McPherson Resources Ltd

Draft Erosion and Sediment Control Plan (ESCP), Quarry Development Stage #1 - for Resource Consent Application

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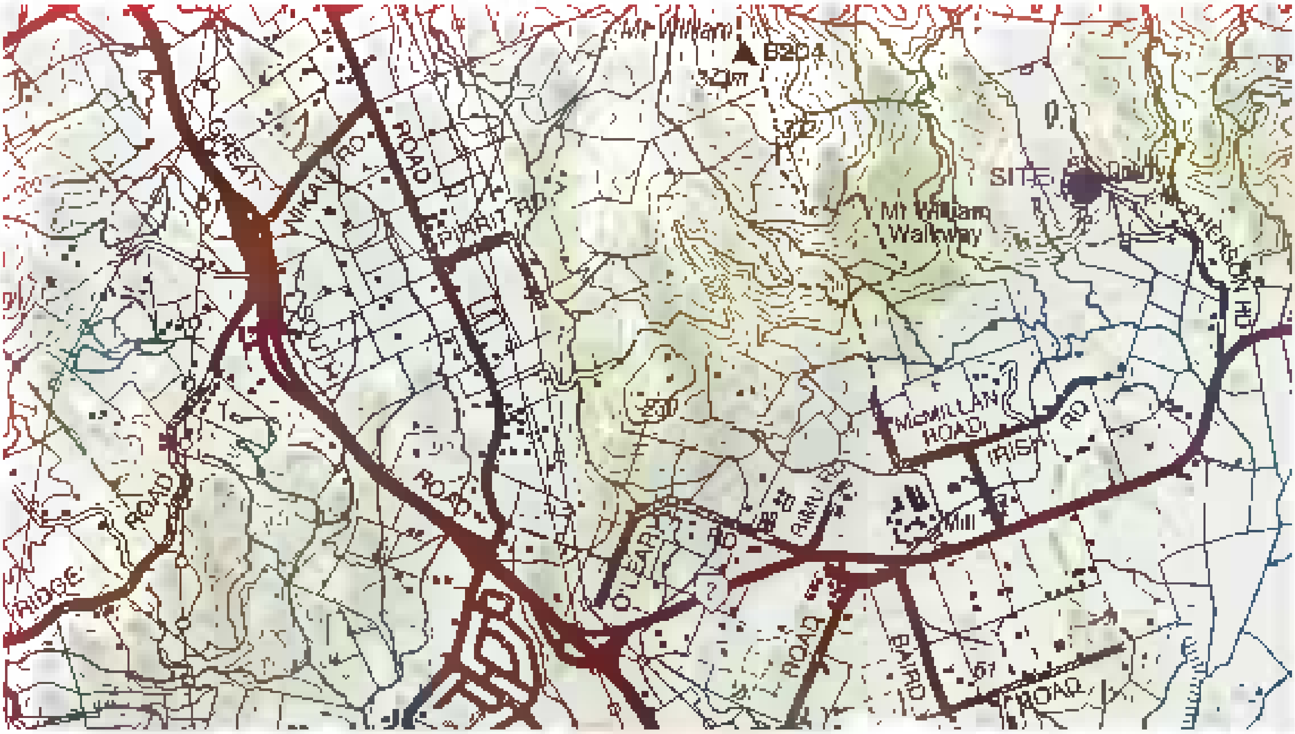
1. Project Description

McPherson Resources Limited are seeking to continue extraction and processing of high quality source of aggregate from their existing quarry at Mangatawhiri. The quarry site is located off McPherson Road, approximately 4 km east of the SH 1/SH 2 interchange at Pokeno, and is displayed in Figure 1 below.

Figure 1: Site Location



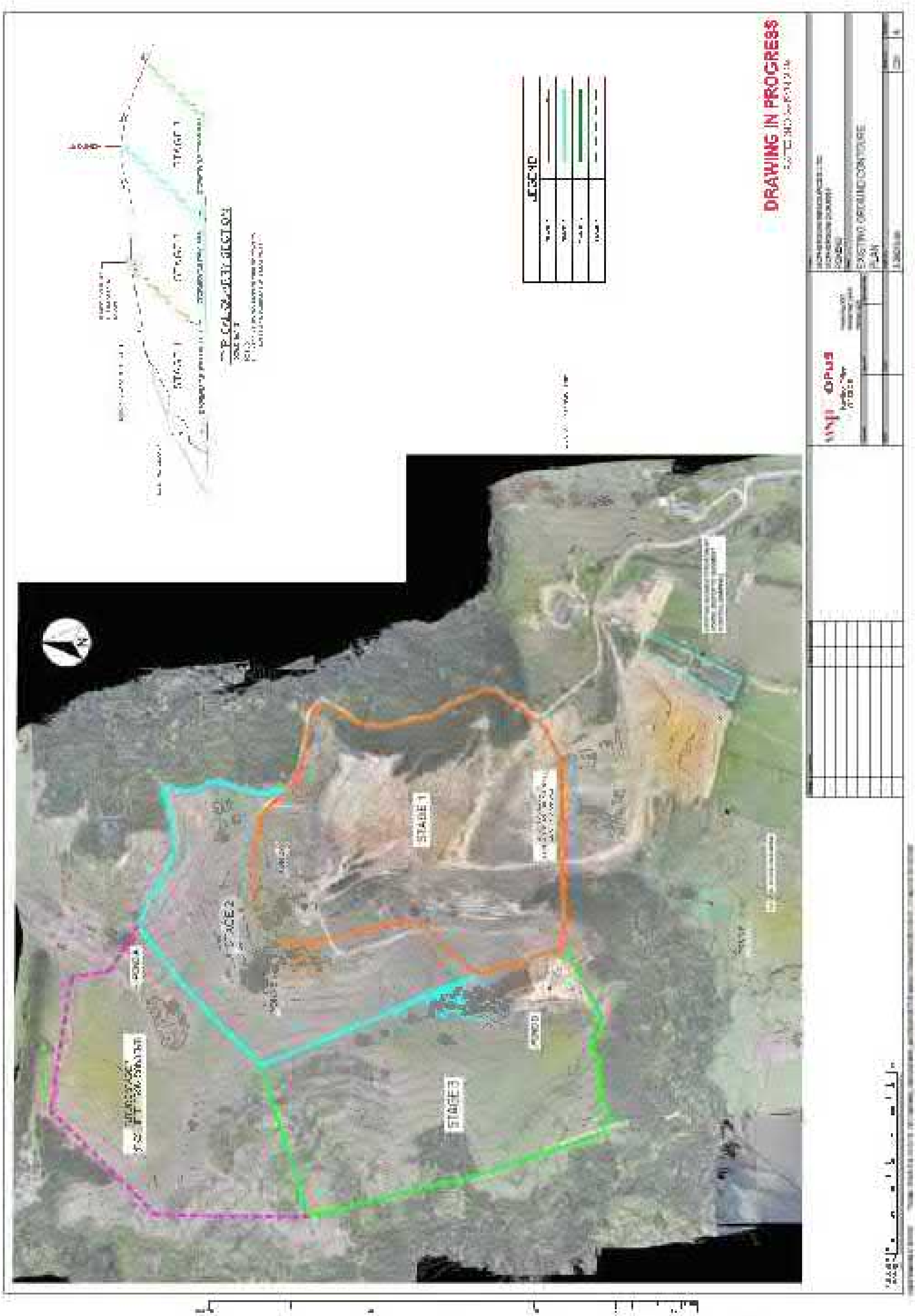
Expansion of the current quarry area (Development Stage 1) will involve stripping of topsoil and overburden, mainly on the northern and western margins of existing works, plus a limited area of vegetation clearance and topsoil/overburden stripping on the eastern site margin. Rock will be excavated with conventional quarrying techniques and material hauled to a screen grading and stockpile area at the base of the pit, and will be removed offsite depending on demand. Overburden will continue to be hauled to a stockpile area located on the southern margin of the site pit, where it is compacted and contoured. Currently there is sustained demand for clean fill and much of this material is removed from site.

