BG&E

CONSULTING ENGINEERS

PERTH
SYDNEY
DUBAI

# LAKE TOOLIBIN

# SEPARATOR GATES

# REPAIR / REPLACMENT OPTIONS

**Prepared for:**

Department of Conservation and Land Management
Narrogin District Office

**Date:** 19 August 2005

**Ref.** P05022 Report No. P05022-01 Rev 0

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|---|---|---|---|---|
| 19/08/05 | 0 | CALM Issue | M.Wiezel | |
| | | | | |
| | | | | |

# 1 INTRODUCTION

This report investigates options for the repair or replacement of a series of separator gates at Toolibin Lake. The gates are used to control the flow of water from Lake Toolibin Creek into the lake. Initial flows in the creek that have a high salinity are allowed to bypass the lake via a bypass channel around the lake. As the flow increases and the salinity drops, the separator gates are installed across the bypass channel to direct the water into the lake.

The current separator gate system consists of a series of 23 gates approximately 2m long. Each gate consists of galvanised steel I-beam posts with timber planks that are slotted into the I-beam posts as shown below.

**Figure 1.1 – Existing separator gates**

Due to warping of the timber planks there has been increased difficulty in inserting the planks and as such the separator gates were modified to have all but the bottom plank bolted to the front of the posts. The introduction of these bolts has further increased the difficulty of inserting the bottom plank.

In this new arrangement the low flows are allowed below the fixed planks, with the bottom planks inserted when flow redirection is required. The warping of the planks has also reduced the water-tightness of the separator gate significantly. As a temporary measure a plastic membrane is secured over the separator gates with sandbags to provide a reasonably watertight barrier to the flow.

## 2 SCOPE

The scope of this report is to investigate the repair of the existing timber separator gate system to improve functionality or the replacement of the existing system with a propriety system or a similar system to the existing using different materials.

CALM have also requested that the inclusion of a sluice gate system at one end of the separator gates is investigated to provide easy flow control when the separator gates are in use.

## 3 REPAIR TIMBER GATES

The first option is to repair the existing timber gates. This would involve selecting suitable planks from the existing seasoned planks and machining them to provide relatively straight planks to use in the bottom levels. The bolted planks at the top would be retained.

To assist in inserting the bottom planks the thread of the protruding bolts (from the bolted planks) would be cut off at the back of the nut and a length of steel angle welded to the back of the bolts to form a smooth guide for the planks.

The above works would not significantly improve the watertightness of the system and the plastic membrane would still be required.

An estimate for these works has been obtained and is approximately $6,800.00. The estimate is presented in Appendix A.

## 4 PROPRIETY SYSTEMS

The complete replacement of the existing timber separator gate system with a propriety system has been considered. An internet search was performed looking for propriety separator gate systems. No applicable results were found for separator gate systems or irrigation gate systems. Some results were returned for automated separator gate control systems however this is outside the scope of this report. Most of the results returned were for large scale separator gate systems on significant rivers that consisted of large gates operated by hydraulic or other mechanical means.

A brief search of other sources also did not reveal a manufacturer of propriety separator gate systems and therefore this option has been rejected.

## 5 REPLACEMENT GATES

### 5.1 REPLACEMENT PANELS

One of the problems with the existing gate system is trying to seal between each of the wooden planks that are dropped in. Warping of the planks has only made this more difficult and a plastic sheet over the whole system is now used to provide a reasonable level of watertightness. To combat this, a replacement gates system consisting of single panels notionally 2m long and 1m high has been investigated. This will ensure a watertight panel with leakage only possible around the edges of the panels at the interface with the posts and the ground.

**A standard panel size of 2m x1m has been adopted for all replacement gates.**

The various materials considered for each gate are discussed in detail below.

### 5.2 REPLACEMENT POSTS

The spacing of the existing posts is notionally 2m but ranges from 1.89m to 2.18m, with the final gate being 1.43m. It has been assumed for the replacement gates that new posts will be installed at regular spacings to suit a 2m panel (with allowance for clearances etc). This would allow mass production of the panels and for any panel to be used at any gate making installing the gates quicker and easier. A standard panel size of 2m x 1m will also reduce cutting for some materials as it matches the standard sheet dimensions or is a multiple of the standard sheet dimensions.

With the installation of new posts it is also proposed to install a new joint system for the base of the gates. The proposed system is to form a raised concrete 'lip' flush with the inside of the post flange. This will allow the increasing water behind the gate to push the bottom edge of the gate onto the lip forming a seal. Breaks in the lip can be included to facilitate cleaning.

An estimate of the costs to install new posts and a new concrete foundation for the separator gates was performed based on rates in the "Rawlinsons Australian Construction Handbook 2003" and factored for inflation and regional considerations.

The estimated cost for the supply of new posts is based on 25 posts (24 for the proposed 23 gates plus one for mounting the sluice gate) constructed from steel 100 UC sections, hot dip galvanised, 2m long. The estimate for the installation allowed for a 2 man crew plus some equipment taking 1 hour per post. The combined supply and install rate was estimated at $500/post.

The estimated cost for the concrete foundation was based on a lightly reinforced concrete section 600mm wide x 300mm deep the full length of the separator gates (46m).

Estimated cost to supply and install 25 of 100 UC galvanised steel posts is $12,500.

Estimated cost to supply and install a 46m long 600mmx300mm concrete footing $5,000.

Total estimated post replacement costs: $17,500.

# 6 ALUMINIUM GATES

Aluminium has good resistance to corrosion making it suitable for the exposed environment and saline conditions in which the gates will be used. Aluminium is also relatively light for it's strength.

Aluminium has a low coefficient of thermal expansion (25 x 10-6 mm/mm / °C) which means an aluminium panel 2m long would change length by 2.0mm over a 40° temperature range. This will reduce likelihood of panels jamming in posts from expansion in the sun.

An aluminium panel constructed from 3mm thick aluminium sheet with 4 vertical and 3 horizontal 50mmx50mmx6mm equal angle aluminium stiffeners welded to the plate was considered, with 2 handles constructed from round bar welded or bolted to the top. In this configuration it is estimated the panel would weigh approximately 30/35kg. This panel could be lifted/carried by one person however using two people would make it a considerably easier lift.

A price for fabrication of these panels was obtained from Marine Metal Fabricators. The cost per gate quoted was $448 ex-GST. The total cost for 23 gates therefore is $10,304 ex-GST. The estimate is attached in Appendix B.

# 7 PLASTIC GATES

## 7.1 POLYETHYLENE

Being a plastic the polyethylene does not corrode. It is also relatively inert and not affected by chemical attack from a wide range of chemicals including salt. Many plastics are susceptible to degradation by exposure to UV however a UV stabilised polyethylene is available that will minimise the effects of UV exposure.

The coefficient of thermal expansion of polyethylene is 2 x 10-4 mm/mm / °C, which represents a change in length of 16mm in a panel 2.0m long over a temperature range of 40°C. This could be a concern with jamming of the panel through heating by the sun, however this could be countered by allowing greater tolerances between the posts to accommodate this range of movement.

The polyethylene loses strength/rigidity as it is heated which could be an issue if the gates are used on warm sunny days, although the likelihood of this is not great. The problem can also be further countered by using a UV stabilised polyethylene in a light colour (i.e. yellow) to minimise the absorption of sunlight by the panel.

A polyethylene panel constructed from 20mm polyethylene sheet with 6 vertical and 3 horizontal stiffeners (20mm thick 50mm deep) welded to the sheet was considered. Handles cut into the top of the

sheet were included. In this configuration it is estimated the panel would weigh approximately 45/50kg. This would be acceptable for a two person lift but could not be lifted by a single person.

A price for fabrication of these panels was obtained from Polytech. The cost per gate quoted was $454 ex-GST. The total cost for 23 gates therefore is $10,442 ex-GST. The estimate is attached in Appendix C.

### 7.2 POLYCARBONATE

Polycarbonate was considered as an option to polyethylene however while it does have a lower coefficient of thermal expansion (6.5 x 10-5 mm/mm / °C) than polyethylene, there are a few issues with the use of polycarbonate that are discussed below.

The polycarbonate is considerably more expensive than polyethylene. A sheet of polycarbonate of equivalent stiffness to a 20mm thick polyethylene sheet is about double the price.

Polycarbonate is more difficult to work than polyethylene. The two jointing methods available for polycarbonate are welding and gluing. To weld the polycarbonate it must first be dried for 24 hours to remove moisture in the sheet that can affect the weld. Polycarbonate welds are not as strong as polyethylene welds. Gluing the polycarbonate results in a joint of considerably lower strength than the parent material.

For these reasons polycarbonate was not considered further.

### 7.3 ACRYLIC

Acrylic is often used in aquarium and marine environments and as such should be suited to the exposed and saline conditions of the separator gates. It is unaffected by moisture, and offers a high strength-to-weight ratio.

The coefficient of thermal expansion of polyethylene is 6.8 x 10-5 mm/mm / °C, which represents a change in length of 5mm in a panel 2.0m long over a temperature range of 40°C.

An acrylic panel could be constructed from 20mm thick acrylic with handles cut into the sheet for handling. An acrylic panel of this thickness would weigh approximately 40kg. This would be acceptable for a two person lift but could not be lifted by a single person.

