information of the dams to assess the current safety performance. Relevant dam safety and dam maintenance recommendations are made. The status of previous recommendations from the 2018 IDSR have been reviewed and updated (Section 6), and the status of the 2015 CDSR recommendations has also been summarised (Section 6.3).

1.1.1 Objectives

An IDSR is intermediate in the sense that it fits between Routine Surveillance and the CDSR in frequency and in its level of detail. The IDSR is largely based on:

- A visual inspection by a Technical Adviser (Stantec).
- A close examination of surveillance, operation, maintenance and testing records.
- For High and Medium Potential Impact Classification (PIC) dams IDSR's should be completed annually by a Technical Adviser external to the Owner's organisation.

1.1.2 Scope

The detail and scope of the IDSR should reflect the PIC of the dam and its complexities. Generally, the scope should include:

- An on-site inspection of the dam and appurtenant structures.
- A review of operation, surveillance, maintenance and testing records.
- An evaluation of the performance of the dam as indicated by the on-site inspection and operation, surveillance, maintenance and testing records for the period since the last IDSR.
- A report that identifies any dam safety issues, any changes to monitoring or visual inspection frequencies, or any additional items to be monitored.

1.2 Scheme Details

The Havelock North Flood Protection Scheme was originally developed to alleviate the flooding problems associated with five major streams in the area (refer to Figures 2 and 3 in Appendix A). Constructed during the early 1980's by the Hawke's Bay Catchment Board, a series of detention dams (Karituwhenua, School Stream, Te Kahika, Mangarau, and Here Here) were designed to reduce peak flood flows and overflow of the stream banks.

The dams were understood to be designed with capacity to detain the flood inflow of a 1 in 100 Annual Exceedance Probability (AEP) flood, without significant use of their emergency spillways. The diversion culverts were designed to pass flood flows up to the 1 in 100 AEP flood event, and the emergency

spillways were designed to pass flood flows in excess of the 1 in 100 AEP flood event. To date, the emergency spillways have not operated, and the outlet structures have not been tested by an extreme flood event.

Previously identified potential failure modes (discussed in the CDSR) for these structures include:

- Overtopping due to blockage of the diversion culverts.
- Overtopping due to a flood event greater than the emergency spillway capacity (inflow design floods).
- Internal erosion and piping failure of the dam embankment from extended detention time if diversion culverts become blocked. The most likely location for a piping failure would be along or adjacent to the diversion culvert.

Since construction of the dams was completed, significant residential development has occurred in the Havelock North Area, and urban encroachment has impacted the upstream catchment basins. Further growth in downstream areas has led to changes in the downstream channel capacity and has increased the potential consequences of dam failure (larger population at risk and potential property and infrastructure damage). Increased development of the catchment areas could lead to changed hydrological conditions (e.g. critical duration and peak flows) and the generation of greater amounts of debris that could be mobilised during flood events and potentially lead to blockage of outlet culverts and spillway channels.

Previous studies (MWH, May 2016) have confirmed the flood capacity of the Havelock North flood detention dams, and that in most cases (except School Stream Dam) these are not sufficient for the High PIC dams under New Zealand Society on Large Dams (NZSOLD) New Zealand Dam Safety Guidelines (Guidelines). The study updated the hydrology, flood routing, and spillway and culvert capacities, using the 2015 survey of the dams and spillways, which has enabled the confirmation of the current flood capacity of these dams. Future recommended work involves looking at improving flood capacity to meet current guidelines, which will be done in conjunction with Dam Safety Management (e.g. Emergency Preparedness).

Te Awanga dams (Upper Dam and Lower Dam) had a flood study completed across 2017/2018 with the final report in October 2019. This concluded that the Lower Dam has a modelled Dam Crest Flood of 1 in 42 AEP and the Upper Dam 1 in 12 AEP. A dam break study (draft October 2019) was completed subsequent to the flood study and determined an interim PIC of both dams as Medium, pending further recommended work to confirm. Regardless, the dams at present do not meet the recommended minimum flood capacity for a Low PIC dam of between 1 in 100 and 1 in 1,000 AEP.

Limited information is known about the Clifton Domain dams. It is assumed that these structures were also originally constructed during the early 1980's, and designed to reduce peak flood flows and overflow of the stream banks. It is unclear what level of flood event was used to design the outlet culverts and spillways. Stantec completed a draft flood study in 2019 which reported on the estimated flood capacity of the Clifton dams. All dams were greater than 1 in 10,000 AEP, which is significantly greater capacity than recommended for a Low PIC dam (as these are all assumed) of between 1 In 100 and 1 in 1,000 AEP.

2 Methodology

Our inspection methodology and dam safety evaluation was based around the requirements of the current NZSOLD Dam Safety Guidelines for Medium to High PIC dams. Our 2019 inspection and review consisted of the following activities:

- Using the land ownership information (from HDC), knowledge of local properties for access to the dams, and visiting the relevant properties at each inspection to notify the landowner (if home) that the inspection was being undertaken. This is out of courtesy, but also to be made aware of any issues or hazards such as livestock.
- Walkover inspection of dam embankments and abutment areas. Inspections looked for evidence of instability, seepage, possible signs of piping, historic flood levels, vegetation and maintenance requirements, and anything unusual.
- Walkover inspection of the areas immediately upstream and downstream of the dam. Inspections looked for evidence of subsidence, instability, seepage, vegetation and other materials in or adjacent to the channels, assessment of likely debris supplies during flood events, and any unusual features that could affect the safety of the dam.
- Limited visual inspections were made of the low level culverts for evidence of structural distress, settlement, faulty joints, seepage, or piping issues. No culverts were entered. Most are of too small diameter to enter, or the ones that could be entered would need to be inspected with health and safety requirements being met.
- Walkover inspection of overflow spillways, with emphasis on assessing the ability of the spillway to effectively discharge design flood flows.
- Photographs were taken during each inspection to document the current conditions at each site.
- Water level and rainfall data has been provided by HDC, which has been summarised for each dam (Havelock North dams only).
- HDC have provided information on the routine inspections and maintenance undertaken (works orders only, not the inspection records).
- An assessment of previous IDSR and CDSR recommendations was considered for each dam, with the updated status of these presented in Section 6.
- The preparation of this report which outlines background information, the inspection observations, dam safety information, recommendations, and a selection of photographs.

3 Observations from the Site Inspections

3.1 General Observations

Site specific observations from the inspections are summarised in Table 3-1 to Table 3-8. Figures with approximate locations of the dam safety issues and maintenance issues along with additional photographs are included in the appendices for each dam (Appendix B to I).

The dams are required to be in a state that enables sufficient regular inspection and to ensure adequate performance in flood events for which they were designed. Continued cooperation with landowners is required so development (including livestock use, fencing/gates, etc.) does not affect the integrity of the dams and associated structures (culverts and spillways) and their ability to store and bypass design floods adequately.

The inspections were all completed on 13 November 2019. All inspections were undertaken by Nathan Fletcher (Dam/Water Resources Engineer) of Stantec. Phelia Klopper (Stantec Civil Engineer – Hastings Office) accompanied for the inspections at School Stream and Te Kahika dams.

3.2 Clifton Dams

Access to the Clifton Dams was via foot through Clifton Station (due 4WD access to Clifton Station not advised due to the wet weather).

Access was gained to the Clifton Motor Camp via Clifton Road.

Inspection comments, recommendations, and key photographs are included in Table 3-1. Refer to Appendix B for figures and additional photographs.

Table 3-1: Summary of Clifton Dams Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Motor Camp Stormwater Gully	The stormwater gully was in similar condition to previous years with damaged pipe sections and concrete blocks. The damage was caused by flooding in April 2011. The full length of the previous pipe was traversed. Section of corrugated metal pipe, concrete blocks, concrete manhole, etc remain in the gully. These could be mobilised further down the gully in future flood events. Flood flows from the catchment and flood detention dams behind the camp will flow down this gully without the control of the manholes/culvert system that was previously there for this purpose. The downstream channel, in the camp, has aggraded significantly, and now appears to have limited flow capacity. In flood events, it is likely flows will easily overtop this channel and spill out into the camp, and playground area on the right. The concrete box channel through the camp to the beach had sediment build up at both the upstream and downstream (beach) end. Beach stones have built up around the culvert exit.	The remediation of the gully or other stormwater control options should be investigated. Clear the downstream gully stormwater channel upstream of the concrete box section, and within the concrete box section.	
West Dam	The west dam was in satisfactory condition. The pipe inlet and outlet were both clear and being well maintained around the inlet/outlet area. Some maintenance of the vegetation across the crest is recommended.		

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Lower Middle Dam	The lower middle dam was in satisfactory condition. The pipe inlet and outlet were clear but becoming partially filled in at the inlet, and the outlet was partially blocked. The lowered crest section in the centre of the embankment (spillway) was clear and stable.	Clear the pipe for any sediment build up (this was obvious and occurring at the inlet and outlet).	
East Dam	The east dam was in satisfactory condition. Grass was of a suitable short length (e.g. 50-150 mm), but other vegetation was becoming prevalent in the reservoir area and across the crest and downstream slope. The barbed wire fencing installed on the left and right abutments to prevent stock damage previously seen has worked well to prevent further stock tracking, but is now containing vegetation that should be maintained. The sea outlet channel was clear and stable, with minor bank erosion visible. The pipe inlet was mostly clear. The outlet was not found, or not confirmed. An investigation such as long wire, or water flow, should be used to confirm the outlet location.	Investigate the outlet location and mark out the outlet of the pipe through the East Dam. Pegging out of all outlets would be useful.	
Upper Middle Dam	The upper middle dam was in satisfactory condition. Grass length was suitable as per the other dams, but other vegetation was becoming prevalent. The inlet and outlet of the pipe was viewed and appeared mostly clear.		

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Catchment	The reservoir areas mostly consist of open grass farmland. The catchment comprises steep slopes and evidence of recent slips. During separate work on landslides following a cliff collapse at Cape Kidnappers in January 2019, Stantec Engineering Geologist Matt Shore identified that the Clifton area where the dams are located is an historic landslide. This was notified to HDC. This should be considered with longer term work associated with the dams.		

3.3 Lower Te Awanga Dam

Access was gained via Clifton Road.

Inspection comments, recommendations, and key photographs are included in Table 3-2. Refer to Appendix C for figures and additional photographs.

Table 3-2: Summary of Lower Te Awanga Dam Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Spillway Channel	As identified in the 2017 flood study of the Te Awanga dams, the gabion spill weirs appear to have been constructed differently to the assumed design intention, and have been infilled in the central sections (which Stantec think should be the spill slot). The upper concrete spillway structure was in good condition. The gabion wall on the right side of the main spillway structure was leaning out (to the right facing downstream), as identified in previous inspections. This should be monitoring for any future stability issues.	Remove the central gabion sections so the gabi**on drop structures become "spill through" rather than "spill over", and as originally** intended in the design.	
Reservoir Area and Upstream Channel	The reservoir area is within a narrow gorge section. This was mostly clear and stable. The heavy build-up of vegetation seen in 2018 had been cleared within the upstream channel and in front of the culvert inlet.		

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Dam Embankment	The embankment area was in good condition with stable slopes and clear crest area.		

3.4 Upper Te Awanga Dam

Access was gained through the Nilsson property to the dam. Matthew Kneebone of HDC and Graham Edmonson of Hawkes Bay Regional Council (HBRC) also attended this site inspection.

Inspection comments, recommendations, and key photographs are included in Table 3-3. Refer to Appendix D for figures and additional photographs.

Table 3-3: Summary of Upper Te Awanga Dam Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Left Abutment	The left abutment embankment was stable and in fair condition. The pipe through this section is in poor condition and this inlet would not function well and the outlet is partially blocked/buried.	Complete maintenance on the left abutment pipe at the inlet and outlet to ensure this will function adequately.	
Spillway and Outlet Culvert	The spillway channel was clear. The outlet structure was similar to previous inspections and in satisfactory condition. The rip rap placement in the downstream channel (to provide erosion protection to the area immediately downstream of the culvert and outlet structure) should be reviewed and improved/replaced where it looks light or vulnerable. The culvert has previously been recommended to be inspected for movement and current condition, and should be completed as part of the HDC dams culvert inspections (which will be set out in the OMS Manual but should be completed at least 5 yearly to coincide with the CDSRs). Some lowered crest level of the embankment (noticed in previous inspections) indicates some movement or internal erosion has occurred with or associated with the culvert location.	Review and improve the rip rap to the area downstream of the culvert and outlet structure. Complete a culvert inspection (CCTV) for current condition and identifying issues.	

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Embankment	The main embankment dam was in good condition with consistent short grass coverage. The right abutment pipe was blocked/buried at the inlet and outlet (in particular) and should be cleared for adequate function.	Complete maintenance on the right abutment pipe at the inlet and outlet to ensure this will function adequately.	
Downstream Outlet (to Charlton Stream)	The manhole inlet structure was in similar condition to previous inspections. Maintenance should be completed around the structure such as clearing of vegetation and review and replacement of rip rap. The outlet culvert structure was in similar condition to previous inspections, but placement of rock protection around the structure had been completed by HBRC Works Group maintenance.	Complete maintenance at the downstream outlet (Charlton Stream) inlet manhole (vegetation and rip rap).	

3.5 Karituwhenua Dam

Access was gained via Fulford Road.

Inspection comments, recommendations, and key photographs are included in Table 3-4. Refer to Appendix E for figures and additional photographs.

Table 3-4: Summary of Karituwhenua Dam Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Embankment	The dam crest and slope in general were in good condition. Long grass made inspection of the slopes more difficulty, but there were no obvious issues with slope movements or crest settlement. Removal of trees and vegetation on the downstream left abutment should be considered. This is not thought to be directly part of the dam, but would assist in providing a clear area for inspection, and lesson risks of potential root infiltration to the embankment. New pine trees were identified as becoming established on the upstream right side of the embankment. Clearance of these trees before they become more established should be completed, as well as consideration of some of the nearby more established pine trees in/around the embankment near the right abutment. Cattle was present in the dam area, which hadn't been seen in previous years. This should be monitored for damage in/around the embankment area.	Clear trees and vegetation from the downstream left abutment (between the dam and spillway). Clear the new pine trees on the upstream slope near the right abutment, and consider clearing established pines in/around the embankment near the right abutment. Maintain grass to approximately 50-150 mm length.	
Upstream Channel and Inlet Structure	The upstream channel from the culvert inlet was becoming heavily vegetated and should be cleared out, including some larger trees just upstream. The side channel inlet flow was missing the concrete manhole (seen in previous years), and should be rectified, mainly as it is so close to the culvert inlet. This could be redesigned/constructed. The inlet structure and debris screen were in good condition.	Upstream channel vegetation maintenance including some larger trees. Redesign the side channel inlet flow (right side of inlet structure) as currently flow is bypassing the manhole and causing erosion.	

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Spillway Chanel	The upstream channel had long grass which should be maintained shorter. Fencing within part of the spillway channel about halfway down has the potential to be a restriction during flood operation of the spillway. This should be removed. The spillway outlet corrugated iron channel requires maintenance from vegetation and erosion scour. Ideally the structure would be removed as it's not serving its purpose, and the slope be armoured or grass reinforced.	Maintenance of grass in spillway channel. Remove all fencing from within the spillway channel. Remove the spillway outlet structure and redesign the erosion protection works (e.g. rock or Reno mattress).	
Outlet Structure and Downstream Channel	The culvert outlet was clear and in satisfactory condition. Vegetation was building up around the downstream walls and should be cleared. The downstream channel was mostly clear but was becoming quite heavily vegetated.	Clear vegetation from around the culvert outlet structure and in the downstream channel.	

3.6 School Stream Dam

Access was gained via Te Mata Peak Road.

Inspection comments, recommendations, and key photographs are included in Table 3-5. Refer to Appendix F for figures and additional photographs.

Table 3-5: Summary of School Stream Dam Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Reservoir Area, Upstream Channel, and Inlet Culvert	The reservoir has a number of large trees, which have the potential to provide significant debris in a large flood event (branches, leaves, trees) which could block the inlet structure. The vertical inlet assists with this should the inlet be blocked. The upstream channel was heavily vegetated and should be cleared. The management of trees in the reservoir area should be improved.	Clear vegetation in the upstream channel.	
Embankment	The dam crest and slopes were stable with no signs of instability. The grass length was long which prevented any detailed inspection of the crest and slopes, however there were no obvious signs of movement or settlement.	Maintain a shorter grass length of 50 mm (min) to 150 mm (max) over the dam crest and slopes.	