Runoff from the central pit and quarry face is directed through a culvert system to two 20,000 litre tanks. This water is then used for dust suppression and the overflow from these tanks is directed into the existing settling pond on the south-east margin of the site, before discharge to a local drain system and then flows 540 m to an outfall on the Waipunga Stream, which flows to the wetland area adjoining the Mangatawhiri River approximately 3 km to the south.

A total cut topsoil/overburden volume for Stage #1 of approximately to 5,327,680 m^3 is proposed over 15 years or more, with an estimated 1,427,655 m^3 cut to fill (stockpile) and an estimated 999, 360 m^3 of that removed offsite as clean fill (depending on sales). Road vehicle and construction compound parking areas will be gravel surfaced and include table drains and drainage outlets. The area of proposed excavation is approximately 8.3 ha and the total catchment area, including existing pit/stock piles and terrain upslope of proposed works, is approximately 34 ha.

A concept plan is displayed in Figure 2 below.

Figure 2. Work Concept Plan



2. Estimate of Sediment Loss

Potential sediment loss from the site is estimated by the Universal Soil Loss Equation (USLE), where: A (Annual Soil Loss, t/ha/yr)) = R x K x LS x C x P

The Sediment Yield is based on a number of factors applied to the USLE, which include:

- Area of Exposure
- Sediment Delivery Ratio
- Sediment Control Measure efficiency
- Duration of Exposure.

The USLE was originally developed to predict sheet and rill soil erosion loss off cropland. For quarry application, some adaption is required. In regard to disturbance of rock substrate, the equation may tend to over-estimate potential sediment yield and results should be treated with some consideration. Calculations are based on sub-catchment areas within Development Stage #1 and accommodate the initial removal of topsoil and overburden, followed by operational works for extraction of rock. Sub- catchment areas are proposed to be worked with progressive staging over a 15-year period, and the following assumptions have been applied:

- Work durations: these are assumed to be year-round for all operational works, or several weeks for specified areas of overburden removal as nominated in the calculations.
- Working areas: these are estimated for sub-catchments from drawings and in the case of the main overburden stockpile area, pending some extraction of clean fill for removal off site, it is assumed that approximately 30% of the area will be rehabilitated/permanently stabilised by the 6th year of operation, and a further 30% by the 11th year of operation.
- K (soil erodibility) factors: for overburden removal, these are based on clay loam sand/ silt/ clay fractions and are standardised across the site; for rock face works or gravel covered areas these are assumed to be predominantly sandy (along with rock chip & scree) with minimal silt and clay fractions.
- Length-Slope (LS) factors: these are generally estimated from map and contour information; in regard to eventual terrain modification (cutting down of ridges) along the eastern and western flanks of the site, LS factors have been modified for the latter part of works staging in sub-catchments 1a – 1d, 2, 8 and 9 by reducing gradients by at least 50%, with a lesser reduction in gradient for sub-catchment 10. Other sub-catchments have LS factors standardised throughout works
- C (cover) factors: the maximum value is assigned to high disturbance activity such as overburden removal, while works on rock substrate and gravelled areas have been assigned a similar value to that provided for dense mulch cover. Stockpile areas subject to varying management in terms of deposition and removal (clean fill sales) of material and extent of temporary cover have been assigned a more conservative 'mulch' cover factor.
- P (surface roughness) factors: it is assumed that overburden stockpiles are regularly track walked during deposition (or removal) of material, and all worked rock extraction or gravelled areas have a similarly-roughened surface.
- Sediment delivery ratios are held at a standard 0.5 value, while sediment control efficiencies are regarded as relatively high for operational areas, given the coarse nature of likely sediments (sand and rock chip).
- Surface stabilisation: as extraction works cease on sub-catchment areas within Stage #1, pending future continuation of work as part of Stage #2, is assumed areas will be stabilised with re-vegetation works and/or gravel mulching scree/aggregate layers as follows:

Sub-catchment area	Year
1a-1d, 2	8
10	10
3 & 4	12
5 & 6	14

These areas are subsequently removed from USLE calculations in the year following stabilisation.

For uncontrolled earthworks throughout the site, the potential sediment generation is estimated on an annual basis over a 15-year period, and is displayed in Table 1 below. With management of storm water runoff flows and use of sediment control devices the potential annual sediment yield is significantly reduced, and these estimates are also shown in Table 1.