An estimate for supply of 20mm thick acrylic panels (no cutting for handles) was obtained verbally from Polytech. The cost per panel given was $700 ex-GST. The total cost for 23 gates therefore is $16,100 ex-GST.

## 8 OTHER MATERIALS

### 8.1 MARINE PLY

Marine Ply could be used to form the panels to replace the existing timber boards, although it's durability compared to aluminium or plastic panels is questionable.

Whilst marine ply is designed for exposed conditions it may still be subject to warping in the wetting and drying cycle and is also susceptible to attack by white ants and other pests.

The coefficient of thermal expansion of timber is 40.0 x 10-6 mm/mm / °C, which represents a change in length of 3.2mm in a panel 2.0m long over a temperature range of 40°C. This should not pose any problems in the operation of the gates.

Marine ply is sold in 2400x1200mm sheets, therefore increasing the panel size to match (provided the plywood has sufficient strength) would result in a cheaper solution. An 18mm thick marine ply sheet is approximately $300. However the marine ply may require stiffening similar to the other sheet materials considered. An estimate for sourcing the marine ply, cutting handles, painting (or coating) and stiffening the marine plywood gates has not been obtained.

An 18mm thick marine plywood gate made from a single sheet with no stiffeners would weigh approximately 30-40kgs depending on the wood used in the ply. This would be a difficult lift for one person but should be fairly easily handled by two people.

### 8.2 COMPOSITE CONSTRUCTION

An alternative to single material gates is to construct gates/panels from two or more materials. Some examples of this would be to construct an aluminium, steel or timber frame with zincalume, timber or plastic sheet attached to the frame. This type of construction may allow thinner sheets of polyethylene or marine ply to be used but the cost of frame fabrication and fixing of the sheet needs to be considered.

The use of a frame with zincalume sheeting may provide a reasonably durable solution however there are issues with sealing the corrugated profile of the sheeting to the frame.

This option has not been pursued further at this stage.

## 9 SLUICE GATES

An initial search did not reveal a distributor of "off the shelf" sluice gates suitable for the application we are considering.

Hydro-Dynamic, a Malaga based company manufactures sluice gates (penstocks) to order. They have typically made penstocks from stainless steel with a 1.2m x 0.9m framed dimension which would be suitable for the separator gates system.

The penstock can be manufactured in a bolt on arrangement as shown in the flyer in Appendix D. This style of penstock could be bolted to two new posts located to suit the penstock size. The stainless steel construction would provide good resistance to the effects of weather and the saline flows.

The Hydro-Dynamic units also have a relatively easy removal system for the handle, spindle and gate allowing them to be removed and stored during the summer months or at other times when the gate is not required. The frame remains bolted in place.

Hydro-Dynamic suggested that a budget price of $5,000 should cover the cost of supplying a stainless steel sluice gate of approximate frame dimensions 1.2m x 0.9m and allows for some customisation of the design to suit the site conditions.

## 10 RECOMMENDATIONS

### 10.1 GENERAL

The two distinct options considered by the investigation into the separator gates were to either repair the existing gates or replace the gates with a new design. Both of these options are discussed below. Recommendation is dependant on the available funds.

### 10.2 REPAIR EXISTING

In summary this option offers the following:

- low cost (approximately $12,000 - $15,000 including a sluice gate)
- slightly improved performance
- Estimated design life of 5-10 years

### 10.3 REPLACE GATES

For the replacement of the existing separator gates it is recommended that new posts with aluminium panels are adopted. The aluminium panels are the cheapest, offer excellent durability and are also the lightest making manual handling easier.

In summary this option (consisting of aluminium panels and new posts) offers the following:

- higher cost (approximately $33,500 including a sluice gate)
- greatly improved performance
- Estimated design life of >20 years

# APPENDIX A

## Existing Timber Gate Repair

MAINFORM CORPORATION PTY LTD
TRADING AS
**JOMAR CONTRACTING**
ABN: 69 084189 051

**Joe Paterniti**
**115 Queens Road**
**SOUTH GUILDFORD W.A. 6055**
**0417 949307- Fax 93791846**

**Martin Rutherford**
**3 Orsett Way**
**GOSNELLS W.A. 6110**
**0417 965661- Fax 93988739**

# QUOTATION

| | |
|---|---|
| DATE | 10/3/05 |
| Quote No | 875 |

Mr P. Coughlan
B.G. & E
PO Box 2776
CLOISTERS SQUARE
PERTH WA 6850

Dear Peter,

RE: **TOOLIBIN LAKES PROJECT**

Thank you for the opportunity to quote on the above.

Our quote is as follows:

**ITEM 1.** Repair Barrage Gates as per our discussions - **$6,800.00**

**ITEM 2.** Widen Road Culvert - **$20,810.00**

**ITEM 3.** Widen Lake Culvert - **$10,695.00**

**ITEM 4.** Install 150 mts of Boardwalk and 2 viewing platforms - **$139,640.00**

All prices exclude GST.

Timber price for boardwalk is valid for 30 days only.

If you have any queries please do not hesitate to contact J. Paterniti on 0417949307.

Yours faithfully,

J. PATERNITI

# APPENDIX B

## Aluminium Gates

# Marine Metal Fabricators

ABN 29 098 034 180

# Fax

| FILE | | | | | BG &E |
|---|---|---|---|---|---|
| RJ | RG | SS | JRH | YP | |
| JU | RD | GD | PJC | | |
| MW | 10 AUG 2005 | | | | |
| SYD | | | | | FLAG |
| ACTION: | | | | | |

**To:** Michael Wiezel **From:** Manfred Loth

**Fax:** 6364 3394 **Pages:** 1

**Phone:** 6364 3300 **Date:** 9.8.05

**Re:** **CC:**

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

• **Comments:**

Michael

Herewith is our Price to fabricate

23 Barrage Gates.

our Price $ 448.00 each for a Total

of $ 10304.00 plus G.S.T.

Regards

Manfred

8 Jones Street O'Connor 6163 Western Australia Telephone (08) 9337 4280 Fax (08) 9331 1371

# APPENDIX C

## Polyethylene Gates

www.polytech.biz

welcome to Polytech

POLYTECH PLASTICS

Industrial Plastics

- Unique Projects Division
- Specialised Welded services
- Laboratory Equipment
- Custom Fabrication
- Site installation
- Sheet Supply
- Phone: ++ 61 08 94930300
  Fax: ++ 61 08 94936060

Date: 15 August 2005
To: **BG&E Pty Ltd**
**Attention:** **MICHAEL WIEZEL**
Fax:

# QUOTATION

| DESCRIPTION | MATERIAL | QUANTITY | PRICE EX- GST | UNIT |
|---|---|---|---|---|
| Price to supply ex our workshop, 20mm thick HDPE barrage gates @ 2000mm wide x 1000mm high c/with 3 x horizontal rids & 6 x vertical ribs x 50mm. | 20mm thick Yellow HDPE | 23 | $454.00 | Each |

**Quoted Price EXCLUDES GST.**

10% GST will be applied to all prices and freight charges separately on the invoice

**TERMS:** COD or Pre-Arranged Account Net 30 days subject to application

**DELIVERY:** Freight costs will be charged to you and itemised on your invoice
**AVAILABILITY:** Approximately 15 working days from Receipt of order

This quotation is valid for 30 days and is subject to our final acceptance and Terms and Conditions of Sales.

Thank you for this opportunity to quote. Should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully

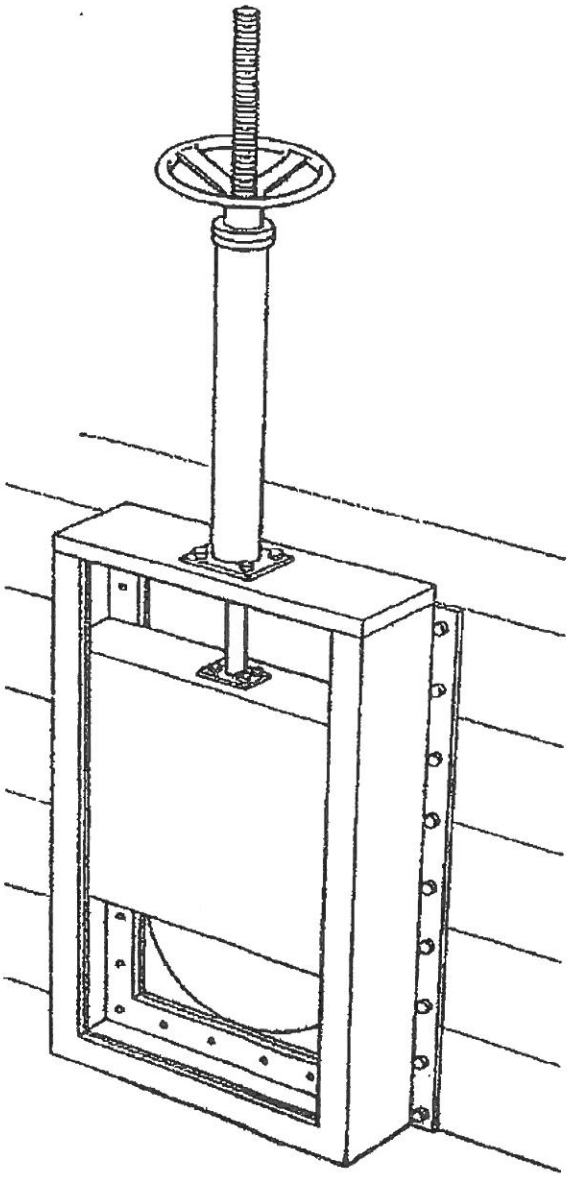
POLYTECH PLASTICS PTY LTD
David Smith
Industrial Manager

**WWW.polytech.biz**

# APPENDIX D

## Sluice Gate (Penstock) Flyer

# Hydro-Dynamic Penstocks



**Hydro-Dynamic** Penstocks are available for rectangular & circular channel openings as well as overflow applications

Penstocks are available in:
- 316 & 304 Stainless Steel,
- Galvanised Steel and
- Aluminium Construction

Other features include:
- Bi-directional (off & on seating)
- Flush invert to prevent solids build-up and ensure consistent sealing
- Wall and channel mount designs
- Rising and non-rising spindles

**APPLICATIONS:**
- Separators
- Flood Control
- Waste Water Treatment Works
- Pumping Stations

Operation can be either manual or automatic. Automatic can have Pneumatic, Hydraulic or Electric actuation, set with limit switches in conjunction with **Hydro-Dynamic** level controllers.