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Spillway	The spillway entrance channel was overgrown with grass and contains some large trees. Ideally the approach channel would be clear of all trees and vegetation and be maintained as a clear approach to the start of the spillway structure. A fence and swing gate are present across the start of the spillway structure (as per previous years). This represents a dam safety issue as it will constrict and potentially cause significant blockage during a flood event, preventing design flow down the spillway. HDC have previously considered whether this issue can be included in the proposed O&M documentation, in which the landowner, or contractor, can open the fence/gate in the event of forecast extreme flooding. This should be considered in the context of the likely short duration, high intensity, flood events for this catchment, and possible limited time or ability to achieve this. This should be the minimum approach, and still needs a modification to allow easy opening of the spillway. The side culvert (right of spillway) entrance was blocked with debris and should be cleared to prevent uncontrolled storm overflow into the spillway structure. The invert of the wooden spillway structure has become infilled with leaves and woody debris and other vegetation, and breakdown into soil with grass and vegetation. The invert of the channel should be cleared out and maintained.	Clear the spillway approach channel from trees and vegetation. Remove the fence and gate from across the start of the spillway structure, and/or include in the proposed O&M documentation about opening (but following appropriate modification). Clear the debris from the entrance to the side culvert (right side of spillway) Clear out and maintain the invert of the wooden spillway structure. Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018).	
Outlet Culvert and Downstream Channel	The outlet structure had a fallen tree across it which should be removed. Grass around the structure was long which made it difficult for inspection. For health and safety, consideration should be made for fencing or rails around the structure to prevent falls (especially when it's hard to see the structure due to the excessive vegetation).	Clear the fallen tree and grass/vegetation around the outlet structure. Consider fencing/handrails around the structure to prevent falls.	

3.7 Te Kahika Dam

Access was gained via Tauroa Road.

Inspection comments, recommendations, and key photographs are included in Table 3-6. Refer to Appendix G for figures and additional photographs.

Table 3-6: Summary of Te Kahika Dam Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Reservoir Area, Upstream Channel, and Inlet Structure	The upstream channel bank erosion and a large hole around the large tree were similar to the previous inspection. Maintenance of this area should be considered to prevent this worsening or causing problems during a flood event. The channel upstream of the concrete section was overgrown with vegetation. The concrete section of the channel upstream of the inlet culvert was in fair condition. Clearance of silt build up and vegetation in the invert is recommended. The side inlet culvert (right side) had flow along the outside of the pipe/culvert and was entering via gaps/joins in the side slope of the concrete rather than the pipe. This should be fixed/replaced. Water appeared to be seeping in various places (mainly at joins) on the right concrete slope of the upstream channel. This should be investigated further with the fix/replacement of the side inlet culvert.	Clear the upstream channel of vegetation (upstream of concrete section) and clear silt and vegetation from within and around the concrete section. Fix/replace the side inlet culvert (right side) into the inlet channel, as some flow is flowing along the outside of the pipe. Also investigate other seepage areas along the right side concrete slope for areas of vulnerability.	
Embankment	The crest was in good condition, with the road and kerb showing no signs of erosion or displacement. The dam slopes were covered in short grass and in good condition, with no obvious movement or settlement. The upper half of the downstream slope had been mown short, which allowed for good inspection of the slope. The standpipes at the downstream toe were similar to previous inspections. These are not monitored. These have previously been recommended to be monitored, at least having them reinstated and monitored irregularly.	Reinstate the downstream toe standpipes and plan future monitoring as part of the Dam Safety Management System.	

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Spillway	The concrete section of the spillway was in similar condition to previous inspections. The gate across the top of the spillway (under the bridge) remains in place as per previous years. This can swing in the direction of flow, but it's unsure how effective this will be. It's recommended this be removed, or at least modified to work more effectively. As per School Stream Dam, HDC are looking at including this in the proposed O&M procedures to contractor and/or owner operation of the gate during predicted flood events. This gate should be more easily modified to be opening effectively during a flood emergency. Significant established trees and plants are located along both sides of the spillway channel, the downstream wooden section in particular. These have caused issues for the wooden structure and have previously been recommended to be removed. The recommendations to replace and strengthen elements of the wooden structure (Stantec structural assessment) should be in conjunction with removal of trees which have contributed to the issue. Removal may be needed as part of maintenance to the wooden structure anyway. The invert of the spillway should also be cleaned out and maintained.	Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018). Remove the gate from across the start of the spillway structure, and/or include in the proposed O&M documentation about opening (but following appropriate modification). Note the owner will need to be notified.	
Outlet Culvert and Downstream Channel	The outlet culvert structure was in good condition and was clear at the outlet and within most of the stilling basin. The downstream channel, and part of the downstream section of the stilling basin had heavy vegetation. The channel should be significantly cleared.	Clear the stilling basin and downstream channel of all vegetation.	

3.8 Mangarau Dam

Access was gained via Keirunga Road.

Inspection comments, recommendations, and key photographs are included in Table 3-7. Refer to Appendix H for figures and additional photographs.

Table 3-7: Summary of Mangarau Dam Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Spillway Channel	The channel on the right abutment was in similar condition to previous inspections. Vegetation and debris piles were present in the channel. Trees and fencing are located down the sides of the channel. All vegetation and debris should be cleared from the channel along with trees and fences. This is to ensure that the design flood flow can be safely contained and discharged. The concrete sill at the spillway crest was in satisfactory condition.	Remove vegetation, debris piles, trees, and fences from within the spillway channel.	
Upstream Channels	The side inlet channel was in similar condition to previous inspections. The manhole lid is not positioned correctly and should be rectified. Some minor leaf debris was present in the area immediately upstream of the inlet culvert and should be cleared. The outlet to the side channel at the upstream right abutment was not viewed due to presence of animals but in 2018 it was in poor condition. The scruffy dome was not attached to the manhole correctly. The flap gate was not working and should be removed or maintained. The main channel upstream of the inlet structure was very overgrown with vegetation and trees and should be cleared.	Replace manhole lid correctly at the side inlet channel (right side of upper spillway). Clear the debris from the inlet area of the side inlet channel culvert. Maintenance of the side channel outlet at the upstream right abutment including scruffy dome attachment and removing/fixing the flap gate. Clear the main upstream channel of trees and vegetation.	

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Embankment	The downstream embankment area was generally in good condition. Some grass was getting long. The crest areas were in poor condition with vegetation clearance needed and stock erosion in places. The downstream slopes of the right abutment (between the spillway and the dam) are steep and undulating, with this area previously having issues with animal burrows. A few burrows and animals were identified again in this inspection. Even though these are not located on the embankment section, discouragement of burrowing animals from the site is recommended. The embankment area included a mixture of animal fencing, long grass, and vegetation. A tree is present on the downstream left of the embankment slope and should be removed.	Backfill existing animal burrows and prevent burrowing animals from the dam area. Clear fences, vegetation, and other items from across the dam area. Repair damaged areas such as erosion across the crest. Clear trees on the dam embankment near the downstream left abutment. Maintain grass at an acceptable length of 50 mm (min) to 150 mm (max).	
Inlet Structure	The area around the inlet was becoming heavily vegetated and should be cleared. This also prevents adequate inspection of the inlet and culvert. The vertical inlet structure appeared in good condition.		
Outlet Structure and Downstream Channel	Trees were established on the sides and ends of the outlet structure (stilling basin) and should be removed. The outlet culvert and stilling basin structure appeared in satisfactory condition. The downstream channel had a number of trees and these should be cleared, as they are encroaching on the channel. The downstream boundary wooden swing fence was in unknown condition due to the heavy vegetation.	Remove trees on the sides and ends of the outlet structure (stilling basin). Remove trees in downstream channel. Clear or remove downstream boundary wooden swing fence.	

3.9 Here Here Dam

Access was gained via Margaret Avenue.

Inspection comments, recommendations, and key photographs are included in Table 3-8. Refer to Appendix I for figures and additional photographs.

Table 3-8: Summary of Here Here Dam Site Inspection

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Reservoir Area and Upstream Channel	The reservoir area was fairly clear and contains mostly open pasture, surrounded by trees. The upstream channel between the boundary fence and the inlet structure was becoming heavily vegetated with lots of trees along the sides of the channel. The channel should be cleared out. The culvert/bridge upstream of the inlet structure was clear and stable. Some of the timber support surrounds were becoming damaged and broken. The reason for this access bridge is unknown.	Remove established trees in the upstream channel to maintain a clear channel and to reduce the potential for future blockage potential at the inlet culvert area.	
Inlet Structure	The upstream inlet structure area was hard to view due to vegetation in and around the structure and within the channel. The culvert appeared in good condition as could be viewed from the upstream end. The tree on the hydraulic left side of the structure should be removed.	Remove the vegetation from within and around the inlet channel area and structure. Consider wider tree clearance around the upstream left abutment where some large trees are present (proactive maintenance at least).	

Dam or Appurtenant Structure	Key Site Inspection Observations	Recommendation	Photograph
Embankment	The upstream face was in good condition with stable slopes. Medium to long grass coverage was across the dam crest and slopes. There were no obvious signs of movement or settlement. The downstream face was similar to the upstream face and crest. The trees on the downstream left and right abutment should be cleared so they don't cause any potential impacts on the embankment or outlet area, and to allow clear inspection.	Remove the trees from the downstream left and right abutment areas. Maintain grass at an acceptable length of 50 mm (min) to 150 mm (max).	
Spillway	The concrete sill was in good condition. The spillway channel had very long grass and should be cut back. The wooden fence and trees along the left side of the channel should be removed. The large trees across the lower slopes upstream of the spillway channel (adjacent to the inlet structure) should have maintenance or be removed so as not to cause issues during a large flood. Remove/alter the fence and gate across the spillway channel at the property boundary (mid section of spillway), as this represents a blockage potential. The downstream spillway channel was viewed from the fence/gate and was becoming overgrown with vegetation and trees and other items. The house on the right side is also close by. The flood levels from spillway flows should be checked against the levels at this house.	Complete maintenance in the spillway channel (clear trees and vegetation and remove wooden fence). Complete maintenance on or remove the large trees at the lower slope upstream of the spillway channel. Remove/alter the fence and gate at the mid section of the spillway channel. Check spillway flood flow levels against the levels of the house on the right side of the spillway channel (halfway down).	
Outlet Structure and Downstream Channel	The downstream channel was generally clear and stable but contained long grass. The outlet structure was generally in satisfactory condition. A tree in the stilling basin should be removed. The stilling basin invert should be cleaned out and inspected for any issues. The iron flap gate (stock prevention) should be cleared as it was blocked up with debris. This gate should be removed and stock prevented from accessing this area by other means (fencing around outlet structure and downstream channel).	Remove the tree in and clear the invert of the stilling basin outlet structure. Remove iron flap gate from the culvert outlet.	

4 Routine Inspections and Maintenance

Routine inspections and maintenance is carried out on a regular basis by Contractors engaged by HDC. Ongoing maintenance relates to the removal of vegetation growth and accumulated sediments upstream and downstream of the diversion culverts and maintaining a clear spillway channel for the safe passage of flood flows. The presence of accumulated sediments, debris, vegetation, and potentially unstable slopes in the approach channels relate to a higher likelihood that the diversion culverts may become blocked during flood events. The removal and maintenance of vegetation assists visual inspection during the routine and annual inspections.

The maintenance contractor has been previously requested to perform routine inspections during all maintenance visits utilising the visual inspection checklist. HDC provided their Work Order summary outlining that maintenance inspections were completed for the following dates since the last IDSR in November 2018:

December 2018	07/01/2019
January 2019	21/01/2019
February 2019	20/02/2019
March 2019	06/03/2019
April 2019	Cancelled by contractor
May 2019	06/05/2019
June 2019	05/06/2019
July 2019	15/07/2019
August 2019	Cancelled by contractor
September 2019	17/09/2019
October 2019	15/10/2019
November 2019	20/11/2019

NZSOLD Dam Safety Guidelines recommend that routine visual inspections should be performed for a High PIC dam (i.e. the five Havelock North Dams) on at least a monthly basis, and inspections should also be performed following any significant flooding or earthquake events (Special Inspections). However, since flood detention dams do not normally permanently impound water, these frequencies can be relaxed and dam safety related inspections completed on the annual basis (as part of the IDSR) would suffice, along with inspections during (if safe to do so) and immediately following significant flood events. The focus of Council or Contractor visits between IDSRs (annual independent dam safety inspections) should be predominantly maintenance related, although key dam safety issues should be highlighted as required for attention.

Regular maintenance is important for flood detention dams, particularly the diversion culverts and spillways, prior to forecast heavy rainfall. Documentation of the maintenance performed and any routine or special inspection checklists completed since the previous IDSR/CDSR should be provided for review with each IDSR/CDSR.

It is recommended that HDC develop a Dam and Reservoir Operation and Maintenance document, outlining the operation of the dams, including the basic surveillance requirements for dam safety (including Special Inspections following significant floods or earthquakes), and the maintenance requirements for operation and dam safety.

This is underway with Stantec with the draft OMS Manual to be issued in early 2020.

Note that an O&M document for the flood detention dams should be extended to cover Surveillance activities under 'Operations', therefore becoming an OMS document.

Operation of the flood detention dams is essentially uncontrolled, or self-operating. The catchment and reservoir area is uncontrolled, so inflows will freely enter the reservoir area. The main controlling feature of the dams, as with most flood detention dams, is the low level culvert. The culvert will control the outflow from the reservoir, limited by the flow capacity of the culvert. The majority of the time (low to normal flow conditions) inflows are passed through the culvert and downstream as if there was no dam in place. In times of inflows greater than normal, when these exceed culvert capacity/outflow, the reservoir will rise. When the reservoir rises enough in a significant inflow/flood event, the reservoir will reach the spillway

level. The spillways are uncontrolled, open channel, and will discharge the flood flows for the capacity of the channel, until the reservoir reaches dam crest level (at which point the water will overflow the dam and the embankment will start eroding which could lead to breach failure of the dam).

The Operations and Maintenance (O&M) document should cover:

1. Procedures and protocols (Dam and Reservoir Operation/Safety).
2. Operator/Contractor Experience and Training.
3. Reservoir Operation Records (rainfall and flow data records).
4. Dam and Reservoir Maintenance (e.g. erosion protection, spillway structure, inlet and outlet structures, surface drainage, vegetation control, etc.).

The surveillance details should include the visual inspections and monitoring activities (to include each inspection point (i.e. from the inspection checklist), instruments (rainfall/flow/water level), maps, GPS coordinates, and photographs of each inspection point, and the process for inspections and reporting).

The special inspections will outline when these are to take place (i.e. after an earthquake with Modified Mercalli Intensity 5 or greater, rainfall of greater than 100 mm in a 24 hour period). The following earthquakes above Magnitude 5 were recorded in the Hawkes Bay region in the period between the 2018 and 2019 dam inspections.

1 October 2019 M5.7 30 km east of Wairoa (approximately 100 km northeast of Hastings).

No damage or issues of significance have been reported at any of the dams with respect to earthquakes.

HDC have not noted any significant floods that have occurred in the previous year. The summary of water levels and rainfall for the Havelock North dams is outlined and discussed in Section 5.

NZSOLD Guidelines outlines the suggested monitoring types and frequencies (shown in Figure 4-1).

Table 4.3: Suggested Routine Monitoring Frequencies

Type of Instrument	Potential Impact Classification (PIC)		
	Low	Medium	High
Reservoir Level	At Routine Inspection	At Routine Inspection	Continuous and Telemetered
Seepage and/or Leakage	At Routine Inspection (refer Note 2)	Refer Note 1 (minimum at Routine Inspection)	Refer Note 1 (minimum at Routine Inspection)
Phreatic surface and/or Uplift Pressure			
Deformation Survey	Refer Note 1 (min. 10-yearly)	Refer Note 1 (minimum 5-yearly)	Refer Note 1 (minimum 5-yearly)
Rainfall		Daily (refer Note 3)	Daily to Hourly (refer Note 3)
Seismic Event Notification		Refer Note 4	Refer Note 4
Turbidity (of seepage)		As required	As required
Chemical Analysis		As required	As required
Post-tensioned anchor cable loads		10-yearly	5-yearly

Note 1: Determine frequency in consultation with appropriate experienced Technical Adviser considering dam and foundation type, the specific dam performance monitoring needs (refer section 4.2.6), the consequences of failure, and the instrument monitoring frequency items listed above the table.