Table 1. Potential Annual Sediment Loss (t)

Year	Sub-Catchments	Potential Sediment Loss – Uncontrolled	Potential Sediment Loss – Controlled	Comment
1	1a – 1d, 2, 10, 11, 12, 13	115.17	11.68	Overburden removal & operation areas
2	1a – 1d, 2, 10, 11, 12, 13	105.53	7.92	Operation areas only
3	1a – 1d, 2, 10, 11, 12, 13	105.53	7.92	Operation areas only
4	1a – 1d, 2, 3, 4, 10, 11, 12, 13	246.86	22.73	Overburden removal & operation areas
5	1a – 1d, 2, 3, 4, 10, 11, 12, 13	206.55	15.49	Operation areas only
6	1a – 1d, 2, 3, 4, 10, 11, 12, 13	167.00	12.53	Operation areas only, 12 pt stabilised
7	1a – 1d, 2, 3, 4, 5, 6, 10, 11, 12, 12a, 13	189.01	15.92	Overburden removal & operation areas
8	1a – 1d, 2, 3, 4, 5, 6, 10, 11, 12, 12a, 13	169.37	12.71	Operation areas only
9	3, 4, 5, 6, 10, 11, 12, 12a, 13	136.07	10.21	Operational, 1a – 1d, 2 stabilised
10	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 12a, 13	215.25	16.54	Overburden removal & operation areas
11	3, 4, 5, 6, 7, 8, 9, 11, 12, 12a, 13	167.78	16.37	Operational, 10 rehabilitated, pt 12 further stabilised
12	3, 4, 5, 6, 7, 8, 9, 11, 12, 12a, 13	167.78	16.37	Operation areas only
13	5, 6, 7, 8, 9, 11, 12, 12a, 13	154.97	15.41	Operational, 3 & 4 stabilised
14	5, 6, 7, 8, 9, 11, 12, 12a, 13	97.17	8.52	Operation areas only
15	7, 8, 9, 11, 12, 12a, 13	90.70	8.04	Operational, 5 & 6 stabilised

See Appendix A for the USLE calculations used to estimate potential sediment yields. Calculations indicate that overburden removal and stockpile activities present the highest risk in terms of potential sediment yield. For preparation of a final ESCP, sub-catchment staging can be reviewed with reference to reducing annual area of overburden removal. Stockpile management will require detailed attention in terms of drainage management, optimum use of temporary and permanent covers, and a chain of sediment controls including sediment traps, settling ponds and use of flocculants.

3. Principles for Minimising Sediment Discharge

ESCP Design Standards: Environment Waikato Technical Report No.2009/02 - *Erosion and Sediment Control Guidelines for Soil Disturbing Activities*, (WRC, January 2009) – cited below as 'Reference A'.

The principles of this ESCP are to identify approaches that reduce potential for erosion and sedimentation effects of the car park construction i.e. proactive approaches to:

Minimise Disturbance: *Fit land development to land sensitivity. Some parts of a site should never be worked and others need very careful working. Watch out for and avoid areas that are wet (streams, wetlands, and springs), have steep or fragile soils or are conservation sites or features. Adopt a minimum earthworks strategy (low impact design) - ideally only clear areas required for structures or access.*

Site Specific Detail:

- Work site areas will be opened up as required in accordance with the construction staging sequence.
- No ground disturbance will take place outside the designated access / construction routes and the Limit of Works area, which can be demarked by flagging or similar means.

Staged Construction: *Carrying out bulk earthworks over the whole site maximises the time and area of soil that is exposed and prone to erosion. "Construction staging", where the site has earthworks undertaken in small units over time with progressive revegetation, limits erosion. Careful planning is needed. Temporary stockpiles, access and utility service installation all need to be planned. Construction staging differs from sequencing. Sequencing sets out the order of construction to contractors.*

Site Specific Detail:

The proposed timeframe for completion over burden removal works is in accordance with annual staging proposed below, with works carried out within the period 1 November to 1 May (summer earthworks period). Rock extraction and processing is deemed to be a year-round activity for draft ESCP purposes.

Pending annual demand for rock products, and development of a final construction methodology for Development Stage #1, actual timing and staging or works may be subject to some variation. The indicative staging of proposed works will generally be in accordance with sub-catchment areas as numbered on the ESCP drawing in Appendix B, as follows:

Year 1	Overburden removal, 4 - 10 week durations Operational, year-round	1, 2 10, 11, 12, 13
Year 2	Operational, year-round	1, 2, 10, 11, 12, 13
Year 3	Operational, year-round	1, 2, 10, 11, 12, 13
Year 4	Overburden removal, 18 & 8 week durations Operational, year-round	3, 4 1, 2, 10, 11, 12, 13
Year 5	Operational, year-round	1, 2, 3, 4 10, 11, 12, 13
Year 6	Operational, year-round	1, 2, 3, 4 10, 11, 12, 13
Year 7	Overburden removal, 12 & 10 week durations Operational, year-round	5, 6 1, 2, 3, 4, 10, 11,1 2, 12a, 13
Year 8	Operational, year-round	1, 2, 3, 4,5, 6, 10, 11, 12, 12a, 13

Year 9	Operational, year-round	3, 4,5, 6, 10, 11, 12, 12a, 13
Year 10	Overburden removal, 6, 8 & 3 week durations Operational, year-round	7, 8, 9 3, 4, 5, 6, 10, 11, 12, 12a, 13
Year 11	Operational, year-round	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 12a, 13
Year 12	Operational, year-round	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 12a, 13
Year 13	Operational, year-round	5, 6, 7, 8, 9, 10, 11, 12, 12a, 13
Year 14	Operational, year-round	5, 6, 7, 8, 9, 10, 11, 12, 12a, 13
Year 15	Operational, year-round	7, 8, 9, 10, 11, 12, 12a, 13

The general construction sequencing is proposed as follows:

- Installation of sub-catchment area environmental controls
- Upgrade of central haul route, with track surface discharge to eastern side of track (roll-over diversion bunds or similar)
- Install sub-surface drainage SE margin of Area 12
- Removal and haul of overburden material to stockpile Areas 12 and 12a (as required); topsoil stockpiled separately to subsoil material
- Removal and processing/stockpiling of rock product, Area 11
- Removal of clean fill from stockpiles
- Rehabilitation of sub-catchment areas when worked out.

The general ESCP construction sequencing is proposed as follows:

- Demarcation / flagging of construction limits and access/haul routes prior to vegetation clearance.
- Installation of Perimeter controls – Clean Water (CW) diversions around northern boundary of Stage #1 as per ESCP drawing in Appendix B; upgrade and stabilise table drain on western side of haul route as central CW diversion; install Silt Fence (SF) on southern boundary of Area 12, adjacent riparian margins.
- Maintain and upgrade existing Sediment Retention Pond, install Dirty Water (DW) diversions for Areas 11 and 12.
- Install DW diversions and U-Shaped sediment trap for Area 13, upgrade and extend gravelled surface over Area 13.
- Install DW diversions and Sediment Retention Pond (SRP) for Area 12a.
- Prior to overburden removal and working of Area 1a-1d, 2 – 7 and 8, install DW diversions and Sediment Retention Pond (SRP) or Decanting Earth Bund (DEB) as per ESCP drawing in Appendix B; install Silt Fence (SF) on eastern (downslope) of Area 9.
- Benching works for overburden removal will generally progress up-slope to facilitate dirty water flows to DW diversions in conjunction with temporary bench cross grades as required.
- Inlet Protection installed on southern culvert inlet; northern culvert inlet connected to SRP decant.
- Worked out areas will be stabilised in the interim through surface roughening and/or scree mulching, pending any future works under Stage #2
- Ongoing monitoring and maintenance of sediment control devices will be undertaken.
- Pending future development of adjoining Stages #2 and #3, ESCP devices and DW diversions will be relocated as required. Following completion of all Stage works and final surface stabilisation, ESCP measures will be progressively removed and permanent drainage channels will be maintained.