**Hydro-Dynamic Mining Services Pty. Ltd.**

1/10 Energy Street, MALAGA W.A. 6090
Ph: (08) 9249 9666 Fax:(08) 9249 9616

E-mail: sales@hydrodynamic.com.au
Website: http://www.hydrodynamic.com.au

## DRAWING INDEX FOR TOOLIBIN LAKE

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| SE03 | R.C.P. ROAD CULVERT SECTIONS |
| SE04 | R.C.P. ROAD CULVERT REINF. PLAN, SECTIONS & DETAILS |
| SE05 | R.C.P. LEVEE BANK CULVERT PLAN, SECTIONS & DETAILS |
| SE06 | SEPARATOR GATE ELEVATION & SECTION |
| SE07 | SEPARATOR GATE SECTION & DETAILS |
| SE08 | FLOOR CHANNEL & PUMP OUT SUMP SETOUT PLAN |

## GENERAL NOTES

### 1. GENERAL

1.1 ALL WORKS INCLUDING TEMPORARY WORKS AND SUPPLY OF CULVERT UNITS SHALL BE CARRIED OUT IN ACCORDANCE WITH THE SPECIFICATION AND THE OCCUPATIONAL SAFETY AND HEALTH ACT 1984.

1.2 NO CHANGES TO DESIGN DETAILS SHALL BE ADOPTED DURING CONSTRUCTION WITHOUT WRITTEN APPROVAL OF THE DESIGN ENGINEER.

1.3 THE EXISTING ROAD CULVERT SHALL BE DEMOLISHED AND REMOVED FROM SITE AS DESCRIBED IN DEMOLITION NOTES.

### 2. CULVERTS

2.1 CULVERT INVERT LEVELS SHALL BE CONFIRMED ON SITE AND APPROVED BY THE SUPERINTENDENT.

2.2 PIPE CULVERT MANUFACTURING AND PLACEMENT TOLERANCES OF 5mm AT EACH JOINT HAVE BEEN ALLOWED FOR IN DETERMINING THE OVERALL CULVERT LENGTH.

2.3 R.C.P. CULVERTS SHALL BE Ø450 CLASS (4z) SUPPLIED AND INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND THE SPECIFICATION. CLEAR COVER TO REINFORCEMENT SHALL BE FOR AN AGGRESSIVE ENVIRONMENT IN ACCORDANCE WITH THE SPECIFICATION AND AS4058.

2.4 BACKFILL AROUND PIPES WITH CEMENT STABILISED MATERIAL FOR THE LENGTH OF THE CULVERT TO THE LEVEL INDICATED ON THE DRAWINGS.

2.5 CEMENT STABILISED FILL SHALL CONSIST OF BASECOURSE QUALITY GRAVEL OR SANDY GRAVEL MATERIAL STABILISED WITH 100Kg OF CEMENT (TYPE A PORTLAND) TO ONE CUBIC METRE OF UNCOMPACTED FILL MATERIAL.

2.6 CEMENT STABILISED BACKFILL SHALL BE BROUGHT UP AND COMPACTED EVENLY ON BOTH SIDES AND BETWEEN BARRELS WITH A MAXIMUM ALLOWABLE DIFFERENCE IN LEVEL OF 150 BETWEEN ANY TWO POINTS. THE CONTRACTOR SHALL ENSURE THAT THE LEVEL AND THE ALIGNMENT OF THE PIPES DOES NOT CHANGE DURING BACKFILLING AND COMPACTION.

2.7 THE CONTRACTOR SHALL ESTABLISH SUITABLE SURVEY CONTROL PRIOR TO COMMENCEMENT OF DEMOLITION TO ALLOW CULVERT SETOUT.

2.8 SELECT BEDDING FILL SHALL BE COHESIONLESS GRANULAR MATERIAL IN ACCORDANCE WITH THE SPECIFICATION.

### 3. CONCRETE

3.1 INSITU CONCRETE SHALL BE CLASS N40 IN ACCORDANCE WITH THE SPECIFICATION.

3.2 CONCRETE SURFACE FINISHES SHALL BE IN ACCORDANCE WITH THE SPECIFICATION.

3.3 ABBREVIATIONS USED:-
- N° — FORMED FINISH CLASS N°.
- UN° — UNFORMED FINISH CLASS N°.

3.4 ALL EXPOSED CORNERS OF CONCRETE SHALL HAVE A 20 CHAMFER.

### 4. REINFORCEMENT

4.1 CLEAR COVER TO REINFORCEMENT SHALL BE 50 mm UNLESS OTHERWISE SHOWN.

4.2 BAR LAP LENGTH SHALL BE A MINIMUM OF 40D AND A MAXIMUM 40D + 150 UNLESS OTHERWISE SHOWN.

4.3 FABRIC OVERLAP SHALL BE A MINIMUM OF TWO CROSS WIRES ON BOTH SHEETS UNLESS OTHERWISE SHOWN.

4.4 ABBREVIATIONS USED:-
- T - TOP
- B - BOTTOM
- NF - NEAR FACE
- FF - FAR FACE
- ES - EQUALLY SPACED

4.5 REINFORCEMENT SHALL CONFORM TO:-
- SL - 500 MPa MESH TO AS/NZS 4671.
- N - 500 MPa REINFORCING BARS TO AS/NZS 4671.

4.6 CUTTING AND BENDING OF REINFORCEMENT SHALL BE IN ACCORDANCE WITH AS 3600.

### 5. ROAD EMBANKMENT FORMATION WIDENING (WHERE REQUIRED)

5.1 FORMATION WIDENING FOR ROAD CULVERT CONSTRUCTION WHERE REQUIRED SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE SPECIFICATION.

5.2 THE FACE OF EXISTING EMBANKMENT SHALL BE BENCHED WITH A MAXIMUM BENCH DEPTH OF 300mm.

5.3 THE FILL SHALL BE PLACED AND COMPACTED IN LAYERS AND FINAL BATTERS TRIMMED TO SPECIFIED TOLERANCES.

5.4 NOTWITHSTANDING THE REQUIREMENTS OF THE SPECIFICATION, THE MINIMUM LEVEL OF COMPACTION SHALL NOT BE LESS THAN 90% OF MAXIMUM DRY DENSITY FOR THE FOUNDATION AND 95% OF MAXIMUM DRY DENSITY FOR THE EMBANKMENT WIDENING EARTHWORKS.

### 6. FOUNDATION

6.1 THE FINISHED CULVERT FOUNDATION SHALL BE COMPACTED TO 98% CHARACTERISTIC DRY DENSITY.

6.2 ANY UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH SELECTED FILL MATERIAL IN ACCORDANCE WITH THE SPECIFICATION.

6.3 THE FINISHED FOUNDATION FOR ROAD EMBANKMENT CONSTRUCTION SHALL BE COMPACTED TO NOT LESS THAN 96% CHARACTERISTIC DRY DENSITY.

### 7. ROAD EMBANKMENT CONSTRUCTION

7.1 THE FILL SHALL BE PLACED AND COMPACTED IN LAYERS IN ACCORDANCE WITH THE SPECIFICATION.

7.2 NOT WITHSTANDING THE REQUIREMENT OF THE SPECIFICATION, THE MINIMUM LEVEL OF COMPACTION SHALL NOT BE LESS THAN 95% OF MAXIMUM DRY DENSITY FOR THE SUBGRADE EARTHWORKS, AND 98% OF THE MAXIMUM DRY DENSITY FOR THE BASECOURSE PAVEMENT LAYER.

### 8. ROCK PROTECTION

8.1. LIGHT CLASS ROCK PROTECTION SHALL BE AS FOLLOWS:-

| ROCK PROTECTION CLASS - LIGHT | | |
|---|---|---|
| AVERAGE ROCK SIZE (m) | ROCK MASS (kg) | MINIMUM % OF ROCK LARGER THAN |
| 0.55 | 250 | 0 |
| 0.40 | 100 | 50 |
| 0.20 | 10 | 90 |

ROCK SHALL BE WELL GRADED BETWEEN THE LIMITS GIVEN.