Note 2: If instrumentation exists.

Note 3: Rainfall measurement at, or near to, the dam site assists with seepage/leakage evaluation. Rainfall measured in or close to the dam's catchment (where available), assists with flood forecasting.

Note 4: For dams located in close proximity to known active faults it is recommended to access a seismic monitoring network that provides timely notification of the locations and magnitudes of earthquakes relative to the dam site. A public notification service based on a national network of instruments is available (GNS Science's Geonet).

Figure 4-1: Suggested Monitoring Types and Frequency (from NZSOLD Dam Safety Guidelines)

Since flood detention dams do not normally store a reservoir, reservoir levels, seepage/leakage, and phreatic surface monitoring is generally not required.

The rainfall and stream flow data (level) is currently monitoring by HDC (Havelock North dams), as early warning for flooding. Details of these and the operation and maintenance of these should be included in the O&M&S document.

Some observation wells are located at the downstream toe of the Te Kahika Dam, but these are not monitored.

When the OMS Manual/Documentation is developed, this should include all the required/recommended monitoring at each dam.

Deformation survey of the dam embankments is recommended to be completed 5 yearly at the minimum (but could be less regularly for the Te Awanga and Clifton Dams with Low to Medium PIC). It is recommended that a survey benchmark and monuments plan is developed, and deformation surveys (crest levelling surveys at the minimum) of the Havelock North dams are completed 5 yearly, to coincide with the CDSRs.

5 Rainfall and Reservoir Level Data (Havelock North Dams)

Failure mode 2 outlined in the 2015 CDSR describes one of the identified failure modes for the flood detention dams. This is the breach by internal erosion/piping associated with a diversion culvert during a flood event. In addition to monitoring water levels for flood conditions, in association with the condition assessments of the culverts (i.e. camera inspections) and dam safety management, it's useful information to know the water levels that have been reached at each dam in history. This will assist in determining water levels which would trigger the need to complete post flood inspections, and culvert condition assessments.

HDC record water levels at each of the Havelock North flood detention dams. Water levels are recorded hourly. Records extend back to June 2007, with the supplied information covering the period to November 2019 (with some gaps). A summary of the information is included in Table 5-1 and graphs for each dam are shown in Figure 5-1 to Figure 5-5. HDC also record rainfall at the Havelock North dams (10 minute recording, which has been converted to daily sums for the graphs).

Table 5-1: Summary of Dam Water Levels (June 2007 – November 2019)

Dam	Maximum Water Level (m)	Date	Approximate Dam Height (m)
Karituwhenua	2.200	26 April 2011	9
School Stream	3.409	26 April 2011	12
Te Kahika	2.072	5 September 2018	13
Mangarau	5.139	24 January 2017	11
Here Here	2.957	30 July 2008	12

Based on the approximate dam heights, the maximum water levels have reached up to approximately 30% of the dam heights.

The culvert sizes range from 1,800 mm diameter (Mangarau Dam) to 525 mm (School Stream Dam). The maximum water levels are thought to have exceeded the culverts at each dam but may not have reached the auxiliary inlet culvert (vertical culverts). Note that Karituwhenua Dam does not have an auxiliary inlet culvert.

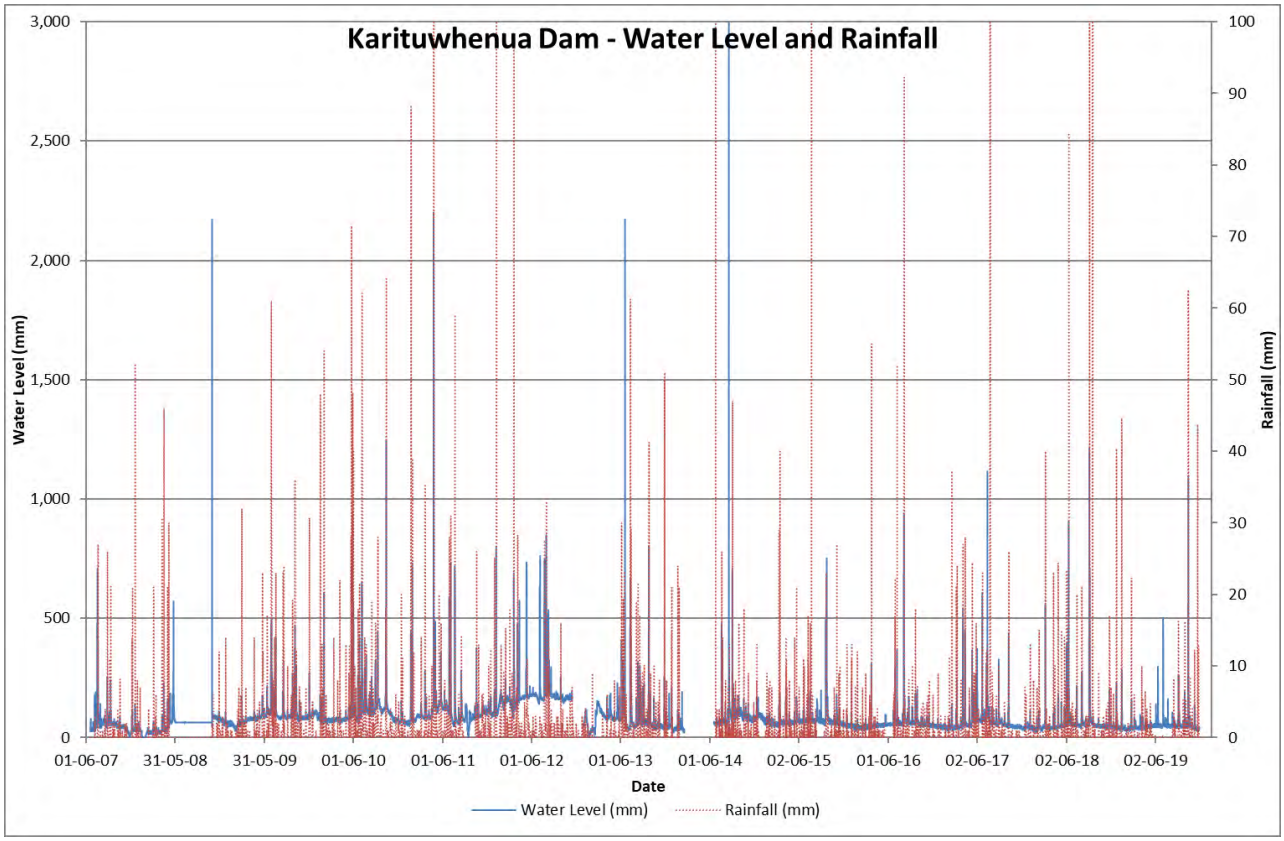


Figure 5-1: Karituwhenua Dam Water Levels and Rainfall (June 2007 – November 2019)

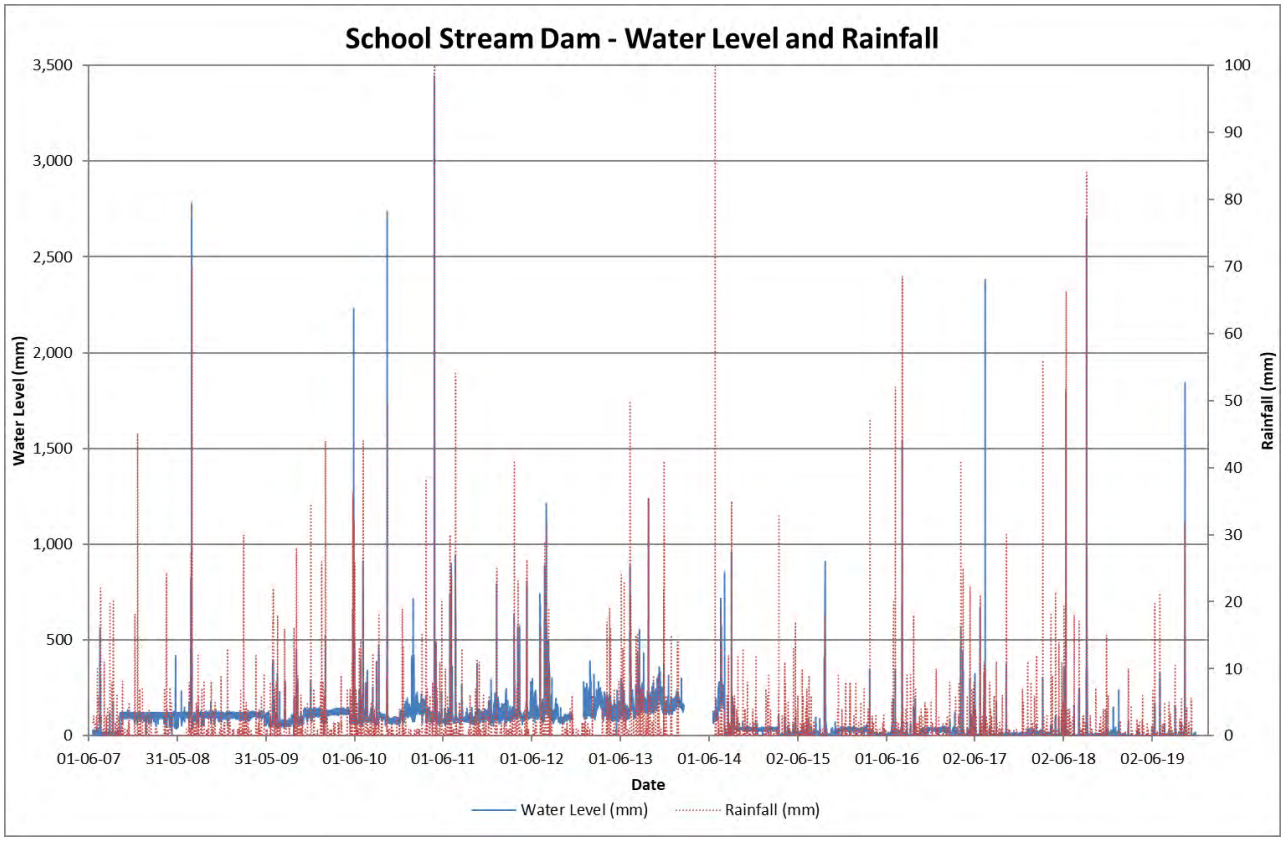


Figure 5-2: School Stream Dam Water Levels and Rainfall (June 2007 – November 2019)

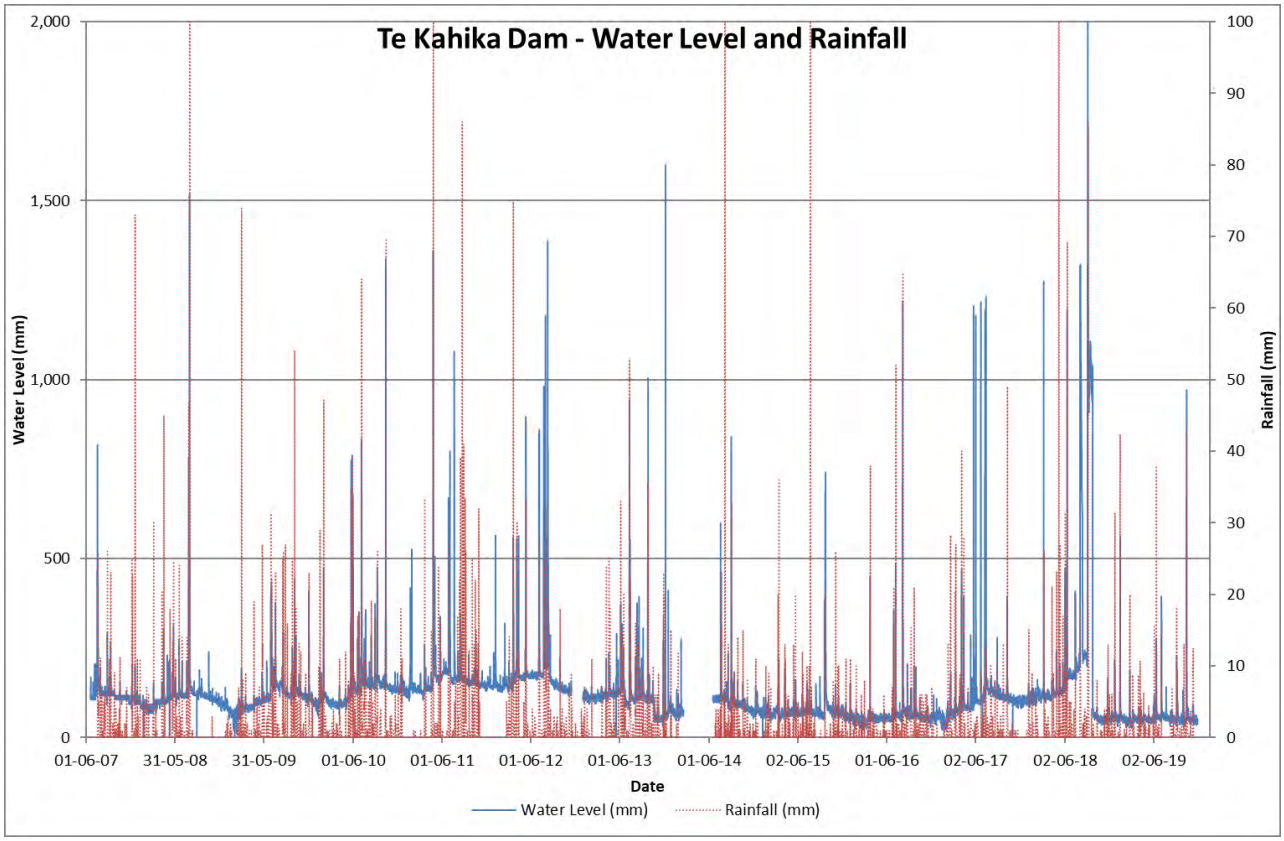


Figure 5-3: Te Kahika Dam Water Levels and Rainfall (June 2007 – November 2019)

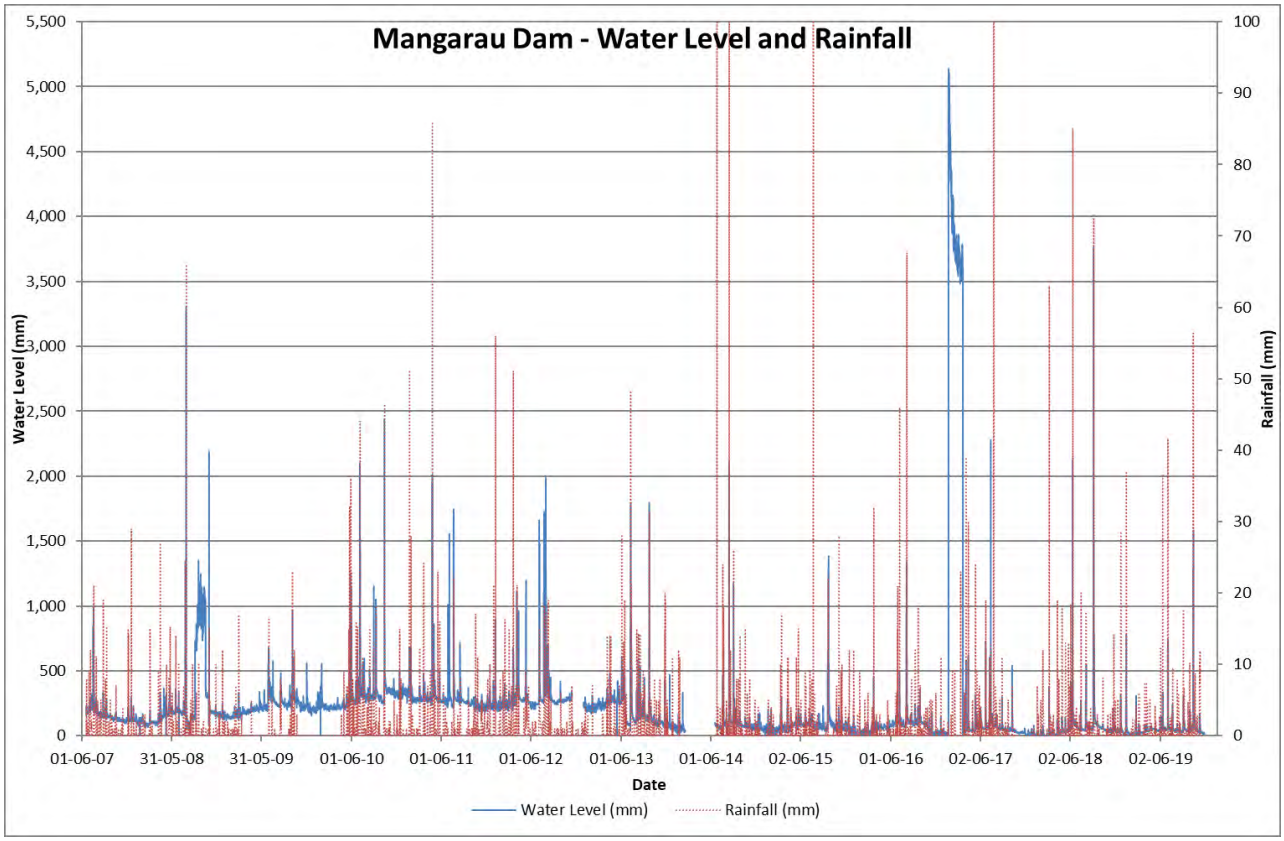


Figure 5-4: Mangarau Dam Water Levels and Rainfall (June 2007 – November 2019)