Runoff from disturbed areas associated with over burden removal and rock extraction will generally drain to a Sediment Retention Pond (SRP) or similar device. Dirty water drainage will use purpose built diversions or temporary bench cross grades, and earth berms if required, to ensure dirty water is directed to sediment traps and is prevented from discharge over fill slopes or across sub-catchment boundaries.

The location of all ESC devices for Stage #1 is shown on the ESCP drawing in Appendix B. The removal of overburden will be managed, where ever practicable, to limit the area of currently exposed/disturbed soil to 0.2ha to restrict potential sediment discharge to sediment control devices.

Protect Steep Slopes: *Existing steep slopes should be avoided. If clearing is absolutely necessary, runoff from above the site can be diverted away from the exposed slope to minimise erosion. If steep slopes are worked and need stabilisation, traditional vegetative covers like top soiling and seeding may not be enough - special protection is often needed.*

Site Specific Detail:

- A Clean Water (CW) diversion channel will be installed around the northern margin of site (Areas 2 – 8) to redirect upslope surface runoff away from work areas. Further detail of this method is given in Reference A – Section 2.1.
- Vegetation clearance and overburden removal on steep slopes on the eastern margin of the site will be progressive in accordance with sub-catchment areas 1a – 1d, with DW diversions separating upslope terrain as each area is cleared.

Protect Watercourses: *Existing streams, watercourses, and proposed drainage patterns need to be mapped. Clearing may not be permitted adjacent to a watercourse unless the works have been approved. Where undertaken, works that cross or disturb the watercourse are also likely to require resource consents.*

Site Specific Detail:

- Two existing open drains on the south-east margin of Area 12 will be converted to subsurface drains, extending 10 m beyond of the Area 12 boundary
- Silt Fences (SF's) will be installed on the margin of Area 12 adjacent the existing watercourse at the south-western corner of the area, and adjacent the proposed subsurface drainage sites
- Surface water discharges from Areas 13 and 12a will be treated with suitable sediment traps before discharge to an adjacent farm drain
- Vegetation buffers will otherwise be maintained on the margins of existing watercourses and vehicle movements will be confined to existing culvert crossings.

Stabilise Exposed Areas Rapidly: *The ultimate objective is to fully stabilise disturbed soils with vegetation after each stage and at specific milestones within stages. Methods are site specific and can range from conventional sowing through to straw mulching. Mulching is the most effective instant protection.*

Site Specific Detail:

- Topsoil and overburden material will be removed in a progressive manner, in areas of approximately 02 ha where ever practical.
- Cut batters in overburden material will be benched where slopes exceed 25^{0}, and will otherwise be surface roughened to limit volume and velocity of surface runoff. Further detail of these methods is given in Reference A – Section 2.8 and 2.16.
- Contingency surface stabilisation measures may also be applied pending predicted storm events (see Section 7)
- Stockpile fill batters will generally be straw mulched and oversown. Further detail on ground cover establishment is given in Reference A – Section 2.11. Where stockpile batters exceed 25% gradient, slope benching will also be applied (see above).

- Where diversion flow paths may temporarily cross cut or fill batters on overburden material, these will be managed as Pipe/Flume Drop Structures constructed in accordance with guidelines given in Reference A – Section 2.14.

Install Perimeter Controls: *Perimeter controls above the site keep clean runoff out of the worked area – a critical factor for effective erosion control. Perimeter controls can also retain or direct sediment laden runoff within the site. Common perimeter controls are diversion drains, silt fences and earth bunds.*

Site Specific Detail:

- Perimeter controls will include Clean Water diversions (CW's) and Silt Fences (SF's). Further detail of these devices is given in Reference A – Sections 2.1 and 3.2.
- A narrow (Type AU) U-Shaped Sediment Trap (UST) will be installed to treat surface runoff from Area 13 (Construction Compound/vehicle park). Further detail of this device is given in Appendix C.
- The western table drain of the central haul route will be managed as a Clean Water (CW) diversion, carrying discharge from treatment devices in the upper sub-catchments of Stage #1, and will be bermed to separate track runoff flows, which will discharge to the eastern side of the track via water cut-offs or undertrack culverts. Further detail of these devices is given in Reference A – Sections 2.7, 2.4 and 2.5, and Sheet C21, drawing 3-39019.00-C02_ESCP DETAILS.
- The CW table drain will be stabilised with armouring and check dams (rock or sediment sock), in accordance with guidelines given in Reference A – Sections 2.3 and 2.9.

Employ Detention Devices: Even with the best erosion and sediment practices, earthworks will discharge sediment-laden runoff during storms. Along with erosion control measures, sediment retention structures are needed to capture runoff so sediment generated can settle out. The presence of fine grained soils means sediment retention ponds are often not highly effective. Ensure the other control measures used are appropriate for the project and adequately protect the receiving environment.

Site Specific Detail:

- Silt fences (SF) will be placed between the main stock pile area and adjacent watercourses and farm drains. Silt fences will also be used around the downslope margin of Area 11, along the downslope margin of Area 9 (rock benching), and at intermediate spacings depending on work sequence within Area 9. Further detail of the installation and management of this device is given in Reference A – Section 3.2.
- A U-Shaped Sediment Trap (UST) will be installed to treat dirty water discharge from Area 13. Further detail of the construction and management of this device is given in Appendix C.
- Sediment Retention Pond (SRP's) and Decanting Earth Bunds (DEB's) and connecting DW diversions will be constructed in sub-catchment subject to overburden removal. SRP volumes are calculated on a '3% contributing catchment area' basis, while DEB volumes are calculated on a 2% area basis. In the case of Areas 1a and 1c, these slightly exceed 0.3 ha and the calculation factor has been adjusted to 2.7%. Dimensions for all these devices are set out in Table 2 below.
- SRP's and DEB's may not be constructed to the exact dimensions as indicated on the ESCP, however they will be formed to meet the specified volume guidelines for SRP and DEB construction and maintenance as set out in Reference A - Sections 3.1 and 3.6.
- A floating T-bar decanting device is recommended for dewatering SRP's, in accordance with guidelines provided for a structure with a contributing catchment size of less than 1.5 ha. Further detail of the construction and management of this device is given in Reference A – Section 3.1 (page 69).