#### 8.2 SAND/CEMENT SLURRY

8.2.1 SAND/CEMENT SLURRY SHALL CONSIST OF A SAND CEMENT MIXTURE CONTAINING THREE PARTS SAND TO ONE PART CEMENT.

8.2.2 THE SLURRY SHALL BE SUFFICIENTLY FLUID TO ALLOW FLOW INTO VOIDS BETWEEN THE ROCK.

### 9. TEMPORARY WORKS FOR ROAD CULVERT

9.1 DURING THE WORKS THE CONTRACTOR SHALL ADDRESS ALL TRAFFIC AND PUBLIC SAFETY ISSUES RELATING TO THE WORKS IN ACCORDANCE WITH SPECIFICATION.

9.2 THE CONTRACTOR SHALL GIVE PRIOR NOTIFICATION OF HIS PROPOSED WORK SCHEDULE FOR CONSTRUCTION OF THIS CULVERT TO SHIRE OF WICKEPIN.

### 10. DEMOLITION

10.1 THE CONTRACTOR SHALL SALVAGE ALL REUSEABLE PIPES FROM THE EXISTING ROAD CULVERT. DISMANTLING METHODS SHALL BE EMPLOYED TO MINIMISE DAMAGE TO THE PIPE CULVERTS.

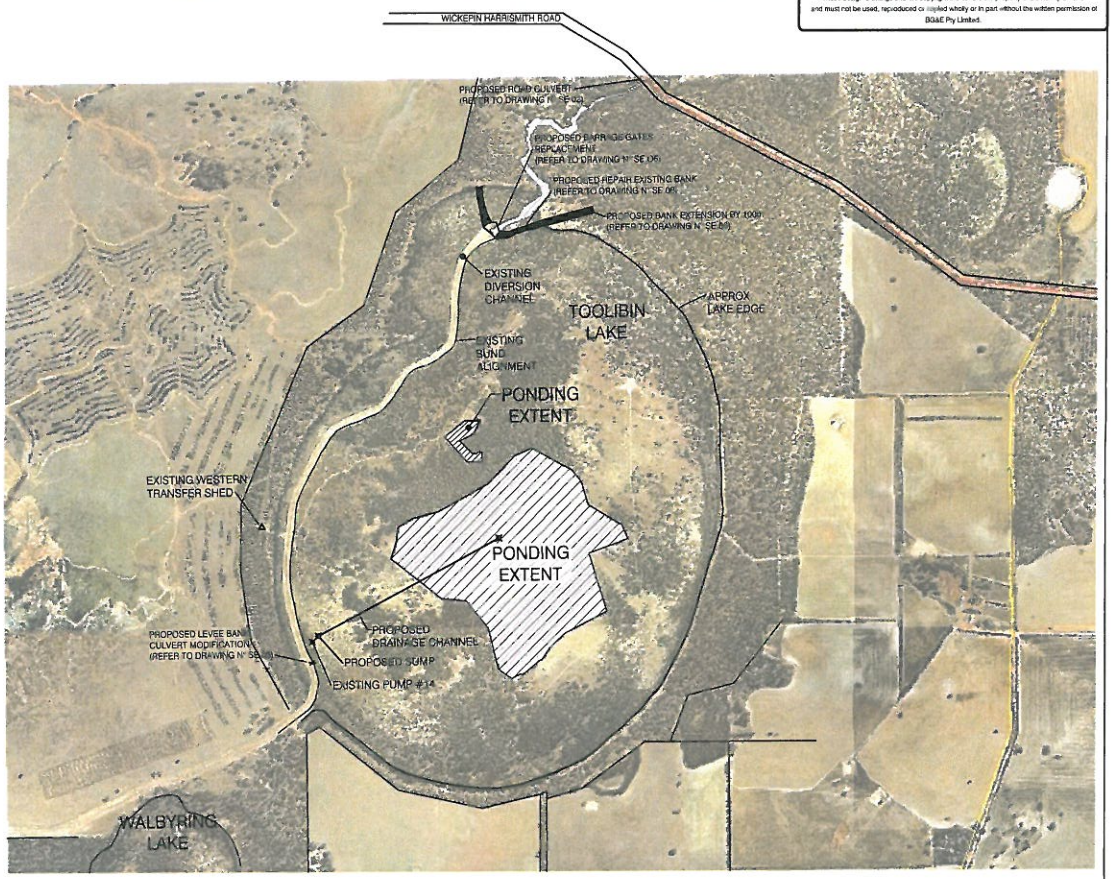
10.2 THE SUPERINTENDENT SHALL IDENTIFY ALL REUSABLE PIPES REQUIRED TO BE SALVAGED. SALVAGED PIPES TO BE PROVIDED TO SHIRE OF WICKIN AT NO COST.

10.3 ALL DEMOLISHED MATERIALS OTHER THAN THOSE SALVAGED SHALL BE REMOVED AND DISPOSED OF BY THE CONTRACTOR TO AN APPROVED DISPOSAL SITE.

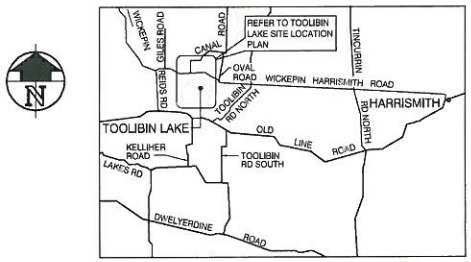
### 11. ROADWORKS

11.1 EXISTING SEAL TO BE REMOVED OVER EXTENT OF WORKS.

11.2 NEW TWO COAT BITUMINOUS SEAL SHALL HAVE A 14mm AND 7mm AGGREGATE SIZE SUPPLIED AND APPLIED IN ACCORDANCE WITH THE SPECIFICATION.




TOOLIBIN LAKE SITE LOCATION PLAN
N.T.S.




LOCALITY PLAN
N.T.S.

| REV. | DATE | DESCRIPTION | R/D |
|---|---|---|---|
| C | 21.07.2006 | CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 30.05.2006 | DESIGN MODIFICATION | R.H. |
| A | 05.02.2006 | ISSUED FOR INFORMATION | O.K. |

REVISIONS

| REV. | DATE | DESCRIPTION | R/D |
|---|---|---|---|

REVISIONS

GOVERNMENT OF WESTERN AUSTRALIA
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA
NARROGIN DISTRICT OFFICE
NARROGIN W.A.
TEL: + 6 1 8 9881 9211

BG&E CONSULTING ENGINEERS
SYDNEY
LEVEL 2, 8 WINDMILL STREET, SYDNEY NSW 2000 AUSTRALIA
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PERTH
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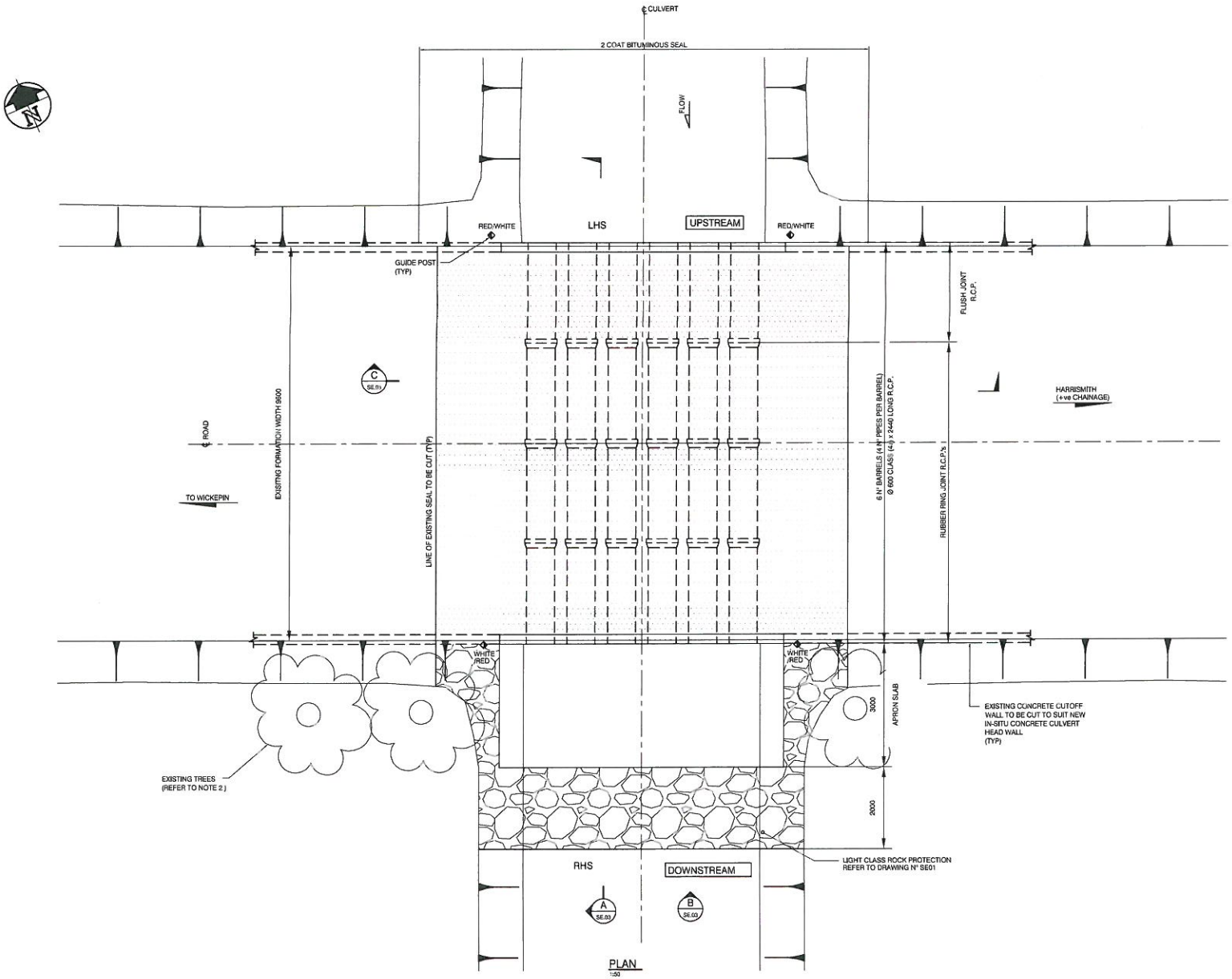
**TOOLIBIN LAKE SITE PLAN & GENERAL NOTES**