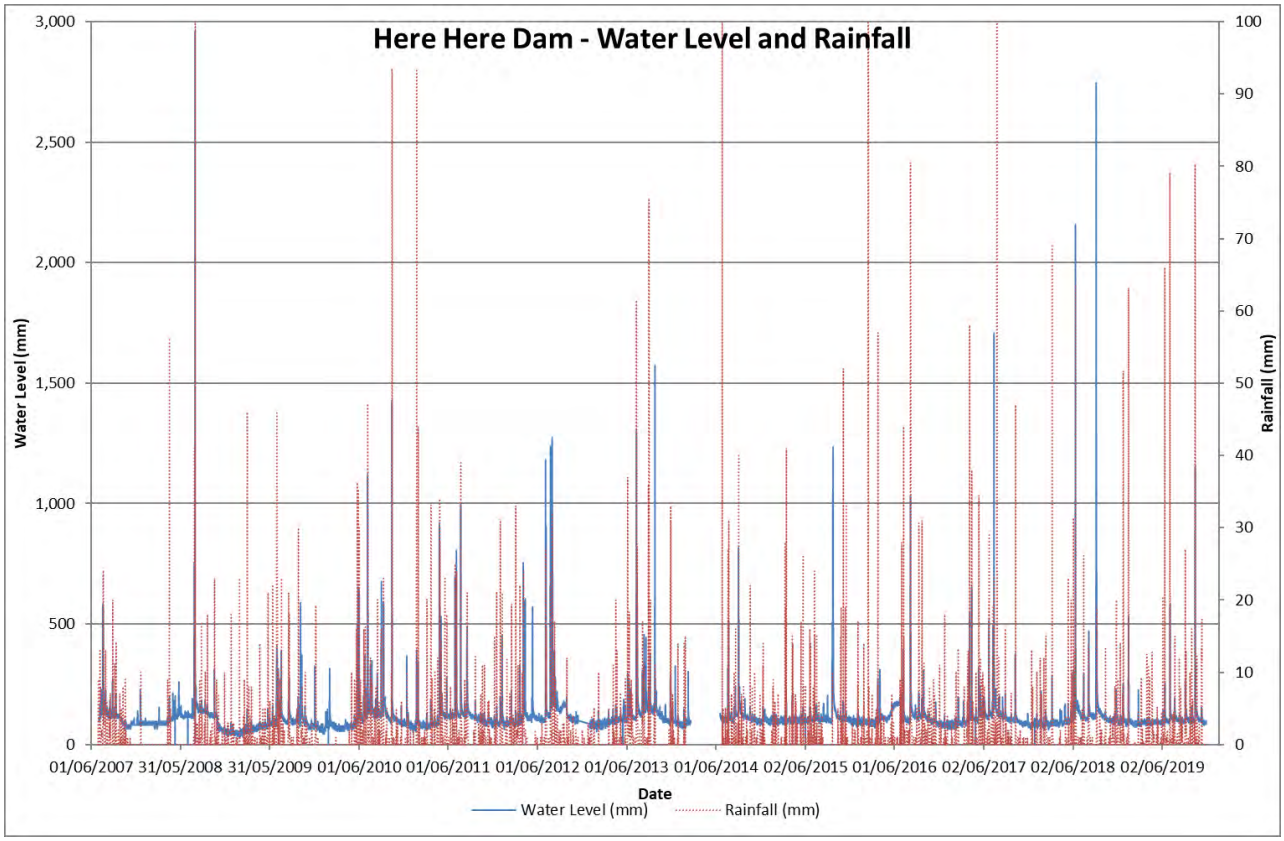


Figure 5-5: Here Here Dam Water Levels and Rainfall (June 2007 – November 2019)

6 Dam Safety Recommendations

6.1 Resource Consent Conditions

The following Resource Consents (Water Permit), from Hawke's Bay Regional Council (HBRC) are in place for the dams:

Table 6-1: HDC Dams – Resource Consents Summary

Resource Consent No.	Dam/Location	Details	Conditions
WP990304M & DP990305W	Mangarau Pufflett Road Havelock North.	Dam the Mangarau Stream. Dam Height = 14 m. Volume of reservoir = 450,000 m³. Discharge water from the dam into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999).	1. All works and structures relating to this resource consent shall be designed and constructed to conform to the best engineering practices and at all times maintained to a safe and serviceable standard. 2. The consent holder shall undertake all operations in accordance with any drawings, specifications, statements of intent and other information supplied as part of the application for this resource consent. Specially this includes. In the event that there is conflict between the information supplied with the application and any consent condition(s), the conditions(s) shall prevail. 3. The consent holder shall carry out an annual inspection of the dam and forward a copy of the inspection report to the Regional Council (Environmental Regulation section), within a month of the inspection taking place. Review of Consent Conditions by the Council = during the months of June 2009, June 2019 and June 2029.
WP990306M & DP990307W	Here Here Lane Road and Margaret Avenue Havelock North	Dam the Herehere Stream. Dam Height = 13 m. Volume of reservoir = 250,000 m³. Discharge water from the dam through a 1,600 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999).	
WP990310M & DP990311W	Te Kahika Tauroa Road Havelock North.	Dam the Te Kahika Stream. Dam Height = 14 m. Volume of reservoir = 194,200 m³. Discharge water from the dam through a 900 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999).	
WP990312M & DP990313	Karituwhenua Durham Drive Havelock North.	Dam the Karituwhenua Stream. Dam Height = 9 m. Volume of reservoir = 41,750 m³. Discharge water from the dam through a 900 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999).	
WP990554M & DP990566W	School Stream Te Mata Peak Road Havelock North.	Dam the School Stream. Dam Height = 10.5 m. Volume of reservoir = 150,000 m³. Discharge water from the dam through a 750 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 31 January 2000).	1. All works and structures relating to this resource consent shall be designed and constructed to conform to the best engineering practices and at all times maintained to a safe and serviceable standard. 2. The consent holder shall undertake all operations in accordance with any drawings, specifications, statements of intent and other information supplied as part of the application for this resource consent. Specially this includes. In the event that there is conflict between the information supplied with the application and any consent condition(s), the conditions(s) shall prevail. 3. The consent holder shall give the Council's Environmental Regulation section at least two working days notice of the intention to commence the works, and shall advise the Council of having finished the works immediately following their completion. 4. The consent holder shall take all practical measure to limit the amount of sediment entering the water during construction. This includes minimising the use of machinery in the stream. 5. Exposed surfaces shall be grassed or planted upon completion of the works and disturbed areas restored to a similar or better state than existed prior to commencement of the works. 6. Machinery operating in the stream shall be adequately maintained so as to avoid the leaking of oil or any other contaminant, and the refuelling of that machinery shall not take place in the bed or in any position where spills may enter the stream. 7. At the completion of any works all debris and rubbish shall be removed. 8. The consent holder shall carry out an annual inspection of the dam and forward a copy of the inspection report to the Regional Council (Environmental Regulation section), within a month of the inspection taking place. Review of Consent Conditions by the Council = during the months of June 2009, June 2019 and June 2029.

Resource Consent No.	Dam/Location	Details	Conditions
WP100264M, WP100265D, LU100306C, LU1003070V and DP100308W	Lower Te Awanga 252 Clifton Road Te Awanga	Dam structure, culvert and a pipe in the bed of an unnamed tributary of the Maraetotara River (known as the Te Awanga Stream). Divert Te Awanga Stream into a 1,050 mm pipeline. Discharge water from a reservoir, via a pipe, to the Maraetotara River. Consent duration (WPs/DP) = expiring 31 May 2045 (dated 16 November 2010).	Post Construction: 1. On completion of the works, the bed of the waterbody shall be restored to no lesser state than it was before the works commenced. 2. The consent holder shall ensure that at the completion of the works, any newly established surfaces and any grassed or vegetated areas that were cleared or damaged as a result of the activity, excluding the reservoir area, are re-vegetated in order to prevent sediment from entering the stream. 3. Upon completion of the works, the consent holder shall submit a dam monitoring and maintenance plan to the satisfaction of Council (Manager Compliance), see advice note. The plan shall include but not limited to: a). An outlined of the methodology of the annual inspection and inspection report as required by Condition 20 below; b). The guidelines of the Auckland Regional Council Technical Publication entitled 'TP109'. 4. The consent holder shall carry out an annual inspection of the dam and a copy of the inspection report shall be sent to the Council (Manager Compliance) within one month of the date of the inspection. Any maintenance issues identified in the inspection report shall be addressed within three months of the date of the inspection and be to the satisfaction of the Council (Manager Compliance). Review of Consent Conditions by the Council = during the month of May, of any year.

No consent conditions are known to exist for the Upper Te Awanga Dam and the Clifton Dams. However, these are part of the HDC flood detention dams and they are inspected and reporting on annually as part of the Havelock North dams and Lower Te Awanga dam. Maintenance and dam safety management generally follows that for the Lower Te Awanga Dam.

6.2 IDSRs

Listed in Table 6-2 is the current (2019) recommendations for each dam, which includes the status of previous recommendations from IDSRs. Previous recommendations which are still valid, or which have been superseded by a new recommendation, are included.

The dam safety recommendations from this review are separated into the following categories:

1. A: Physical infrastructure issues.
2. B: Potential dam safety deficiency.
3. C: Confirmed dam safety deficiency.
4. D: Non-conformances. These are where dam safety management system processes and procedures have not been followed, or established dam safety practices have not been implemented.

Priority:

High – this should be completed immediately

Medium – this should be completed, or substantially progressed, within the next 12 months.

Low – this should be scoped within the next 12 months for future completion.

Table 6-2: 2018 IDSR Recommendations

Recommendation Number	Report Reference	Description	Category	Priority	Comments
CLIFTON DAMS					
2019-CD-1	S3.2, page 4	The remediation of the gully or other stormwater control options should be investigated.	A		Motorcamp stormwater gully.
2019-CD-2	S3.2, page 4	Clear the downstream gully stormwater channel upstream of the concrete box section, and within the concrete box section.	A		
2019-CD-3	S3.2, page 5	Clear the pipe for any sediment build up (this was obvious and occurring at the inlet and outlet)	A		Lower Middle Dam
2019-CD-4	S3.2, page 5	Investigate the outlet location and mark out the outlet of the pipe through the East Dam. Pegging out of all outlets in particular would be useful.	A		
LOWER TE AWANGA DAM					
2019-LTA-1	S3.3, page 7	Remove the central gabion sections so the gabion drop structures become "spill through" rather than "spill over", and as originally intended in the design.	A		

Recommendation Number	Report Reference	Description	Category	Priority	Comments
UPPER TE AWANGA DAM					
2019-UTA-1	S3.4, page 9	Complete maintenance on the left abutment pipe at the inlet and outlet to ensure this will function adequately.	A		
2019-UTA-2	S3.4, page 9	Review and improve the rip rap to the area downstream of the culvert and outlet structure.	A		
2019-UTA-3	S3.4, page 9	Complete a culvert inspection (CCTV) for current condition and identifying issues.	A		
2019-UTA-4	S3.4, page 10	Complete maintenance on the right abutment pipe at the inlet and outlet to ensure this will function adequately.	A		
2019-UTA-5	S3.4, page 10	Complete maintenance at the downstream outlet (Charlton Stream) inlet manhole (vegetation and rip rap).	A		
KARITUWHENUA DAM					
2019-K-1	S3.5, page 11	Clear trees and vegetation from the downstream left abutment (between the dam and spillway).	A		
2019-K-2	S3.5, page 11	Clear the new pine trees on the upstream slope near the right abutment, and consider clearing established pines in/around the embankment near the right abutment.	A		
2019-K-3	S3.5, page 11	Maintain grass to approximately 50-150 mm length.	A		
2019-K-4	S3.5, page 11	Upstream channel vegetation maintenance including some larger trees.	A		
2019-K-5	S3.5, page 11	Redesign the side channel inlet flow (right side of inlet structure) as currently flow is bypassing the manhole and causing erosion.	A		
2019-K-6	S3.5, page 12	Maintenance of grass in spillway channel.	A		
2019-K-7	S3.5, page 12	Remove all fencing from within the spillway channel.	A+B		
2019-K-8	S3.5, page 12	Remove the spillway outlet structure and redesign the erosion protection works (e.g. rock or Reno mattress).	A		
2019-K-9	S3.5, page 12	Clear vegetation from around the culvert outlet structure and in the downstream channel.	A		
SCHOOL STREAM DAM					
2019-SS-1	S3.6, page 13	Clear vegetation in the upstream channel.	A		
2019-SS-2	S3.6, page 13	Maintain a shorter grass length of 50 mm (min.) to 150 mm (max.) over the dam crest and slopes.	A		
2019-SS-3	S3.6, page 14	Clear the spillway approach channel from trees and vegetation.	A		
2019-SS-4	S3.6, page 14	Remove the fence and gate from across the start of the spillway structure, and/or include in the proposed O&M documentation about opening (but following appropriate modification).	A+B		
2019-SS-5	S3.6, page 14	Clear the debris from the entrance to the side culvert (right side of spillway)	A		
2019-SS-6	S3.6, page 14	Clear out and maintain the invert of the wooden spillway structure.	A		
2019-SS-7	S3.6, page 14	Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018).	A		
2019-SS-8	S3.6, page 14	Clear the fallen tree and grass/vegetation around the outlet structure.	A		
2019-SS-9	S3.6, page 14	Consider fencing/handrails around the structure to prevent falls.	A		
TE KAHIKA DAM					
2019-TK-1	S3.7, page 15	Clear the upstream channel of vegetation (upstream of concrete section) and clear silt and vegetation from within and around the concrete section.	A+B		
2019-TK-2	S3.7, page 15	Fix/replace the side inlet culvert (right side) into the inlet channel, as some flow is flowing along the outside of the pipe.	A		
2019-TK-3	S3.7, page 15	Reinstate the downstream toe standpipes and plan future monitoring as part of the Dam Safety Management System.	A+D		
2019-TK-4	S3.7, page 16	Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018).	A+C		
2019-TK-5	Previous IDSRs	Clear trees/vegetation from sides of spillway (probably needed for access for repair works to spillway).	A		
2019-TK-6	S3.7, page 16	Remove the gate from across the start of the spillway structure, and/or include in the proposed O&M documentation about opening (but following appropriate modification).	A+C		
2019-TK-7	S3.7, page 16	Clear the stilling basin and downstream channel of all vegetation.	A+B		
MANGARAU DAM					
2019-M-1	S3.8, page 17	Remove vegetation, debris piles, trees, and fences from within the spillway channel.	A+B		
2019-M-2	S3.8, page 17	Replace manhole lid correctly in side inlet channel (right side of upper spillway).	A		