- A perforated upstand outlet will be used for dewatering DEB's. Further detail of the construction and management of this device is given in Reference A –Section 3.6 (page 88).
- Where space permits, Sediment Sumps may also in incorporated in track drainage structures. Further detail of the construction and management of this device is given in Reference A –Section 2.6.
- Existing culvert inlets on tracks and around the margins of Areas 11 and 12 will have Inlet Protection measures installed for additional sediment trapping. Further information on inlet protection is given in Reference A –Section 3.5, and Sheet C21, drawing 3-39019.00-C02_ESCP DETAILS.

Table 2. Stage #1 Development, Sediment Retention Pond and Decanting Earth Bund Dimensions

Sub catchment	Area (m2)	Type	Volume (m3)	Length (m)	Width (m)	Depth (m)
1a	3200	DEB	86	13.2	4.4	1.5
1b	7040	SRP	211	21.3	7.1	1.4
1c	3200	DEB	86	13.2	4.4	1.5
1d	3000	DEB	60	11	3.6	1.5
2	5040	SRP	101	15.3	5.1	1.3
3	12000	SRP	360	26.9	8.9	1.5
4	4200	SRP	126	17.1	5.7	1.3
5	6000	SRP	180	19.7	6.5	1.4
6	6990	SRP	210	21.2	7.1	1.4
7	9070	SRP	272	23.4	7.8	1.5
8	10080	SRP	302	24.6	8.2	1.5
9	14400	Silt Fence				
10	30800	SRP	924	39.3	13.1	1.8
1	36000	SRP	720	34.7	11.5	1.8
12	30390	SRP	912	39.0	13.0	1.8
13	500	UST				
12a	8000	SRP	160	18.5	6.2	1.4

Experience and Training: *A trained and experienced contractor is an important element of an ESCP. These people are responsible for installing and maintaining erosion and sediment control practices. Such staff can save project time and money by identifying threatened areas early on and putting into place correct practices.*

Site Specific Detail:

- A pre-construction meeting shall take place with the Quarry Manager and a representative from Waikato Regional Council (WRC). This meeting is to ensure that the requirements of WRC in terms of the implementation of the ESCP are understood and met by the Site Manager.

Assess and Adjust: *An effective E&SCP is modified as the project progresses from bulk earthworks to project completion. Factors such as weather, changes to grade and altered drainage can all mean changes to planned erosion and sediment control practices. An intense storm may leave erosion and sediment controls in need of repair, reinforcement or cleaning out. Assessment of controls and making repairs without delay reduces further soil loss and environmental damage,*

Site Specific Detail:

- It will be the responsibility of the Site Foreman to ensure that all ESC devices are maintained.
- ESC measures to be regularly monitored to identify maintenance and repair requirements, and sediment build-up will be cleared and disposed of in a suitable manner.

Management of materials: *The effective management of materials on site will have a substantial effect on the transportation of sediment from site.*

Site Specific Detail:

- Any localised top soil stockpiles adjacent sub-catchment areas will be located to avoid upslope runoff as much as possible, and have a Silt Fence or similar sediment containment barrier installed around the downslope margin.
- Stockpiles will have a maximum height of 1.5 m and be surface compacted to reduce the risk of wind erosion.
- Aggregate / processing area stockpiles will have a Silt Fence installed on the downslope margin to contain runoff off coarse sediments.

4. Design of Erosion and Sediment Control (ESC) Devices

The works will involve excavation (up to 5,327,680 m^3) and permanent fill (at least 428,305 m^3), bench formation and extensive stockpile formation. Topsoil and overburden removal earthworks are proposed during the summer earthworks season (1 November to 1 May), and soil type is largely of a clay loam texture.

Universal Soil Loss Equation calculations for Stage #1 demonstrate that the highest risk of sediment discharge is associated with overburden removal, and stockpiling activity in particular. Accordingly, the ESCP design approach for all stages is primarily focused on development activity (topsoil and overburden removal), with an emphasis on sub-catchment staging and use of localised sediment retention ponds (SRP's) for overburden removal and stockpile activity.

Sediment Retention Ponds, Decanting Earth Bunds, Silt Fences, Clean Water and Dirty Water Diversions will be used to control potential sediment discharge from site, mainly during development (overburden removal) activity. In accordance with Reference A - Section 3.10, the Sediment Retention Ponds have been sized for sites with slopes greater than 10 percent, using a minimum volume of 3 percent of the contributing catchment (300 m^3 for each ha of contributing catchment). DEB volumes are generally calculated on a 2% area basis for a maximum area of 0.3 ha. Areas 1a and 1c are approximately 0.32 ha and the sizing factor has been adjusted to 2.7% accordingly.

As Stage #1 development activity transitions into operational (rock extraction) activity, landform change within the working pit will direct runoff patterns to the central pit floor, connecting to the existing drainage system, discharging to the existing sediment pond. The existing sediment pond comprises a main pond (south pond), receiving flow from an elongated forebay (north pond). The main pond is estimated to have a volume of 5,040 m3 (subject to verification). Based on a '3%' sizing factor the pond would be able to service a catchment area of up to 16,8000 m2, sufficient to treat runoff from operation activity from most of Stage #1, and parts of Stage #2, when developed, along with Area 11 (processing) and Area 12 (stockpile).

The main (south) pond will have overdue maintenance carried out, including removal of accumulated silt and additional bunding on the low north-eastern corner to reduce risk of over-topping. Review and possible upgrade of the outlet and emergency spillway structures is also recommended. Actual working volume can then be assessed and verified. In the event volume might be found to be insufficient for long-term use for treating operational pit runoff from the eastern half of the site when fully developed, there northern pond is available for modification (increase in width and separation from the south pond with reconfigured outlet) to provide additional treatment capacity.

All ESC devices will be installed and maintained in accordance with Environment Waikato Technical Report No.2009/02 - *Erosion and Sediment Control Guidelines for Soil Disturbing Activities*, and may also reference other authoritative guidelines for additional ESC measures.

5. Timetable and Nature of Site Stabilisation

Fill batters will have stabilisation measures applied progressively, in close succession to trim of temporary or final levels, and will generally use straw mulching and oversowing. Cut rock face batters will generally be left as is, unless modification is required for landscaping purposes. As sub-catchment areas are worked-out, rock benches will have topsoil re-spread and planting of suitable species such as toetoe, akeake, koromiko and manuka; or may otherwise be left as is for natural colonisation by native species.