| DATE | SCALE |
|---|---|
| 03.02.2006 | AS SHOWN |

| DRAWN | DESIGNED | REVIEWED | APPROVED |
|---|---|---|---|
| O.K. | M.W. | P.J.H. | P.J.C. |

| PROJECT No. | DRAWING No. | REV. |
|---|---|---|
| PO5022 | SE.01 | C |




NOTE

1. FOR GENERAL NOTES REFER TO DRAWING N° SE.01
2. SOME TREES CLOSE TO CULVERT MAY BE REMOVED PRIOR TO CONSTRUCTION
3. EXISTING CULVERT DEMOLITION REFER TO DRAWING N° SE.01 NOTE 10

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|
| C | 20.07.2006 | PIPE Ø TO 600 / CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 06.05.2006 | DESIGN MODIFICATION | A.C. |
| A | 03.02.2006 | ISSUED FOR INFORMATION | O.K. |

REVISIONS

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|

REVISIONS

GOVERNMENT OF WESTERN AUSTRALIA
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA
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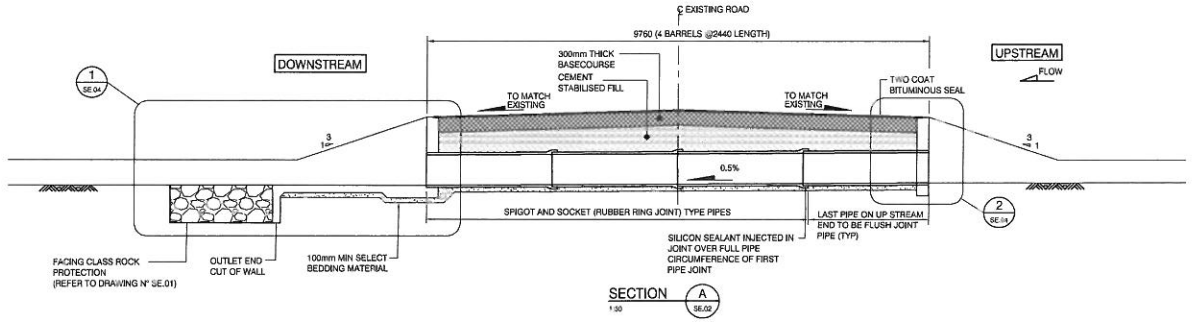
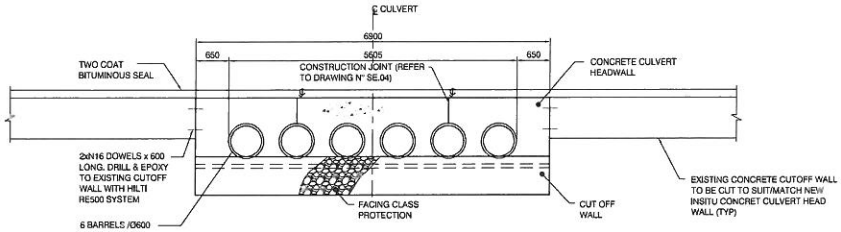
# TOOLIBIN LAKE
# R.C.P. ROAD CULVERT
# PLAN

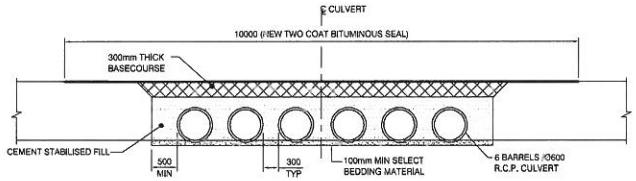
| DATE | SCALE | | |
|---|---|---|---|
| 03.02.2006 | AS SHOWN | | |
| DRAWN | DESIGNED | REVIEWED | APPROVED |
| O.K. | M.W. | P.J.H. | P.J.C. |
| PROJECT No. | DRAWING No. | | REV. |
| PO5022 | SE.02 | | C |




SECTION A (SE.02) 1:30




SECTION B (SE.02) 1:50




SECTION C (SE.02) 1:50

NOTE
1. FOR GENERAL NOTES REFER TO DRAWING N° SE.01

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|
| C | 20.02.2006 | PIPE Ø TO 600 / CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 30.05.2006 | DESIGN MODIFICATION | A.C. |
| A | 03.01.2006 | ISSUED FOR INFORMATION | O.K. |

REVISIONS

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|

REVISIONS

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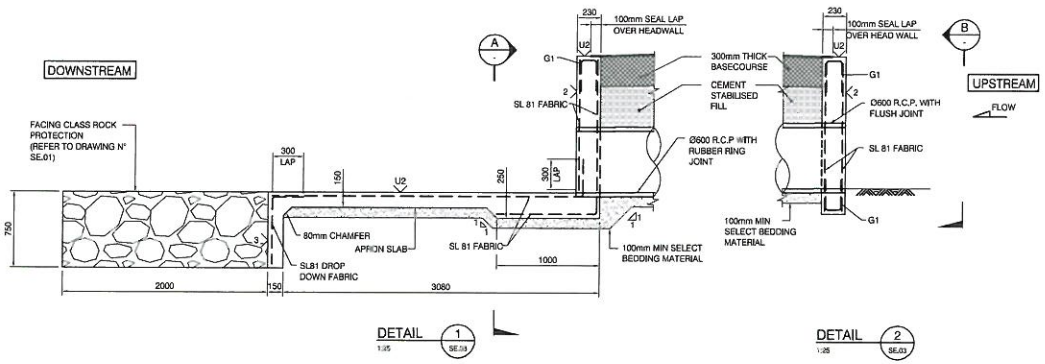
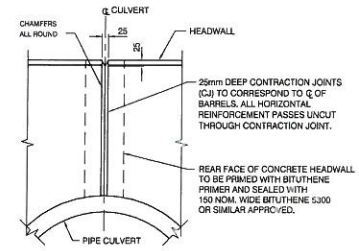
# TOOLIBIN LAKE R.C.P. ROAD CULVERT SECTIONS

| DATE | SCALE | | |
|---|---|---|---|
| 03.02.2006 | AS SHOWN | | |
| DRAWN | DESIGNED | REVIEWED | APPROVED |
| O.K. | M.W. | P.J.H. | P.J.C. |
| PROJECT No. | DRAWING No. | | REV. |
| PO5022 | SE.03 | | C |

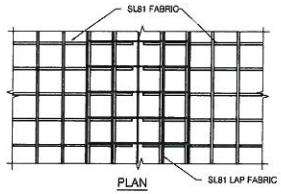



DETAIL 1 (SE.03) 1:25

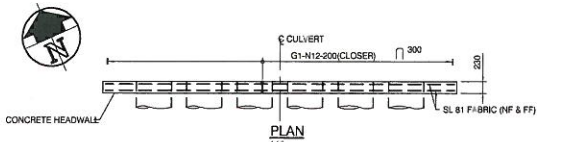
DETAIL 2 (SE.03) 1:25



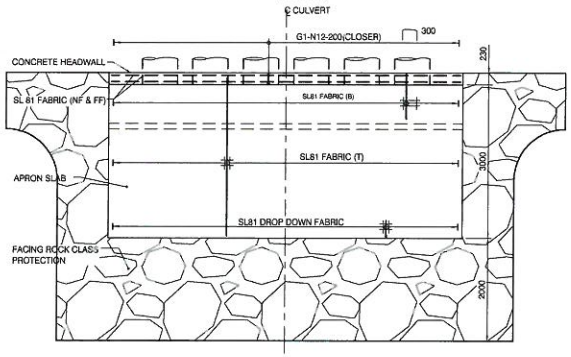

TYPICAL HEADWALL CONTRACTION JOINT DETAIL
1:10



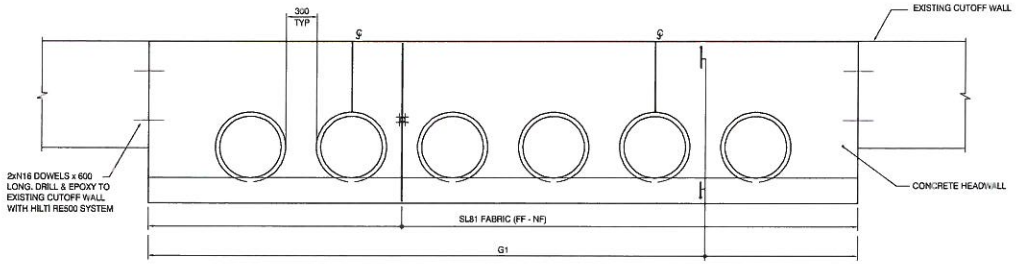

LAPPING FOR FABRIC
1:10




PLAN
1:50
(UPSTREAM)