Recommendation Number	Report Reference	Description	Category	Priority	Comments
2019-M-3	S3.8, page 17	Clear the debris from the inlet area of the culvert (side inlet).	A		
2019-M-4	S3.8, page 17	Maintenance of the side channel outlet at the upstream right abutment including scruffy dome attachment and removing/fixing the flap gate.	A		
2019-M-5	S3.8, page 17	Clear the main upstream channel of trees and vegetation.	A+B		
2019-M-6	S3.8, page 18	Backfill existing animal burrows and prevent burrowing animals from the dam area.	A+B		
2019-M-7	S3.8, page 18	Clear fences, vegetation, and other items from across the dam area. Repair damaged areas such as erosion across the crest.	A		
2019-M-8	S3.8, page 18	Clear trees on the dam embankment near the downstream left abutment.	A+B		
2019-M-9	S3.8, page 18	Maintain grass at an acceptable length of 50 mm (min) to 150 mm (max).			
2019-M-10	S3.8, page 18	Remove tree on the sides and ends of the outlet structure (stilling basin).	A+B		
2019-M-11	S3.8, page 18	Remove trees in downstream channel.	A		
2019-M-12	S3.8, page 18	Clear or remove downstream boundary wooden swing fence.	A		
HERE HERE DAM					
2019-HH-1	S3.9, page 19	Remove established trees in the upstream channel to maintain a clear channel and to reduce the potential for future blockage potential at the inlet culvert area.	A+B		
2019-HH-2	S3.9, page 19	Remove the vegetation from within and around the inlet channel area and structure. Consider wider tree clearance around the upstream left abutment where some large trees are present (proactive maintenance at least).	A+B		
2019-HH-3	S3.9, page 20	Remove the trees from the downstream left and right abutment areas.	A+B		
2019-HH-4	S3.9, page 20	Maintain grass at an acceptable length of 50 mm (min) to 150 mm (max).			
2019-HH-5	S3.9, page 20	Complete maintenance in the spillway channel (clear trees and vegetation and remove wooden fence).	A+B		
2019-HH-6	S3.9, page 20	Complete maintenance on or remove the large trees at the lower slope upstream of the spillway channel.	A+B		
2019-HH-7	S3.9, page 20	Remove/alter the fence and gate at the mid section of the spillway channel.	A+B		
2019-HH-8	S3.9, page 20	Check spillway flood flow levels against the levels of the house on the right side of the spillway channel (halfway down).	A		
2019-HH-9	S3.9, page 20	Remove the tree in and clear the invert of the stilling basin outlet structure.	A+B		
2019-HH-10	S3.9, page 20	Remove iron flap gate from the culvert outlet.	A+B		
2019-HH-11	Previous IDSRs	Clean out RHS toe drain pipe (exits into the outlet structure). Confirm whether blockage noted (0.7 m from wall) is related to pipe collapse (surface depression) previously noted.	A		
2019-HH-12	Previous IDSRs	Confirm whether embankment toe drain outlet pipes are free of sediment and functional.	A		

6.3 CDSR Recommendations

The 2015 CDSR made recommendations relating to dam safety of the flood detention dams. Table 6-3 provides a summary of these recommendations and the current understood status of these.

Table 6-3: 2015 CSR Recommendations and Current Status

2015 CSR Recommendation Reference	Recommendation	Purpose	Status
2015.1	Develop a dam safety management plan and procedures for the flood detention dams	To ensure the Owner has plans and procedures appropriate to the dams and consistent with the principles given in NZSOLD (2015) particularly the modules related to Dam Safety Management, Emergency Preparedness and Lifecycle Management.	In progress. The OMS documentation has been scoped and approved in late 2019, with draft reporting early 2020.
2015.2	Develop an emergency action plan for the flood detention dams and procedures for training and testing.	As per NZSOLD recommendations, particularly as there are known flood deficiencies at some dams that have a High potential impact classification with a large PAR downstream.	Outstanding. To be considered following review of the previous downstream flood studies, the potential need to update the existing dam break modelling, and completion of the OMS documentation.
2015.3	Use As Built survey data to confirm the spillway discharge capacity and rerun hydraulic models to confirm the dam crest flood capacity and improvement options	To confirm any flood deficiencies and to identify improvement options and assist in prioritisation of planned remedial works	The flood capacity confirmation for the five Havelock North dam is complete (MWH (May 2016)). Improvement works and prioritisation is to be completed but could follow or align with

2015 CSR Recommendation Reference	Recommendation	Purpose	Status
			dam safety management (in particular the EAP). The Te Awanga dams flood study has also been completed (Stantec (October 2019)). The dam break study was draft reported in October 2019. Further studies required to cover both the deficiency in the flood capacity of both dams and possible flood improvement options in the catchment.
2015.4	Undertake a condition survey of the timber spillway chutes for the appropriate dams.	There is visual evidence of deterioration and evidence of large deformations on some elements.	Complete. Stantec completed inspections and reporting in 2018. Recommendations for both School Stream and Te Kahika were made and should be planned for completion by HDC.
2015.5	Evaluate options to repair the cracked section of culvert through School Stream Dam. Repeat CCTV examination after any very large flood or before next CDSR.	The culvert cracking potentially allows dam material to be drawn into the culvert under flood conditions, and may lead to a sinkhole developing.	Outstanding. HDC to plan and budget this work to complete. This should also be included in the OMS documentation. HDC should include the inspection of dam culverts in future budgets and schedule these 5 yearly prior to CDSRs. The next CDSR is due in 2020.

7 Conclusions

On the basis of the visual inspections, the flood detention dams appeared to be functioning adequately and safe performance is expected under normal operating conditions.

To ensure performance during small to medium flood events, the culverts, in particular the upstream channels and inlet structures, should be maintained and clear of vegetation.

To ensure safe discharge of large floods via the spillways, the spillway channels should be maintained clear of any obstructions such as fences and gates and vegetation removed.

Gates and fences across and within the spillways remain as live dam safety issues at all five Havelock North dams. Some gates across the spillway entrance have been modified to hinge in the direction of flow (School Stream and Te Kahika) although their effectiveness is unknown. If a gate or fence is required across a spillway, then alternative arrangements should be investigated that will not impede flow when it is required to operate in a flood event. For example, a fence could be constructed upstream of the spillway and below the level of the spillway crest. HDC now wish to manage the operation of gates across spillways as part of emergency management with the landowners and/or maintenance/emergency contractors.

HDC are planning to complete Operation, Maintenance, and Surveillance documentation in 2020, to cover all relevant aspects of dam safety across their portfolio of dams. This includes relationship with HDC contractors for maintenance and flood response, and with landowners around maintenance and dam safety requirements.

A number of the previous IDSR and CDSR recommendations are being progressed, with HDC prioritising these within existing and planned future budgets.

8 References

Opus (2005), Te Awanga Stream Diversion and Intake Structure – Preliminary Design Report.

New Zealand Society on Large Dams (2015), New Zealand Dam Safety Guidelines.

MWH (March 2016), Flood Detention Dams – 2015 Comprehensive Dam Safety Review.

MWH (May 2016), Havelock North Flood Detention Dams – Hydrology and Flood Capacity Review.

Stantec (April 2018), Te Kahika and School Stream Spillways Structural Condition Assessment.

Stantec (July 2019), 2018 Intermediate Dam Safety Review of Flood Detention Dams.

Stantec (August 2019), Clifton Dams Flood Assessment (Draft).

Stantec (October 2019), Te Awanga Dams Flood Assessment.

Stantec (October 2019), Te Awanga Dams Dam Break and Potential Impact Classifications (Draft).

Appendices

Appendix A Background Information

A.1 Appendix A1 Location Map of HDC Flood Detention Dams

A.2 Appendix A2 Aerial View of Havelock North Flood Detention Dams

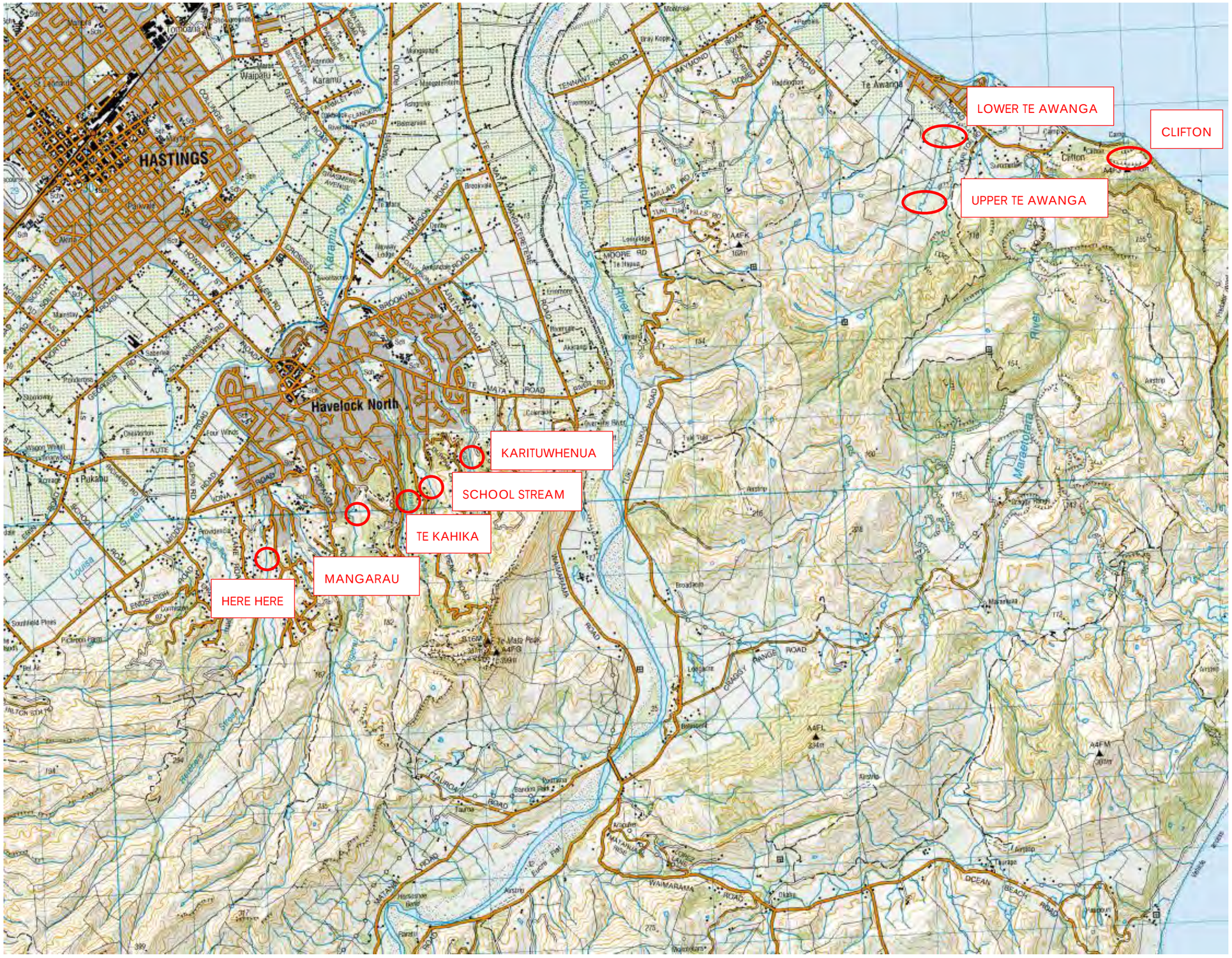


Figure A-1: Location Map of HDC Flood Detention Dams

Figure A-2: Aerial Overview of Havelock North Flood Detention Dams

Appendix B Clifton Dams Inspection 2019

B.1 Figures

I.L. 102·9

CREST LEVEL 104·5

CREST LEVEL 112·0

I.L. 110·5

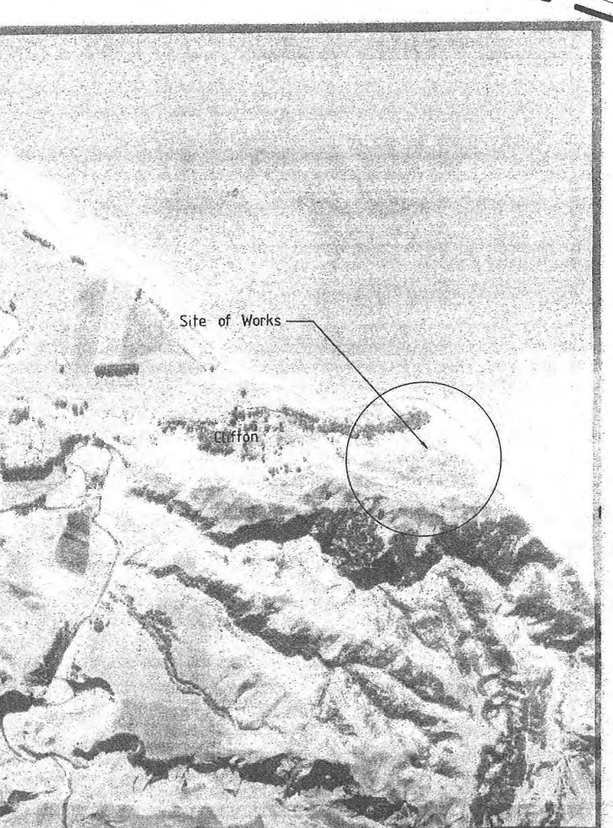
CREST LEVEL 118·0

I.L. 116·3

I.L. 112·8

USE KNOB FOR EMBANKMENT

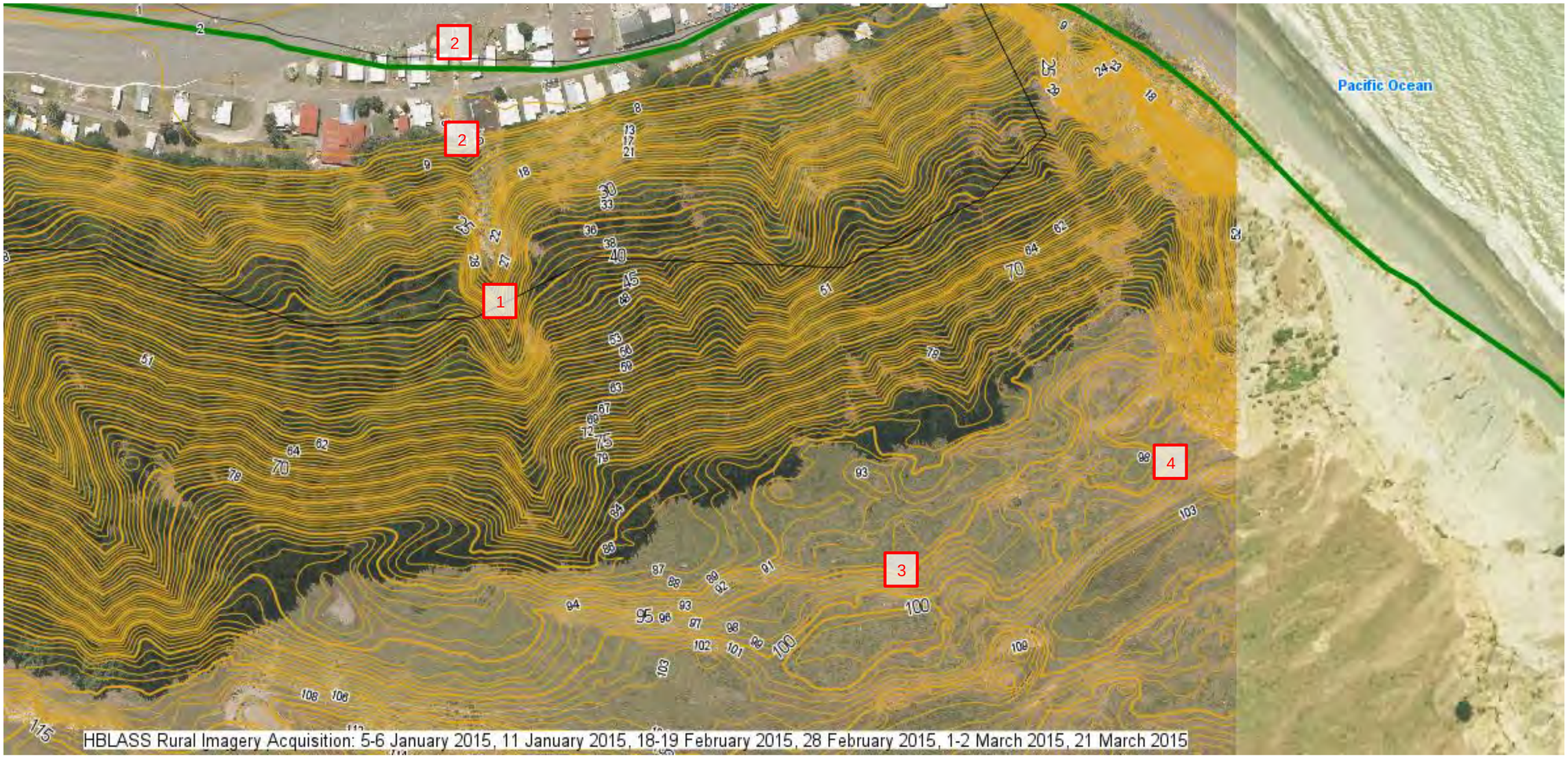
TRIG. N.