Prior to re-spreading of topsoil, rock benches will be ripped to some extent to create a zone of fractured rock which will allow the topsoil to 'key in' and prevent the formation of potential slip planes between the two materials. The fractured zone also serves to retain moisture and assist plant root development.

Any disturbed ground bordering the earthworks areas will be re-grassed at the completion of area stages. The Quarry Manager shall be responsible for maintaining all topsoiled and grassed areas until a strong, stable covering of grass has been established.

6. Maintenance, Monitoring and Reporting

A general inspection will be undertaken weekly on all sediment control measures to ensure they are effective, and after any significant rainfall event.

All ESC devices will be inspected prior to any forecast significant rainfall event.

All weather access will be maintained to the control devices and stockpile fill sites.

Maintenance will be recorded on a Sediment Control and Maintenance Sheet. The performance of ESC measures will be reported monthly to the Quarry Manager, along with any related contractual issues through normal contract reporting requirements.

7. Heavy Rainfall Response and Contingency Measures

The Quarry Manager will register with NZ MetService for serve weather warnings. Following any heavy rainfall warning the ESC measures will be inspected and repaired/cleaned. Exposed surfaces will be prepared by removing loose material and surface roughing/compacting the fill slopes and stockpiles.

The following contingency measures are proposed:

- Proposed earthworks sequencing can be varied depending on likelihood of rainfall.
- Temporary surface stabilisation measures can be applied with straw mulch, or by use or a suitable soil binder product used in accordance with the manufacturer's directions.
- Ensure any temporary stockpiled material is away from drainage paths and water bodies.
- Ensure machinery is not parked in flow paths or potential flood zones.
- If alternative or additional de-watering is required, this should be undertaken in accordance with the **Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region** (Auckland Council 2016), Section G1.0.
- In the event ephemeral flow paths require diversion, a diversion structure (sandbags and unslotted novacoil pipe) can be temporarily installed, in accordance with methods set out the **Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region** (Auckland Council 2016), Section G4.2.2.
- Any contingency measures implemented will be recorded on a Sediment Control and Maintenance Sheet.

8. Procedures for review and/or amendment to ESCP

The ESCP shall be monitored and reviewed monthly by the Quarry Manager.

Any minor updates or amendments to the ESCP will be discussed with the Site Foreman. Any major changes will be documented and an amended ESCP will be submitted to WRC for approval.

9. Site Responsibilities

The Quarry Manager shall have a nominated person for the works who will be responsible for the implementation and maintenance of the Erosion and Sediment Control measures, and updating the ESCP as required during the works. The Site Foreman will likely be responsible for the day-to-day maintenance of the sediment control measures. Implementation and performance of the ESCP will be monitored by the WRC representative.

10. Construction Timeline

Pending a final construction methodology, in the interim the proposed timeframe for Development Stage #1 is at least 15 years, with sub-catchment area topsoil and overburden works taking place within the summer earthworks season (between 1 November and 1 May). Rock extraction and processing, and other operational activities, will take place on a year-round basis.

11. Quarry Manager Input

Prior to start of the main construction works, the Quarry Manager will prepare a Quarry Management Plan, which will set out the detail of the proposed construction methodology and the measures to be taken to ensure compliance with the resource consent documents.

In addition, an Environmental Management Plan (EMP) may be prepared by the Quarry Manager prior to the start of work. The EMP should address:

- Dust Control
- Noise Control
- Erosion and Sediment Control
- Fuel and Spill Containment
- Accidental Discovery Protocol;
- Any other measures necessary to meet all resource consent conditions.
- Any other measures necessary to meet good work practice, including safety in design and appropriate work place safety procedures.

Dust Control measures should include:

- Retaining existing vegetation cover where ever possible.
- Staging of earthworks to limit areas of exposed soil.
- Setting a defined Limit of Works area and enforcing a maximum vehicle speed of 25 kph.
- Use of a water truck or sprinkler irrigation to maintain soil moisture on exposed areas.
- Management of stockpiles including appropriate surface stabilisation.

The draft ESCP report and drawings may be optimised by the Quarry Manager before the start of any activity on site. Any proposed changes to the documents must be approved by the Engineer and WRC prior to works commencing. It is anticipated that the environmental controls, including Erosion and Sediment Controls, on site will be subject to periodic environmental audit by the Engineer.

Appendix A

Estimation of Sediment Yield using the Universal Soil Loss Equation

Project No: 3-39019.00 **By** CS **Date** 7/08/2018 **Checked**

Site Description: McPhearson Quarry - Development Stage #1 - 15 yr

YEAR 1

	Overburden removal					Operational			
Catchment:	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Work Duration:	0.07	0.09	0.11	0.07	0.19	1	1	1	1
Working Area(ha):	0.32	0.7	0.32	0.3	0.5	3	3.6	2.7	0.5

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
%Sand	40	40	40	40	40	90	90	40	90
%Clay	20	20	20	20	20	5	5	20	20
%Silt	40	40	40	40	40	5	5	40	40
% Granular	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4
K=	0.37	0.37	0.37	0.37	0.37	0.06	0.06	0.06	0.06

Slope Length and Steepness Factor(LS)

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Length m	40	88	68	40	40	240	300	170	130
Slope %	7	37	37	50	7	35	10.15	15	0.5
LS =	1.01	17.72	16.16	21.84	1.01	28.93	2.13	6.27	0.13

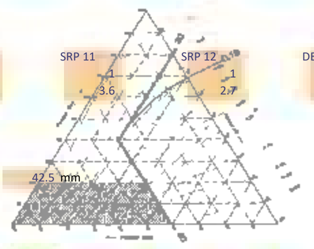
Vegetation cover factor and Erosion control Practise(C and P)

	DEB 1a	SRP 1b	DEB 1c	SRP 4	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
C =	1	1	1	1	1	0.2	0.2	0.4	0.2
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
DEB 1a	53.81891	0.37	1.01	1	0.9	18.1	0.32	0.07	0.41	0.5	70	0.06
SRP 1b	53.81891	0.37	17.72	1	0.9	317.6	0.7	0.09	20.01	0.5	70	3.00
DEB 1c	53.81891	0.37	16.16	1	0.9	289.6	0.32	0.11	10.19	0.5	70	1.53
DEB 1d	53.81891	0.37	21.84	1	0.9	391.4	0.3	0.07	8.22	0.5	70	1.23
SRP 2	53.81891	0.37	1.01	1	0.9	18.1	0.5	0.19	1.72	0.5	70	0.26
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.06	6.27	0.4	0.9	7.3	2.7	1	19.68	0.5	85	1.48
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01