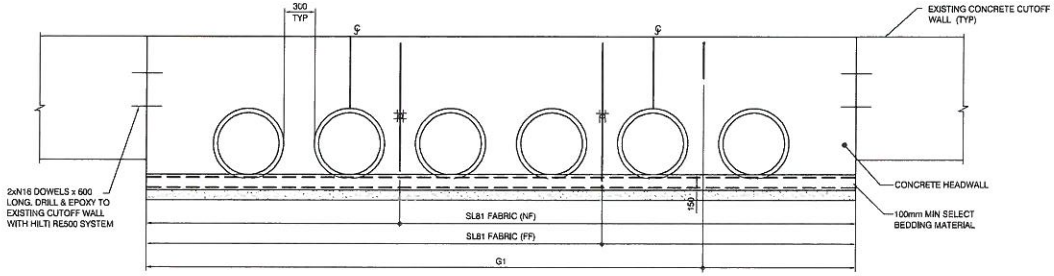



PLAN
1:50
(DOWNSTREAM)




SECTION B
1:25

TRIM ALL FABRIC AS NECESSARY TO SUIT PIPE PENETRATIONS




SECTION A
1:25

NOTE
1. FOR GENERAL NOTES REFER TO DRAWING N° SE.01

| REVISIONS | | | |
|---|---|---|---|
| REV | DATE | DESCRIPTION | RVD |
| C | 20.07.2006 | PIPE Ø TO 600 / CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 30.05.2006 | DESIGN MODIFICATION | A.C. |
| A | 03.37.2006 | ISSUED FOR INFORMATION | D.K. |

| REVISIONS | | | |
|---|---|---|---|
| REV | DATE | DESCRIPTION | RVD |

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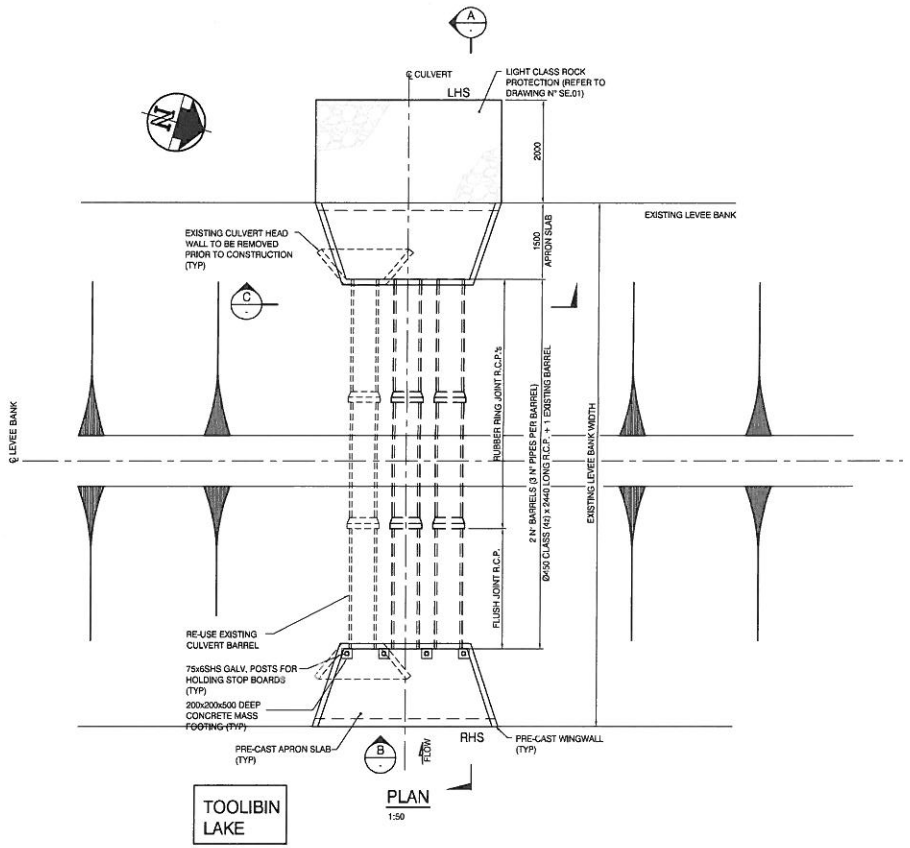
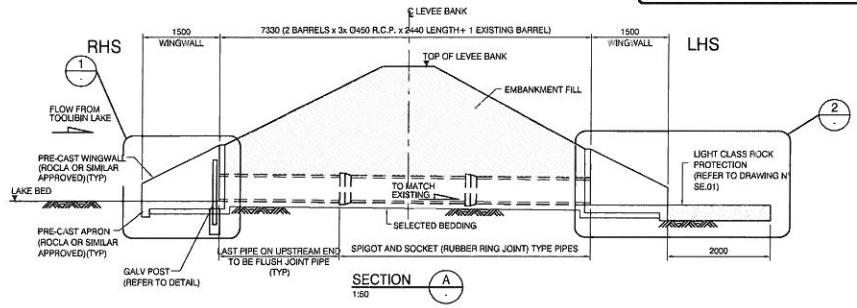
# TOOLIBIN LAKE
# R.C.P. ROAD CULVERT
## REINF. PLAN, SECTIONS & DETAILS

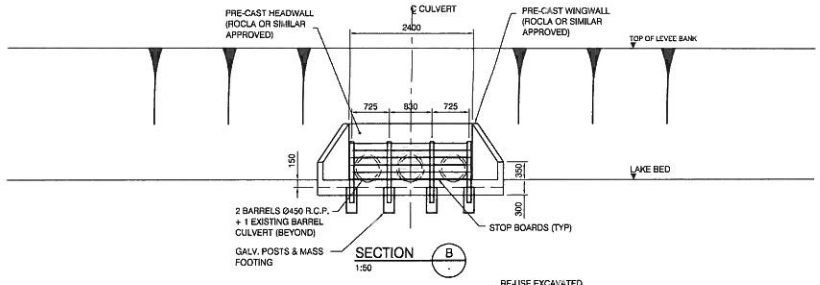
| DATE | SCALE | |
|---|---|---|
| 03.02.2006 | AS SHOWN | |
| DRAWN: O.K. | DESIGNED: M.W. | REVIEWED: P.J.H. |
| APPROVED: P.J.C. | | |
| PROJECT No.: PO5022 | DRAWING No.: SE.04 | REV: C |



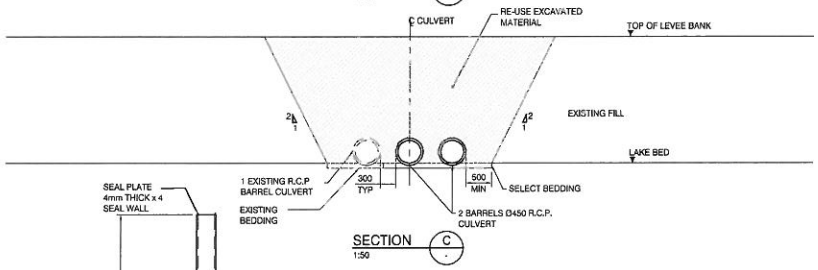

PLAN
1:50



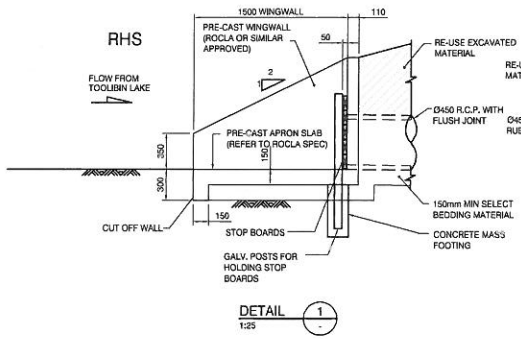

SECTION A
1:50



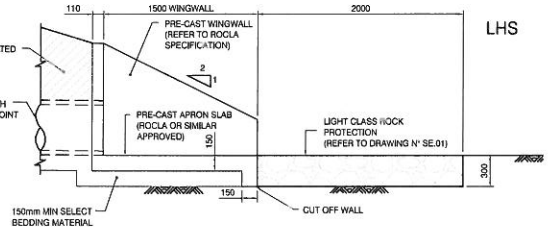

SECTION B
1:50



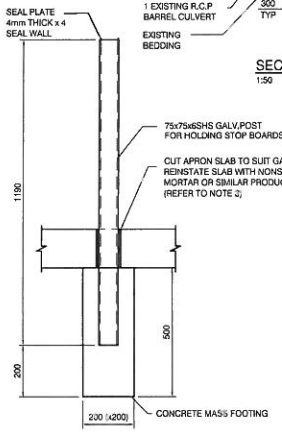

SECTION C
1:50




DETAIL 1
1:25




DETAIL 2
1:25




TYPICAL POST DETAIL
1:10

NOTE:
1. FOR GENERAL NOTES REFER TO DRAWING N° SE.01
2. FOR STANDARD PRE-CAST DETAILS REFER TO MANUFACTURERS SPECIFICATION
3. CONTRACTOR SHALL LIASE WITH APRON MANUFACTURER TO AVOID CLASHES BETWEEN STOP BOARD POSTS AND APRON SLAB REINFORCEMENT.