HAWKE'S BAY CATCHMENT BOARD

CLIFTON

PROPOSED FLOOD DETENTION DAMS


Pacific Ocean
1
2
2
3
4
HBLASS Rural Imagery Acquisition: 5-6 January 2015, 11 January 2015, 18-19 February 2015, 28 February 2015, 1-2 March 2015, 21 March 2015

Ref	Description	Photo (s)
1.	The remediation of the gully or other stormwater control options should be investigated. The stormwater gully was in similar condition to previous years with damaged pipe sections and concrete blocks. The damage was caused by flooding in April 2011. The full length of the previous pipe was traversed. Section of corrugated metal pipe, concrete blocks, concrete manhole, etc remain in the gully. These could be mobilised further down the gully in future flood events. Flood flows from the catchment and flood detention dams behind the camp will flow down this gully without the control of the manholes/culvert system that was previously there for this purpose.	
2.	Clear the downstream gully stormwater channel upstream of the concrete box section, and within the concrete box section. The downstream channel, in the camp, has aggraded significantly, and now appears to have limited flow capacity. In flood events, it is likely flows will easily overtop this channel and spill out into the camp, and playground area on the right. The concrete box channel through the camp to the beach had sediment build up at both the upstream and downstream (beach) end. Beach stones have built up around the culvert exit.	 

Ref	Description	Photo (s)
3.	Clear the pipe for any sediment build up (obvious this was occurring at the inlet and outlet) Lower Middle Dam.	
4.	Mark out outlet of the pipe through the East Dam. Pegging out of all outlets in particular would be useful.	

Appendix C Lower Te Awanga Dam Inspection 2019

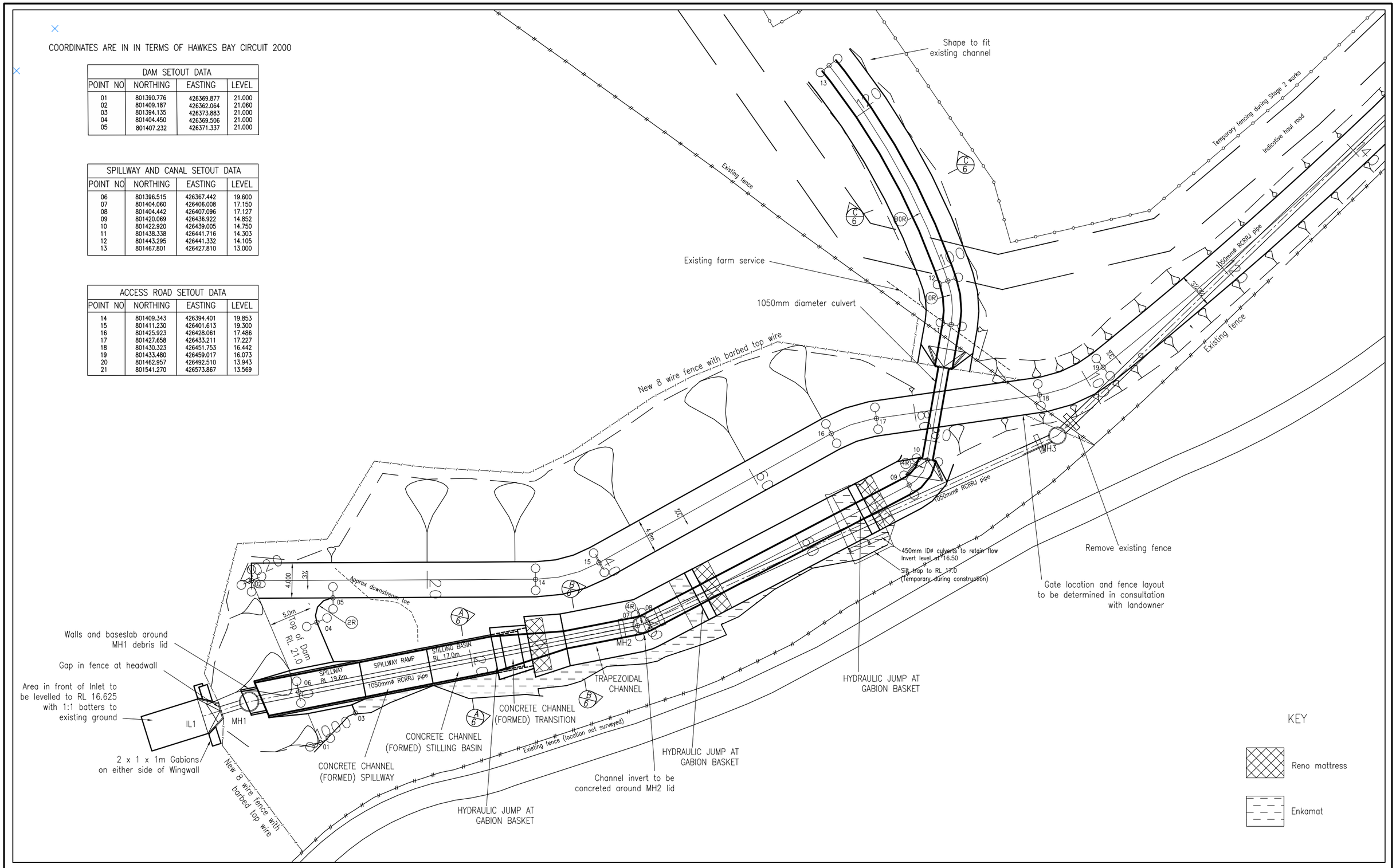
C.1 Figures

COORDINATES ARE IN IN TERMS OF HAWKES BAY CIRCUIT 2000

DAM SETOUT DATA			
POINT NO	NORTHING	EASTING	LEVEL
01	801390.776	426369.877	21.000
02	801409.187	426362.064	21.060
03	801394.135	426373.883	21.000
04	801404.450	426369.506	21.000
05	801407.232	426371.337	21.000

SPILLWAY AND CANAL SETOUT DATA			
POINT NO	NORTHING	EASTING	LEVEL
06	801396.515	426367.442	19.600
07	801404.060	426406.008	17.150
08	801404.442	426407.096	17.127
09	801420.069	426436.922	14.852
10	801422.920	426439.005	14.750
11	801438.338	426441.716	14.303
12	801443.295	426441.332	14.105
13	801467.801	426427.810	13.000

ACCESS ROAD SETOUT DATA			
POINT NO	NORTHING	EASTING	LEVEL
14	801409.343	426394.401	19.853
15	801411.230	426401.613	19.300
16	801425.923	426428.061	17.486
17	801427.658	426433.211	17.227
18	801430.323	426451.753	16.442
19	801433.480	426459.017	16.073
20	801462.957	426492.510	13.943
21	801541.270	426573.867	13.569



R3	House platform, temp works, MH and bypass deleted, access moved	N.A. 04/10
R2	Fencing, access, temporary works and background changes	N.A. 03/10
R1	Relocation of spillway and access	N.A. 09/09
	AMENDMENT	APP'D DATE

	BY	CHECKED	DATE
DESIGN	M.G.Smith	R.Hill	09/09
DRAWN	D.D.Heads/G.Lawley	B.Kennington	10/09
RECOM'D	M.G.Smith		09/09
APPROVED	N.Absalom		09/09

Hastings District Council

Napier Office
Private Bag 6019
Napier, New Zealand
Tel: (06) 833 5100
Fax: (06) 835 0881

TITLE: HASTINGS DISTRICT COUNCIL
TE AWANGA STREAM DIVERSION STAGE II CONSTRUCTION

PLAN VIEW OF DAM, OVERLAND FLOW AND SPILLWAY

STATUS		FILE			
		2-S4494.20.032NC			
SCALE	PLOT DATE	FEATURE IDENTIFIER	CODE	SHEET	REVISION
1:200 [A1]	31/03/10 @ 10:00	3/177/65	7304	02	R3

GRAPHIC SCALES

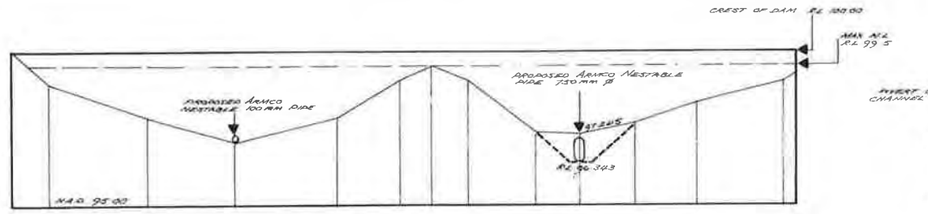
G:\s-series\s4494\20\032nc\CAD\3_177_65_7304_01-07,09-20.dwg ORIGINAL SHEET SIZE A1 [840x594]


1
1
HBLASS Rural Imagery Acquisition: 5-6 January 2015, 11 January 2015, 18-19 February 2015, 28 February 2015, 1-2 March 2015, 21 March 2015

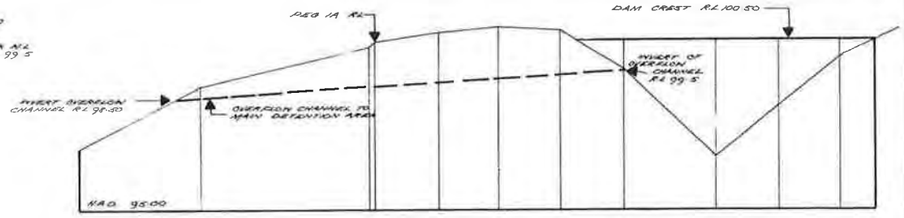
Ref	Description	Photo (s)
1.	**Remove the central gabion sections so the gabion drop structures become “spill through” rather than “spill over”, and as originally intended in the design.**	