Sediment Generation Potential 115.17

Estimated Total Net Sediment Loss(tonnes) 11.68



YEAR 2

Operational

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Work Duration:	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.32	0.7	0.32	0.3	0.5	3	3.6	2.7	0.5

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
%Sand	90	90	90	90	90	90	90	40	90
%Clay	5	5	5	5	5	5	5	20	20
%Silt	5	5	5	5	5	5	5	40	40
% Granular	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Slope Length and Steepness Factor(LS)

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Length m	40	88	68	40	40	240	300	170	130
Slope %	7	37	37	50	7	35	10.15	15	0.5
LS =	1.01	17.72	16.16	21.84	1.01	28.93	2.13	6.27	0.13

Vegetation cover factor and Erosion control Practise(C and P)

	DEB 1a	SRP 1b	DEB 1c	SRP 4	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
C =	0.2	0.2	0.2	1	1	0.2	0.2	0.4	0.2
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
DEB 1a	53.81891	0.06	1.01	0.2	0.9	0.6	0.32	1	0.19	0.5	85	0.01
SRP 1b	53.81891	0.06	17.72	0.2	0.9	10.3	0.7	1	7.21	0.5	85	0.54
DEB 1c	53.81891	0.06	16.16	0.2	0.9	9.4	0.32	1	3.01	0.5	85	0.23
DEB 1d	53.81891	0.06	21.84	1	0.9	63.5	0.3	1	19.04	0.5	85	1.43
SRP 2	53.81891	0.06	1.01	1	0.9	2.9	0.5	1	1.47	0.5	85	0.11
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.06	6.27	0.4	0.9	7.3	2.7	1	19.68	0.5	85	1.48
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01

Sediment Generation Potential 105.53

Estimated Total Net Sediment Loss(tonnes) 7.92

YEAR 3

Operational

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Work Duration:	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.32	0.7	0.32	0.3	0.5	3	3.6	2.7	0.5

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
%Sand	90	90	90	90	90	90	90	40	90
%Clay	5	5	5	5	5	5	5	20	20
%Silt	5	5	5	5	5	5	5	40	40
% Granular	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Slope Length and Steepness Factor(LS)

	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Length m	40	88	68	40	40	240	300	170	130
Slope %	7	37	37	50	7	35	10.15	15	0.5
LS =	1.01	17.72	16.16	21.84	1.01	28.93	2.13	6.27	0.13

Vegetation cover factor and Erosion control Practise(C and P)

	DEB 1a	SRP 1b	DEB 1c	SRP 4	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
C =	0.2	0.2	0.2	1	1	0.2	0.2	0.4	0.2
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
DEB 1a	53.81891	0.06	1.01	0.2	0.9	0.6	0.32	1	0.19	0.5	85	0.01
SRP 1b	53.81891	0.06	17.72	0.2	0.9	10.3	0.7	1	7.21	0.5	85	0.54
DEB 1c	53.81891	0.06	16.16	0.2	0.9	9.4	0.32	1	3.01	0.5	85	0.23
DEB 1d	53.81891	0.06	21.84	1	0.9	63.5	0.3	1	19.04	0.5	85	1.43
SRP 2	53.81891	0.06	1.01	1	0.9	2.9	0.5	1	1.47	0.5	85	0.11
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.06	6.27	0.4	0.9	7.3	2.7	1	19.68	0.5	85	1.48
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01

Sediment Generation Potential 105.53

Estimated Total Net Sediment Loss(tonnes) 7.92

YEAR 4

Overburden removal **Operational**

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Catchment:	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Work Duration:	0.34	0.15	0.07	0.09	0.11	0.07	0.11	1	1	1	1
Working Area(ha):	1.2	0.42	0.32	0.7	0.32	0.3	0.5	3	3.6	3	0.5

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
%Sand	40	40	90	90	90	90	90	90	90	40	90
%Clay	30	30	5	5	5	5	5	5	5	30	30
%Silt	30	30	5	5	5	5	5	5	5	30	30
% Granular	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4
K=	0.37	0.37	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.37

Slope Length and Steepness Factor(LS)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Length m	160	140	40	88	68	40	40	240	300	170	130
Slope %	16	14	7	37	37	50	7	35	10.15	15	0.5
LS =	6.8	5.43	1.01	17.72	16.16	21.84	1.01	28.93	2.13	6.27	0.13

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	SRP 4	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
C =	1	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 3	53.81891	0.37	6.8	1	0.9	121.9	1.2	0.34	49.72	0.5	70	7.46
SRP 4	53.81891	0.37	5.43	1	0.9	97.3	0.42	0.15	6.13	0.5	70	0.92
DEB 1a	53.81891	0.06	1.01	0.2	0.9	0.6	0.32	0.07	0.01	0.5	85	0.00
SRP 1b	53.81891	0.06	17.72	0.2	0.9	10.3	0.7	0.09	0.65	0.5	85	0.05
DEB 1c	53.81891	0.06	16.16	0.2	0.9	9.4	0.32	0.11	0.33	0.5	85	0.02
SRP 2	53.81891	0.06	1.01	0.2	0.9	0.6	0.5	0.11	0.03	0.5	85	0.00
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3.0	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	3.0	1	134.84	0.5	85	10.11
DEB 13	53.81891	0.37	0.13	0.2	0.9	0.5	0.5	1	0.23	0.5	65	0.04

Sediment Generation Potential 246.86

Estimated Total Net Sediment Loss(tonnes) 22.73

YEAR 5

Operational

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Catchment:	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Work Duration:	1	1	1	1	1	1	1	1	1	1	1
Working Area(ha):	1.2	0.42	0.32	0.7	0.32	0.3	0.5	3	3.6	3	0.5

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
%Sand	90	90	90	90	90	90	90	90	90	40	90
%Clay	5	5	5	5	5	5	5	5	5	30	5
%Silt	5	5	5	5	5	5	5	5	5	30	5
% Granular	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06

Slope Length and Steepness Factor(LS)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Length m	160	140	40	88	68	40	40	240	300	170	130
Slope %	16	14	7	37	37	50	7	35	10.15	15	0.5
LS =	6.8	5.43	1.01	17.72	16.16	21.84	1.01	28.93	2.13	6.27	0.13