| REV. | DATE | DESCRIPTION | R'D |
|---|---|---|---|
| C | 03.07.2006 | CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 30.05.2006 | DESIGN MODIFICATION | A.C. |
| A | 02.02.2006 | ISSUED FOR INFORMATION | O.K. |

REVISIONS

| REV. | DATE | DESCRIPTION | R'D |
|---|---|---|---|

REVISIONS

GOVERNMENT OF WESTERN AUSTRALIA
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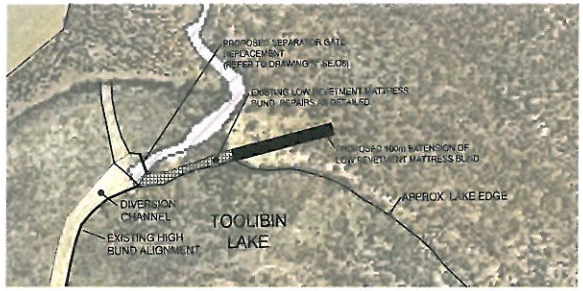
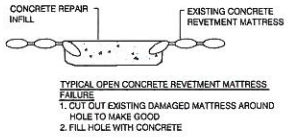
# TOOLIBIN LAKE
# R.C.P. LEVEE BANK CULVERT
# PLAN, SECTIONS & DETAILS

| DATE | SCALE | | |
|---|---|---|---|
| 03.02.2006 | AS SHOWN | | |
| DRAWN: O.K. | DESIGNED: M.W. | REVIEWED: P.J.H. | APPROVED: P.J.C |
| PROJECT No.: PO5022 | DRAWING No.: SE.05 | REV.: C | |

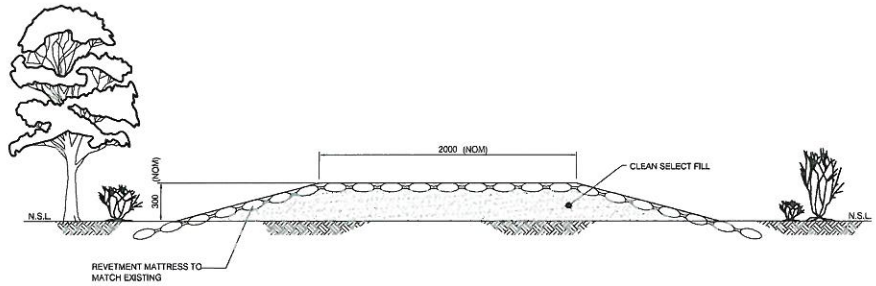



PLAN OF SEPARATOR GATES AND LOW BUND

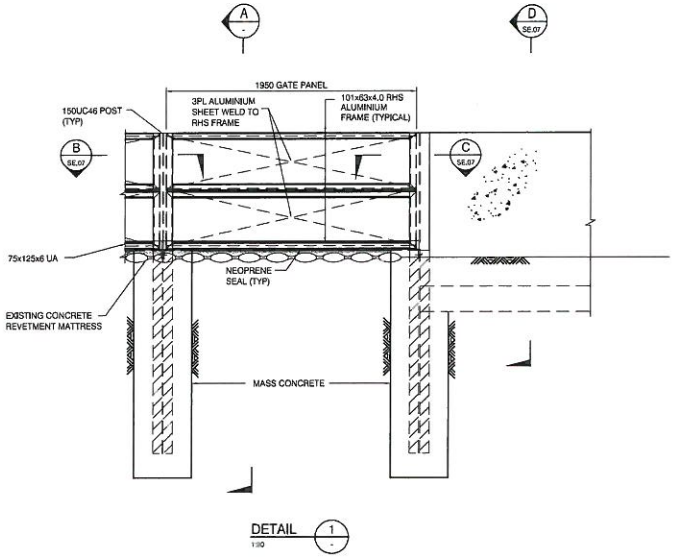
NTS



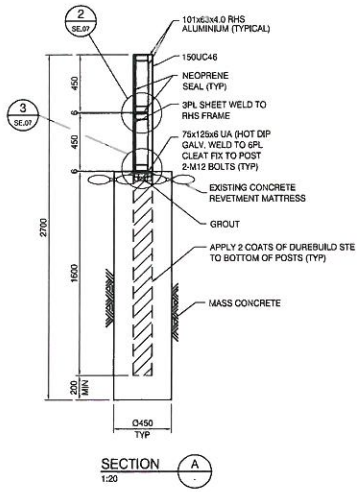

TYPICAL CONCRETE REVETMENT MATTRESS REPAIRS




TYPICAL CROSS SECTION OF LOW REVETMENT MATTRESS BUND

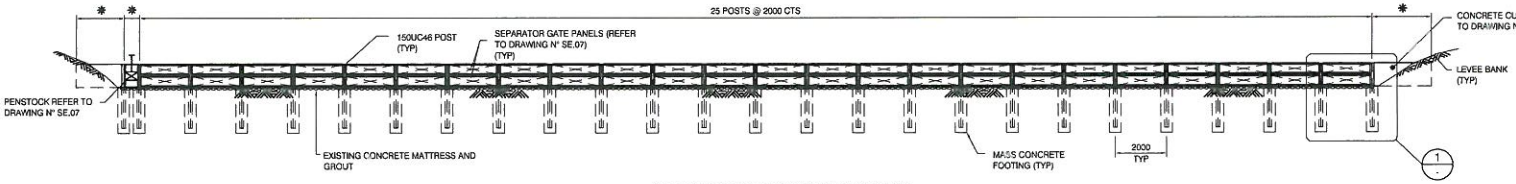



DETAIL 1 / 1:10




SECTION A / 1:20

TYPICAL FORM OF EXISTING LOW REVETMENT MATTRESS BUND




SEPARATOR GATES ELEVATION

1:100

## NOTE:

1. FOR GENERAL NOTES REFER TO DRAWING N° SE.01
2. EXISTING TIMBER BARRAGE GATES AND POSTS TO BE REMOVED PRIOR TO COMMENCING WORK
3. DIMENSION MARKED ✱ TO BE CONFIRMED ON SITE
4. ALL STEELWORK TO BE HOT DIP GALVANISED 70 MICRONS

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|
| C | 09.07.2006 | CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 30.06.2006 | DESIGN MODIFICATION | R.H. |
| A | 03.02.2006 | ISSUED FOR INFORMATION | O.K. |

REVISIONS

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|

REVISIONS

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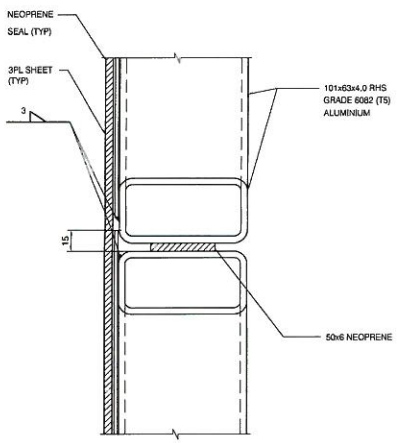
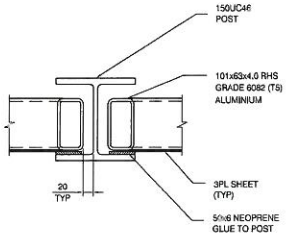
# TOOLIBIN LAKE SEPARATOR GATES ELEVATION & SECTION

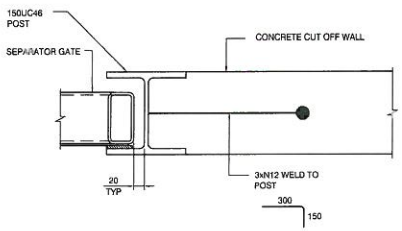
| DATE | SCALE | |
|---|---|---|
| 03.02.2006 | AS SHOWN | |
| DRAWN: O.K. | DESIGNED: M.W. | REVIEWED: P.J.H. / APPROVED: P.J.C |
| PROJECT No.: PO5022 | DRAWING No.: SE.06 | REV.: C |