Appendix D Upper Te Awanga Dam Inspection 2019

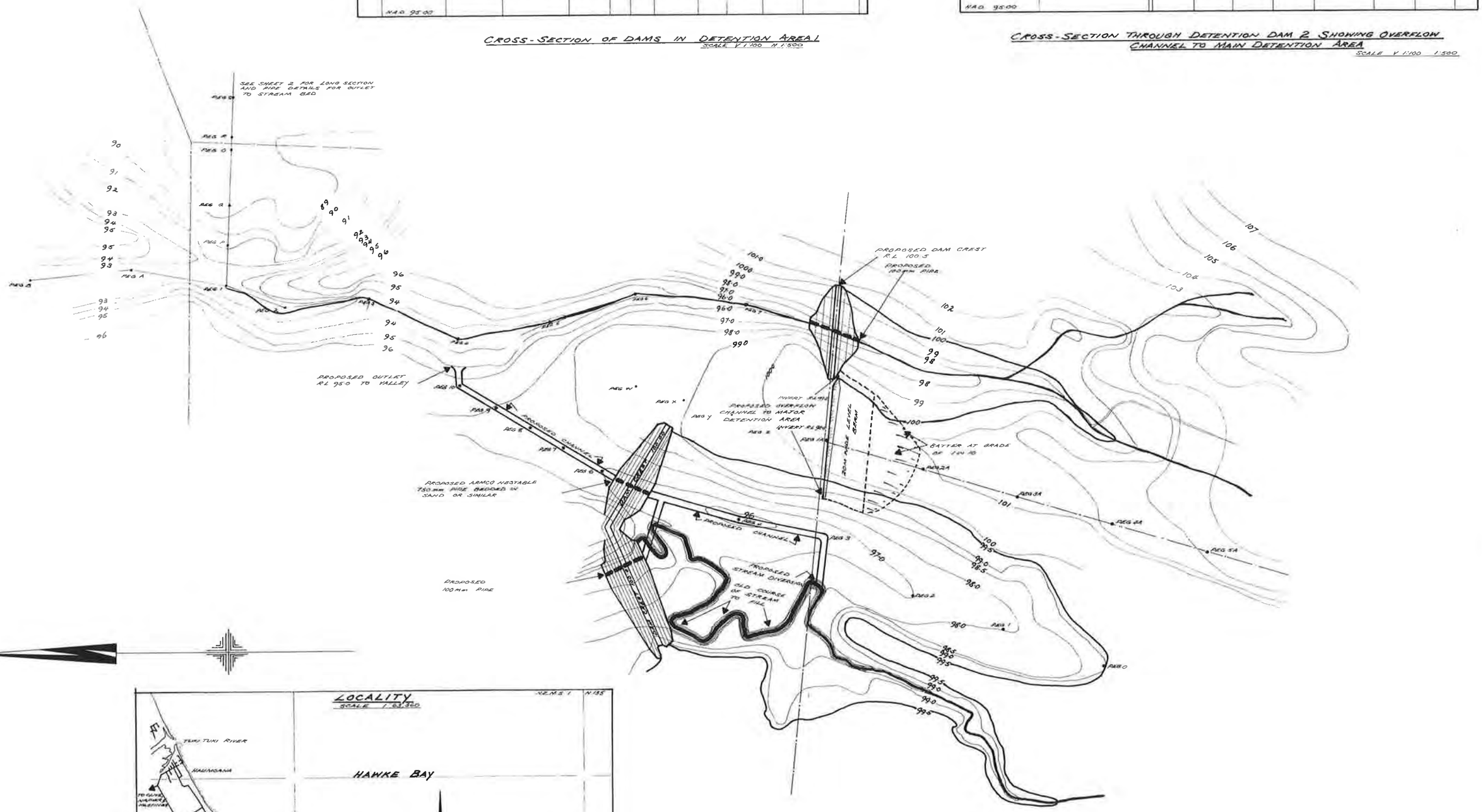
D.1 Figures

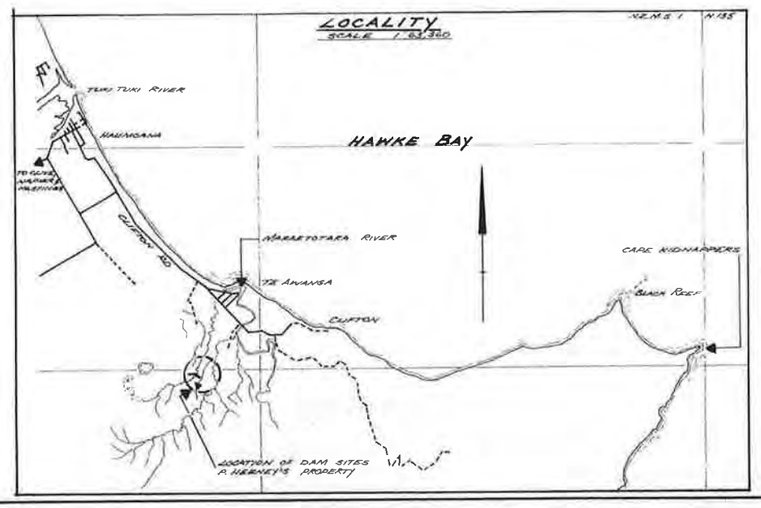


CROSS-SECTION OF DAMS IN DETENTION AREA1
SCALE V 1:100 H 1:500



CROSS-SECTION THROUGH DETENTION DAM 2 SHOWING OVERFLOW CHANNEL TO MAIN DETENTION AREA
SCALE V 1:100 1:500





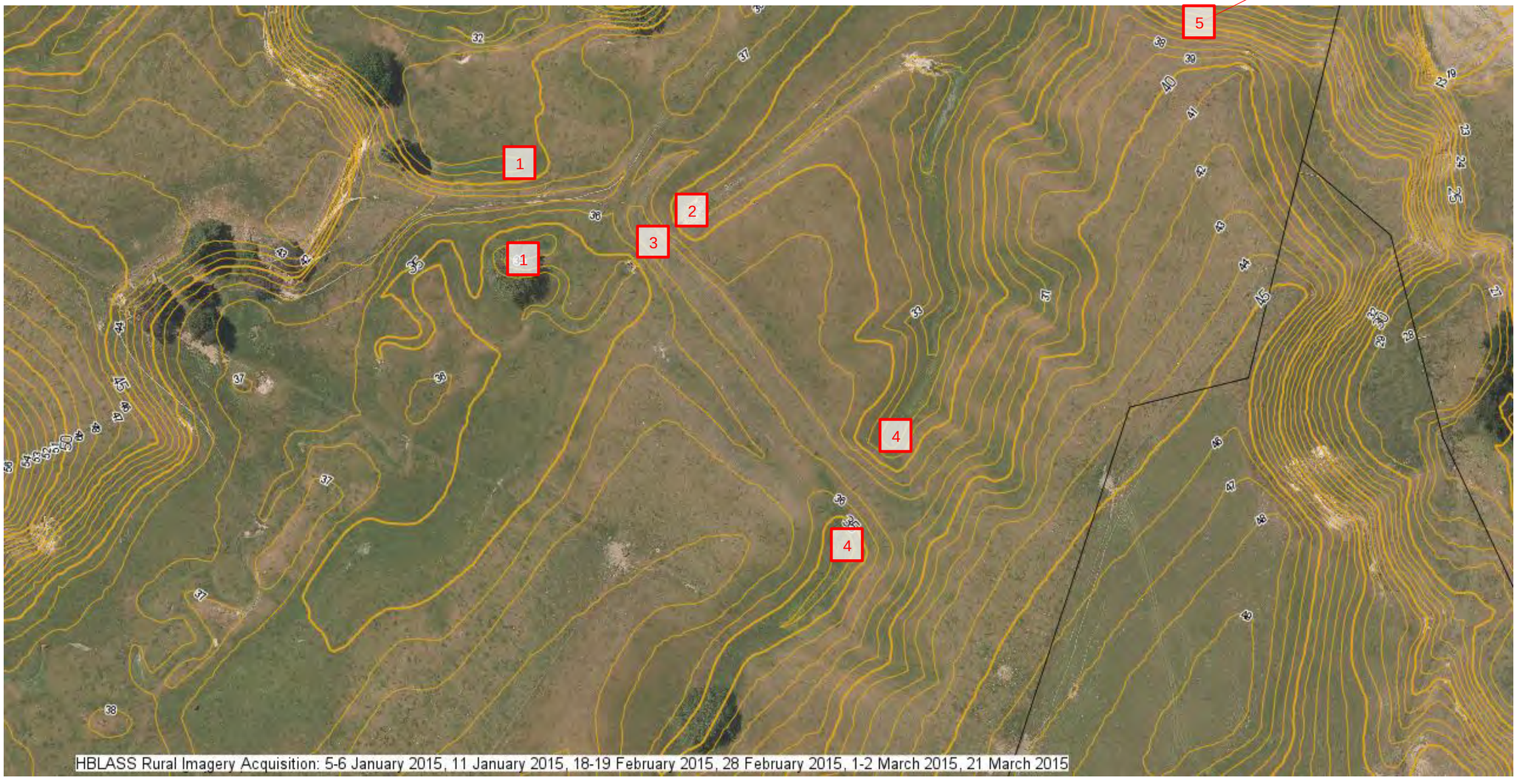
HAWKE'S BAY CATCHMENT BOARD

TE AWANGA FLOOD CONTROL SCHEME (UPPER). PROPOSED DETENTION – DAM SITES ON MR P. KEENEY'S PROPERTY.

Amendments				
	Surveyed	S.D.	26/7/77	Scale 1:1000
	Drawn	S.D.	26/7/77	Level Book M20 NMS NO
	Designed			Field Book
	Checked			Map Ref. N 178 385/138
	Approved			Aerial Photo 1202/60
			CHIEF ENGINEER	Catchment No. 258000

PLAN No. 1363

Sheet 1 of 3 Sheets


1
2
3
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5
1
4
HBLASS Rural Imagery Acquisition: 5-6 January 2015, 11 January 2015, 18-19 February 2015, 28 February 2015, 1-2 March 2015, 21 March 2015

Ref	Description	Photo (s)
1.	Complete maintenance on the left abutment pipe at the inlet and outlet to ensure this will function adequately.	
2.	Review and improve the rip rap to the area downstream of the culvert and outlet structure.	

Ref	Description	Photo (s)
3.	Complete a culvert inspection (CCTV) for current condition and identifying issues.	
4.	Complete maintenance on the right abutment pipe at the inlet and outlet to ensure this will function adequately.	

Ref	Description	Photo (s)
5.	Complete maintenance at the downstream outlet (Charlton Stream) inlet manhole (vegetation and rip rap).	

Appendix E Karituwhenua Dam Inspection 2019

E.1 Figures

PLAN No P 1633 SHEET No 12

EDGE OF TOPSOIL FILL

EDGE OF BORROW AREA

BORROW AREA

ACCESS TRACK

DAM

DAM ℄

SETTLEMENT PEGS

INLET STRUCTURE
I/L 66 69

OUTLET STRUCTURE
I/L 64 08

SPILLWAY

Boundary Peg

Boundary Peg

Boundary Peg 68 28

PEG W
75·90

OLD PEG
87 54

72·19 46° 46' 00" 49·51 M

88° 26' 00"

MAP REF.	
CATCH. No	
AERIAL PH.	
JOB No	
WORKS No	
CONTRACT	

REV.	DATE	DESCRIPTION

HAWKE'S BAY CATCHMENT BOARD

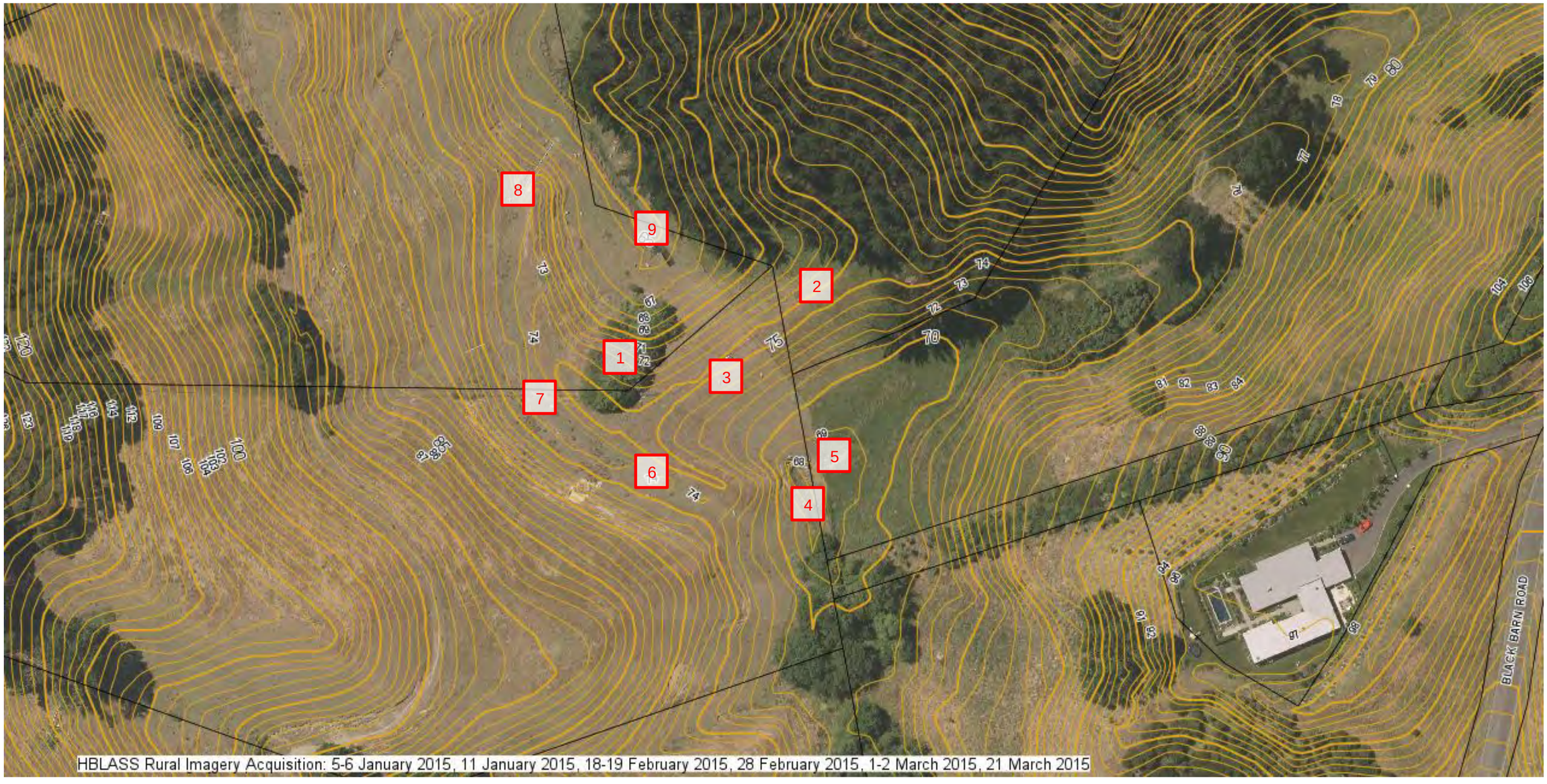
SURVEYED	ST	4/81
DESIGNED		
DRAWN	ST	4/81
TRACED	GH	5/81
CHECKED		
LEVEL BOOK	M 108	
FIELD BOOK		
PRINTED		

KARITUWHENUA DAM.

POST CONSTRUCTION SURVEY

SCALES	APPROVED	REVISION	PLAN No	SHEET No
1: 250	P.K. Simons Chief Engineer		1633	12 Total sheets 12

KARITUWHENUA DAM



Ref	Description	Latitude	Longitude	Photo (s)
1.	Clear trees and vegetation from the downstream left abutment (between the dam and spillway).			
2.	Clear the new pine trees on the upstream slope near the right abutment, and consider clearing established pines in/around the embankment near the right abutment.			

Ref	Description	Latitude	Longitude	Photo (s)
3.	Maintain grass to approximately 50-150 mm length.			
4.	Upstream channel vegetation maintenance including some larger trees.			

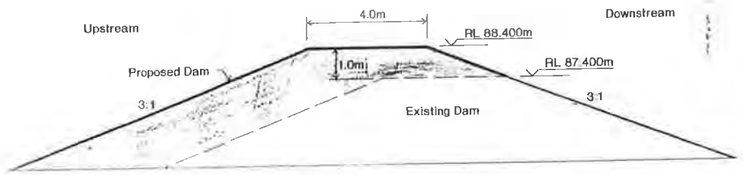
Ref	Description	Latitude	Longitude	Photo (s)
5.	Redesign the side channel inlet flow (right side of inlet structure) as currently flow is bypassing the manhole and causing erosion.			
6.	Maintenance of grass in spillway channel.			

Ref	Description	Latitude	Longitude	Photo (s)
7.	Remove all fencing from within the spillway channel.			
8.	Remove the spillway outlet structure and redesign the erosion protection works (e.g. rock or Reno mattress).			

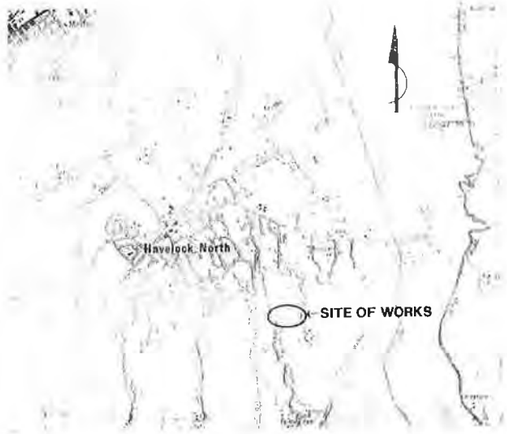
Ref	Description	Latitude	Longitude	Photo (s)
9.	Clear vegetation from around the culvert outlet structure and in the downstream channel.			

Appendix F School Stream Dam Inspection 2019

F.1 Figures



Typical Cross Section of Dam



Locality Plan

SURVEYED		1998
DESIGNED		1998
DRAWN		1998
CHECKED		1998

HASTINGS DISTRICT COUNCIL
ENGINEERING DIVISION
DAVID FRASER: MANAGER

REVIEWED | RECOMMENDED | APPROVED
DATE | DATE

Hawke's Bay Regional Council
Sustaining Your Environment

Upgrading of School Stream Detention Dam Locality & Site Plan

ISSUE	AMENDMENTS	BY	APP'D	DATE

SCALES		SHEET	
1:1,000	1:50,000		4 of 4
SDR No.	JOB DOSSIER No.	INDEX No.	
	SURVEY BOOK No.		2606

SCHOOL STREAM DAM

Ref	Description	Latitude	Longitude	Photo (s)
1.	Clear vegetation in the upstream channel.			
2.	Maintain a shorter grass length of 50 mm (min.) to 150 mm (max.) over the dam crest and slopes.			

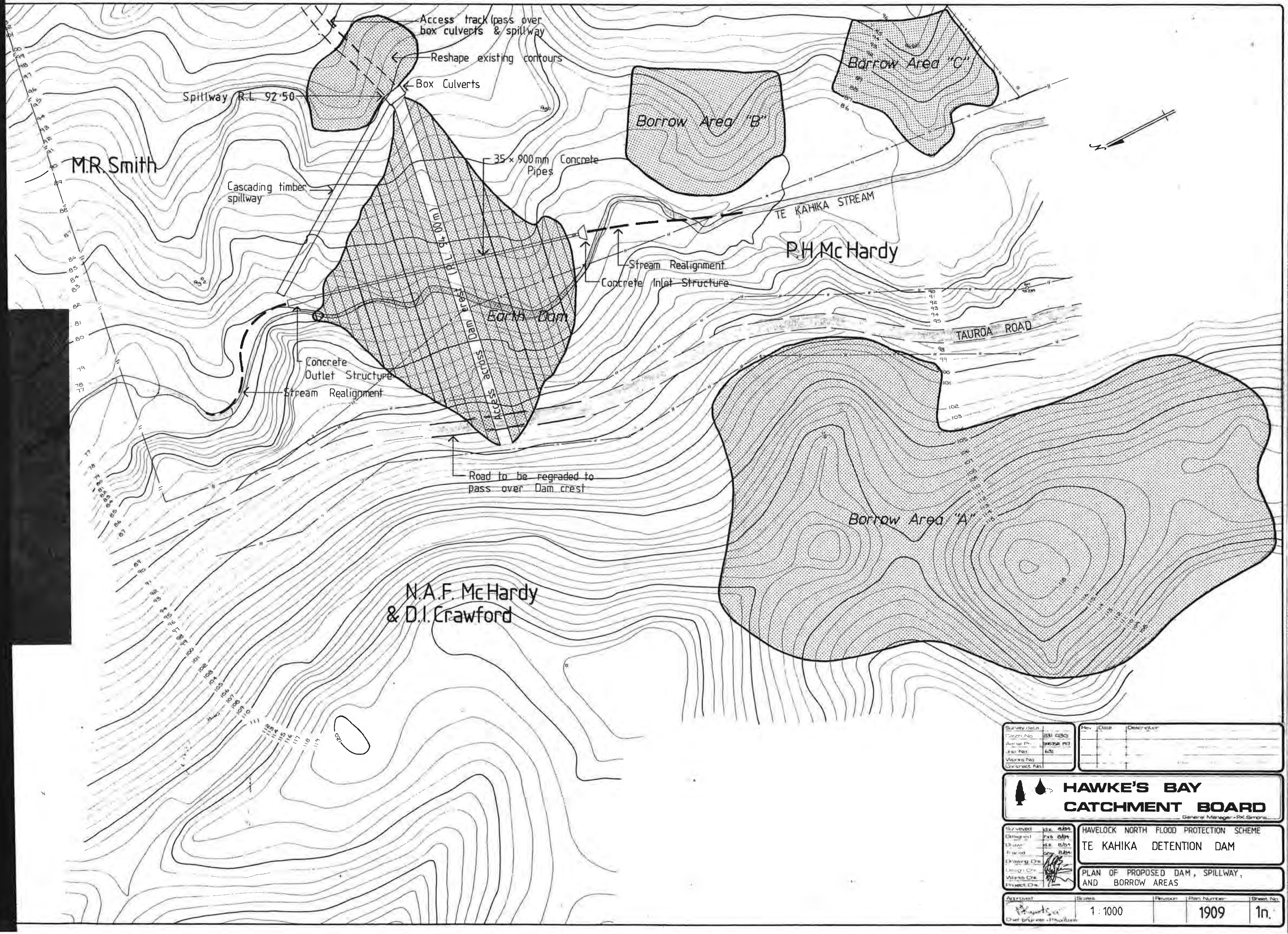
Ref	Description	Latitude	Longitude	Photo (s)
3.	Clear the spillway approach channel from trees and vegetation.			
4.	Remove the fence and gate from across the start of the spillway structure, and/or include in the proposed O&M documentation about opening (but following appropriate modification).			

Ref	Description	Latitude	Longitude	Photo (s)
5.	Clear the debris from the entrance to the side culvert (right side of spillway)			
6.	Clear out and maintain the invert of the wooden spillway structure.			
7.	Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018).			

8.	**Clear the fallen tree and grass/vegetation around the outlet structure.**			
9.	**Consider fencing/handrails around the structure to prevent falls.**			

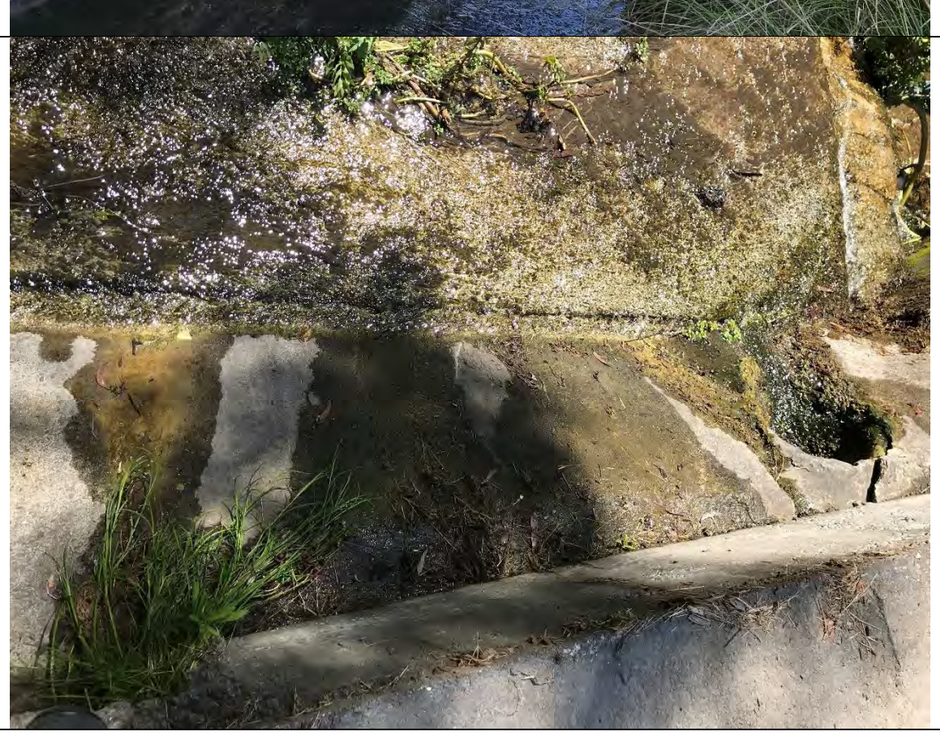
Appendix G Te Kahika Dam Inspection 2019

G.1 Figures



Access track (pass over box culverts & spillway
Reshape existing contours
Box Culverts
Spillway R.L. 92·50
Borrow Area "B"
Borrow Area "C"
M.R. Smith
35 × 900 mm Concrete Pipes
Cascading timber spillway
TE KAHIKA STREAM
P.H. Mc Hardy
Stream Realignment
Concrete Inlet Structure
Dam crest (R.L. 94.00 m)
Earth Dam
TAUROA ROAD
Access across
Concrete Outlet Structure
Stream Realignment
Road to be regraded to pass over Dam crest
Borrow Area "A"
N.A.F. Mc Hardy
& D.I. Crawford
Survey data
Catch. No 231 030
Job No 631
Works No
Contract No
Rev
Date
Description
HAWKE'S BAY
CATCHMENT BOARD
General Manager - P.K. Simons
Surveyed
Designed
Drawn
Traced
Drawing Chk
Design Chk
Works Chk
Project Chk
HAVELOCK NORTH FLOOD PROTECTION SCHEME
TE KAHIKA DETENTION DAM
PLAN OF PROPOSED DAM, SPILLWAY, AND BORROW AREAS
Approved
Scales
1 : 1000
Revision
Plan Number
1909
Sheet No
1n.


HIKANUI PLACE
TAUROA ROAD
7
3
5
4
6
2
1
HBLASS Rural Imagery Acquisition: 5-6 January 2015, 11 January 2015, 18-19 February 2015, 28 February 2015, 1-2 March 2015, 21 March 2015

Ref	Description	Photo (s)
1.	Clear the upstream channel of vegetation (upstream of concrete section) and clear silt and vegetation from within and around the concrete section.	
2.	Fix/replace the side inlet culvert (right side) into the inlet channel, as some flow is flowing along the outside of the pipe.	

Ref	Description	Photo (s)
3.	Reinstate the downstream toe standpipes and plan future monitoring as part of the Dam Safety Management System.	
4.	Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018).	

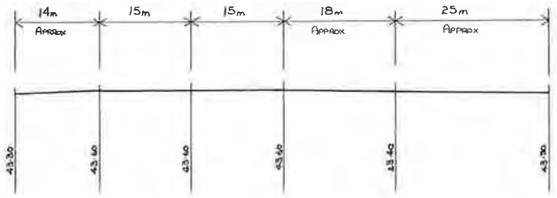
Ref	Description	Photo (s)
5.	Clear trees/vegetation from sides of spillway (probably needed for access for repair works to spillway).	
6.	Remove the gate from across the start of the spillway structure, and/or include in the proposed O&M documentation about opening (but following appropriate modification). Note the owner will need to be notified.	

Ref	Description	Photo (s)
7.	Clear the stilling basin and downstream channel of all vegetation.	

Appendix H Mangarau Dam Inspection 2019

H.1 Figures

PLAN No 1730 SHEET No 3



DAM CREST FINISHED LEVEL PROFILE

EXISTING OUTLET STRUCTURE
Refer To Sheet 6 & 7
For Details

PROPOSED EARTH DAM
Existing 800mm Dia Conc.
Pipe Culvert Under
Refer To Sheet 8 For
Typical Cross Section
Refer To Above For Finished
Dam Crest Profile.

EXISTING INLET STRUCTURE
Refer To Sheet 4
For Details

PROPOSED EARTH FORMED SPILLWAY
Refer To Sheet 10 For
Cross Sections
Refer To Sheet 9 For
Longitudinal Section

PROPOSED EMBANKMENT STRENGTHENING
Refer To Sheet 11 For
Cross Sections

600mm Dia. A.C. Pipe
Diversion With Flap Gate
And Timber Chute Details
To Be Determined On Site
Invert Level - 38.20
Outlet Level - 37.00
(Not In Contract)

Existing Stream Bed

PLAN

MAP REF.	N134-301157
CATCH. No	251-035
AERIAL PH.	
JOB No	617
WORKS No	
CONTRACT	82/10/12/1(Mgt)

REV.	DATE	DESCRIPTION

HAWKE'S BAY
CATCHMENT BOARD

SURVEYED		
DESIGNED	RvS	5/82
DRAWN	ARM	11/82
TRACED	ARM	11/82
CHECKED		
LEVEL BOOK	M85	
FIELD BOOK		
PRINTED		

HAVELOCK NORTH FLOOD PROTECTION SCHEME

MANGARAU DETENTION DAM

PLAN SHOWING FINAL CONTOURS

SCALES	APPROVED	REVISION	PLAN No	SHEET No
1:500	P.K. Simpson, Chief Engineer		1730	3


TOOP STREET
1
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11
12

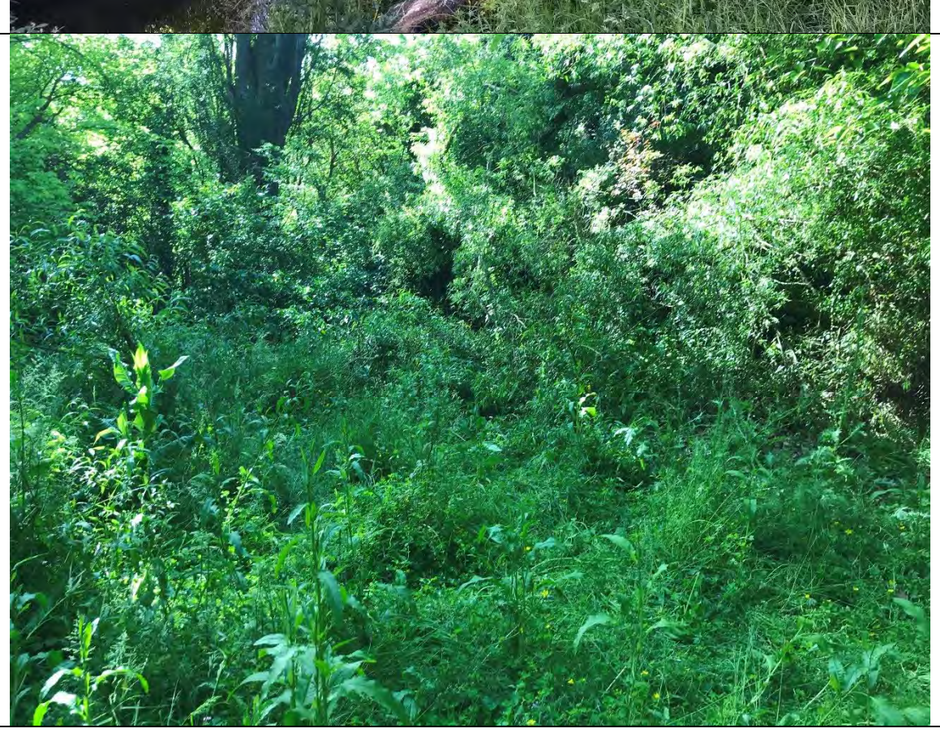
Ref	Description	Photo (s)
1.	Remove vegetation, debris piles, trees, and fences from within the spillway channel.	
2.	Replace manhole lid correctly in side inlet channel (right side of upper spillway).	

Ref	Description	Photo (s)
3.	Clear the debris from the inlet area of the culvert (side inlet).	
4.	Maintenance of the side channel outlet at the upstream right abutment including scruffy dome attachment and removing/fixing the flap gate.	

Ref	Description	Photo (s)
5.	Clear the main upstream channel of trees and vegetation.	
6.	Backfill existing animal burrows and prevent burrowing animals from the dam area.	

Ref	Description	Photo (s)
7.	Clear fences, vegetation, and other items such as irrigation line from across the dam area. Repair damaged areas such as erosion across the crest.	
8.	Clear trees on the dam embankment near the downstream left abutment.	

Ref	Description	Photo (s)
9.	Maintain grass at an acceptable length of 50 mm (min) to 150 mm (max).	
10.	Remove tree on left side and left end of the outlet structure (stilling basin).	

Ref	Description	Photo (s)
11.	Remove trees in downstream channel.	
12.	Clear or remove downstream boundary wooden swing fence.	

Appendix I Here Here Dam Inspection 2019

I.1 Figures

Plan No. 1862 Sheet No. 3

Grass

2:1 Batter

Gum trees

Haul Road

Temporary deer proof fence

Abutment drain Refer details this sheet

Outlet structure Refer sheet 6

Hand placed RipRap

Fill & existing ditch here obtain.

Temporary deer proof fence.

Topsoil stockpile

Proposed cut offs Refer sheet 7

Proposed new channel refer sheet 12

Inlet structure Refer sheet 5

Cut Off

BM 46.035

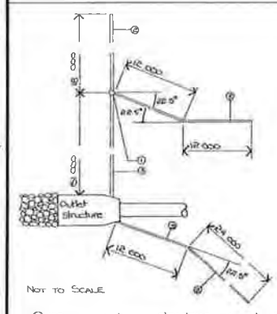
House

Sill level RL 48.200

Proposed Concrete Weir Refer sheet 7

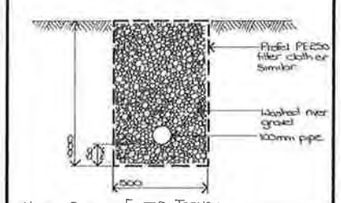
Topsoil stockpile

DETAILS OF ABUTMENT DRAIN



Not to Scale

① 100mm monitoring standpipe capped with box and cover at the dam surface.
② 100mm perforated high density plastic drainage pipe in filter trench (as below) adjoining existing gravel layer.
③ 100mm plastic disposal pipe.



Not to Scale. FILTER TRENCH

NOTE.

Temporary deer proof fences define the limits of the construction site on P. Purchas property. Areas outside these limits are out of bounds to ALL construction personel unless previous approval has been obtained from the construction supervisor.

PHOTOGRAPHIC REPRODUCTION

DO NOT SCALE

Survey data	Layer 1982
Catch. No.	231/036
Aerial Ph.	[illegible]
Job No.	631
Works No.	
Contract No.	[illegible]

Rev	Date	Description
A	27/3/84	Repositioning of dam
B	5/4/84	Revised to finished contours

HAWKE'S BAY CATCHMENT BOARD

General Manager - R.K. Simons

Surveyed	H.O. 10/83
Designed	J.W. 3/84
Drawn	A.M.H. 3/84
Traced	A.M. 3/84
Drawing Chk.	
Design Chk.	
Works Chk.	
Project Chk.	

HAVELOCK NORTH FLOOD PROTECTION SCHEME

HERE HERE DETENTION DAM

DAM AND SPILLWAY CONTOUR PLAN

Approved	Scales	Revision	Plan Number	Sheet No.
Chief Engineer - P. Kolitsos	1:500	B	1862	3


To 6
8
7
9-12
3
3
4
5
2
1
MARGARET AVENUE

Ref	Description	Photo (s)
1.	Remove established trees in the upstream channel to maintain a clear channel and to reduce the potential for future blockage potential at the inlet culvert area.	
2.	Remove the vegetation from within and around the inlet channel area and structure. Consider wider tree clearance around the upstream left abutment where some large trees are present (proactive maintenance at least).	

Ref	Description	Photo (s)
3.	Remove the trees from the downstream left and right abutment areas.	
4.	Maintain grass at an acceptable length of 50 mm (min) to 150 mm (max).	

Ref	Description	Photo (s)
5.	Complete maintenance in the spillway channel (clear trees and vegetation and remove wooden fence).	
6.	Complete maintenance on or remove the large trees at the lower slope upstream of the spillway channel.	

Ref	Description	Photo (s)
7.	Remove/alter the fence and gate at the mid section of the spillway channel.	
8.	Check spillway flood flow levels against the levels of the house on the right side of the spillway channel (half way down).	

Ref	Description	Photo (s)
9.	Remove the tree in and clear the invert of the stilling basin outlet structure.	
10.	Remove iron flap gate from the culvert outlet.	
11.	Clean out RHS toe drain pipe (exits into the outlet structure). Confirm whether blockage noted (0.7 m from wall) is related to pipe collapse (surface depression) previously noted.	
12.	Confirm whether embankment toe drain outlet pipes are free of sediment and functional.	

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