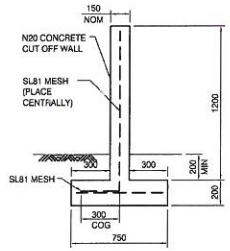

DETAIL 3 SE.06
1:2



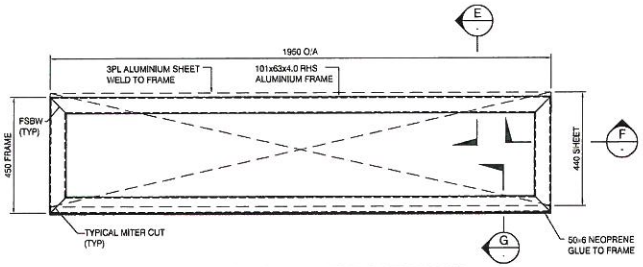

SECTION B SE.06
1:5



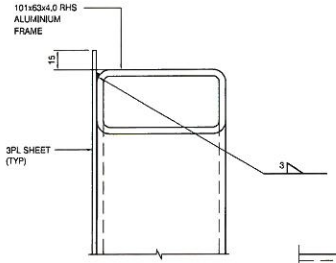

SECTION C SE.06
1:5



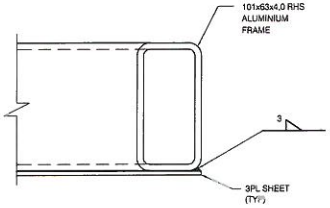

SECTION D SE.06
1:20



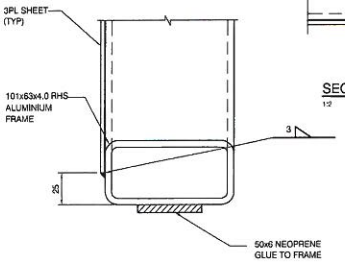

TYPICAL SEPARATOR GATE PANEL
1:10



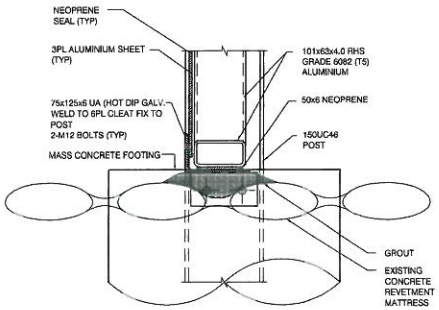

SECTION E SE.06
1:2



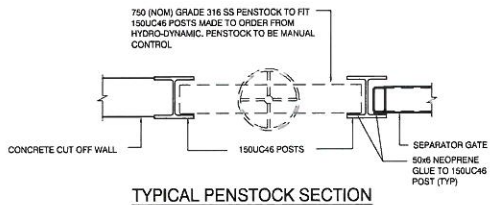

SECTION F SE.06
1:2




SECTION G SE.06
1:2




DETAIL 4 SE.06
1:5




TYPICAL PENSTOCK SECTION
1:10

## NOTE:

1. FOR GENERAL NOTES REFER TO DRAWING N° SE.01

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|
| C | 20.07.2006 | CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 30.05.2006 | DESIGN MODIFICATION | R.N. |
| A | 03.01.2006 | ISSUED FOR INFORMATION | O.K. |

REVISIONS

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|

REVISIONS

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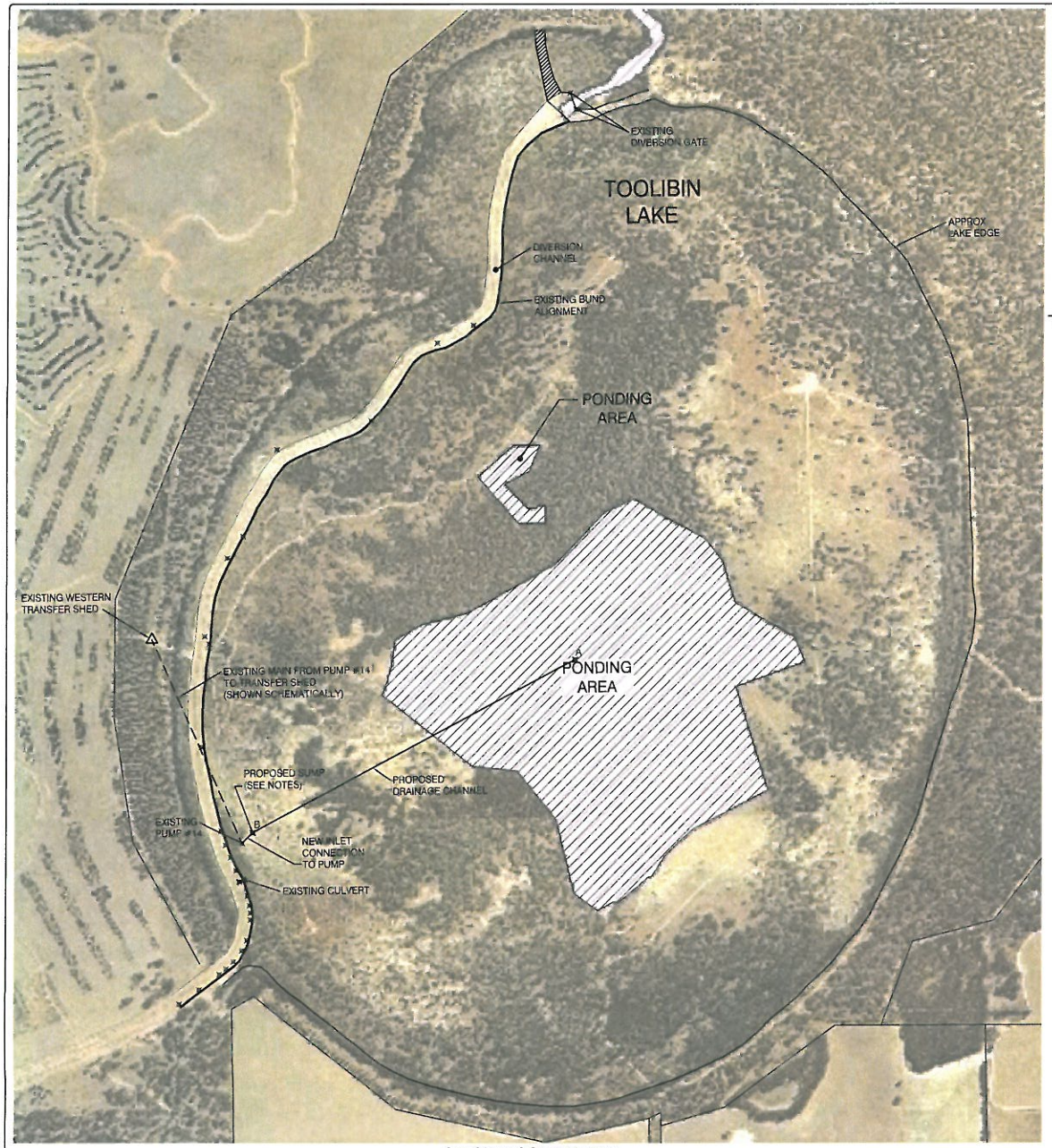
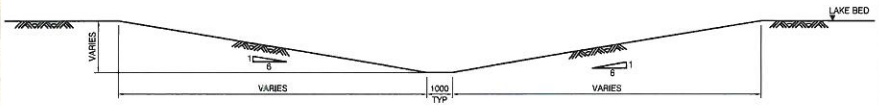
# TOOLIBIN LAKE SEPARATOR GATES SECTION & DETAILS

| DATE | SCALE | | |
|---|---|---|---|
| 03.02.2006 | AS SHOWN | | |
| DRAWN: O.K. | DESIGNED: M.W. | VERIFIED: P.J.H. | APPROVED: P.J.C |
| PROJECT No.: PO5022 | DRAWING No.: SE.07 | REV.: C | |




SETOUT LOCALITY PLAN
1:5000




TYPICAL CHANNEL SECTION
1:100

| SETOUT POINTS | | |
|---|---|---|
| POINT | EASTINGS | NORTHINGS |
| PUMP 14 | 556046 | 6356830 |
| A | 556771 | 6357231 |
| B | 556069 | 6356853 |

LEGEND
- SURVEY POINT (TOP OF BUND)
- SURVEY POINT (EXIST. DRAINAGE STRUCTURE)
- SETOUT POINT (PROPOSED DRAINAGE STRUCTURE)
- CULVERT

NOTE
1. FOR GENERAL NOTES REFER TO DRAWING N° SE.01.
2. ANY TREES NEAR CHANNEL TO BE RELOCATED AS REQUIRED.
3. DRAINAGE CHANNEL TO HAVE A NOMINAL GRADE OF 0.5%.
4. CONTRACTOR IS TO UNDERTAKE DETAIL SURVEY OF DRAIN ALIGNMENT AND SUBMIT TO SUPERINTENDENT FOR APPROVAL PRIOR TO COMMENCING EXCAVATION.
5. PROPOSED SUMP 5m x 5m BASE DIMENSION WITH 1:2 SIDE SLOPES. MAX. DEPTH 3m. IF GREATER THAN 3m DEPTH REQUIRED FOR DRAINAGE CHANNEL GRADE, SUBMIT TO SUPERINTENDENT FOR DIRECTION.
6. LOCATION OF PROPOSED SUMP TO BE CONFIRMED WITH SUPERINTENDENT ON-SITE.
7. INLET CONNECTION TO PUMP #14 TO BE SIZED TO MATCH PUMP #14 INLET. INVERT AT PROPOSED SUMP TO BE AT BASE OF SUMP.
8. CONNECTION DETAILS OF SUMP INLET TO PUMP #14 TO BE AGREED WITH SUPERINTENDENT.

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|
| C | 09.02.2006 | CLIENT LOGO / ISSUED FOR FINAL REVIEW | M.B. |
| B | 01.05.2006 | DESIGN MODIFICATION | R.N. |
| A | 05.02.2006 | ISSUED FOR INFORMATION | O.K. |

REVISIONS

| REV. | DATE | DESCRIPTION | RVD |
|---|---|---|---|

REVISIONS

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# TOOLIBIN LAKE
# FLOOR CHANNEL & PUMP OUT SUMP
# SETOUT PLAN

| DATE | SCALE | | |
|---|---|---|---|
| 09.02.2006 | AS SHOWN | | |
| DRAWN O.K. | DESIGNED M.W. | REVIEWED P.J.H. | APPROVED P.J.C. |
| PROJECT No. PO5022 | DRAWING No. SE.08 | REV. C | |