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	SRP 4	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
C =	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 3	53.81891	0.06	6.8	0.2	0.9	4.0	1.2	1	4.74	0.5	85	0.36
SRP 4	53.81891	0.06	5.43	0.2	0.9	3.2	0.42	1	1.33	0.5	85	0.10
DEB 1a	53.81891	0.06	1.01	0.2	0.9	0.6	0.32	1	0.19	0.5	85	0.01
SRP 1b	53.81891	0.06	17.72	0.2	0.9	10.3	0.7	1	7.21	0.5	85	0.54
DEB 1c	53.81891	0.06	16.16	0.2	0.9	9.4	0.32	1	3.01	0.5	85	0.23
SRP 2	53.81891	0.06	1.01	0.2	0.9	0.6	0.5	1	0.29	0.5	85	0.02
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3.0	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	3.0	1	134.84	0.5	85	10.11
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01

Sediment Generation Potential 206.55

Estimated Total Net Sediment Loss(tonnes) 15.49

YEAR 6

Operational

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Catchment:	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Work Duration:	1	1	1	1	1	1	1	1	1	1	1
Working Area(ha):	1.2	0.42	0.32	0.7	0.32	0.3	0.5	3	3.6	2.12	0.5

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
%Sand	90	90	90	90	90	90	90	90	90	40	90
%Clay	5	5	5	5	5	5	5	5	5	30	5
%Silt	5	5	5	5	5	5	5	5	5	30	5
% Granular	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06

Slope Length and Steepness Factor(LS)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
Length m	160	140	40	88	68	40	40	240	300	170	130
Slope %	16	14	7	37	37	50	7	35	10.15	15	0.5
LS =	6.8	5.43	1.01	17.72	16.16	21.84	1.01	28.93	2.13	6.27	0.13

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	SRP 4	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13
C =	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 3	53.81891	0.06	6.8	0.2	0.9	4.0	1.2	1	4.74	0.5	85	0.36
SRP 4	53.81891	0.06	5.43	0.2	0.9	3.2	0.42	1	1.33	0.5	85	0.10
DEB 1a	53.81891	0.06	1.01	0.2	0.9	0.6	0.32	1	0.19	0.5	85	0.01
SRP 1b	53.81891	0.06	17.72	0.2	0.9	10.3	0.7	1	7.21	0.5	85	0.54
DEB 1c	53.81891	0.06	16.16	0.2	0.9	9.4	0.32	1	3.01	0.5	85	0.23
SRP 2	53.81891	0.06	1.01	0.2	0.9	0.6	0.5	1	0.29	0.5	85	0.02
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3.0	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	2.1	1	95.29	0.5	85	7.15
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01

Sediment Generation Potential 167.00

Estimated Total Net Sediment Loss(tonnes) 12.53

YEAR 7

Overburden removal **Operational**

Catchment:	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
Work Duration:	0.23	0.19	1	1	1	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.6	0.7	1.2	0.42	0.32	0.7	0.32	0.3	0.5	3	3.6	2.12	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	40	40	90	90	90	90	90	90	90	90	90	40	90	40
%Clay	30	30	5	5	5	5	5	5	5	5	5	30	5	30
%Silt	30	30	5	5	5	5	5	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4	4	4	4
K=	0.37	0.37	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	100	100	160	140	40	88	68	40	40	240	300	170	130	120
Slope %	14	15	16	14	4	18	18	25	4	35	10.15	14	0.5	4
LS =	4.79	4.79	6.8	5.43	0.47	7.07	5.77	7.22	0.47	28.93	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
C =	1	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 5	53.81891	0.37	4.79	1	0.9	85.8	0.6	0.23	11.85	0.5	70	1.78
SRP 6	53.81891	0.37	4.79	1	0.9	85.8	0.7	0.19	11.42	0.5	70	1.71
SRP 3	53.81891	0.06	6.8	0.2	0.9	4.0	1.2	1	4.74	0.5	85	0.36
SRP 4	53.81891	0.06	5.43	0.2	0.9	3.2	0.42	1	1.33	0.5	85	0.10
DEB 1a	53.81891	0.06	0.47	0.2	0.9	0.3	0.32	1	0.09	0.5	85	0.01
SRP 1b	53.81891	0.06	7.07	0.2	0.9	4.1	0.7	1	2.88	0.5	85	0.22
DEB 1c	53.81891	0.06	5.77	0.2	0.9	3.4	0.32	1	1.07	0.5	85	0.08
DEB 1d	53.81891	0.06	7.22	0.2	0.9	4.2	0.3	1	1.26	0.5	85	0.09
SRP 2	53.81891	0.06	0.47	0.2	0.9	0.3	0.5	1	0.14	0.5	85	0.01
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	2.12	1	95.29	0.5	85	7.15
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 189.01

Estimated Total Net Sediment Loss(tonnes) 15.92

YEAR 8 **Operational**

Catchment:	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
Work Duration:	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.6	0.7	1.2	0.42	0.32	0.7	0.32	0.3	0.5	3	3.6	2.12	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	90	90	90	90	90	90	90	90	90	90	90	40	90	40
%Clay	5	5	5	5	5	5	5	5	5	5	5	30	5	30
%Silt	5	5	5	5	5	5	5	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	100	100	160	140	40	88	68	40	40	240	300	170	130	120
Slope %	14	15	16	14	4	18	18	25	4	35	10.15	14	0.5	4
LS =	4.79	4.79	6.8	5.43	0.47	7.07	5.77	7.22	0.47	28.93	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 5	SRP 6	SRP 3	SRP 4	DEB 1a	SRP 1b	DEB 1c	DEB 1d	SRP 2	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
C =	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 5	53.81891	0.06	4.79	0.2	0.9	2.8	0.6	1	1.67	0.5	85	0.13
SRP 6	53.81891	0.06	4.79	0.2	0.9	2.8	0.7	1	1.95	0.5	85	0.15
SRP 3	53.81891	0.06	6.8	0.2	0.9	4.0	1.2	1	4.74	0.5	85	0.36
SRP 4	53.81891	0.06	5.43	0.2	0.9	3.2	0.42	1	1.33	0.5	85	0.10
DEB 1a	53.81891	0.06	0.47	0.2	0.9	0.3	0.32	1	0.09	0.5	85	0.01
SRP 1b	53.81891	0.06	7.07	0.2	0.9	4.1	0.7	1	2.88	0.5	85	0.22
DEB 1c	53.81891	0.06	5.77	0.2	0.9	3.4	0.32	1	1.07	0.5	85	0.08
DEB 1d	53.81891	0.06	7.22	0.2	0.9	4.2	0.3	1	1.26	0.5	85	0.09
SRP 2	53.81891	0.06	0.47	0.2	0.9	0.3	0.5	1	0.14	0.5	85	0.01
SRP 10	53.81891	0.06	28.93	0.2	0.9	16.8	3	1	50.45	0.5	85	3.78
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	2.12	1	95.29	0.5	85	7.15
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 169.37

Estimated Total Net Sediment Loss(tonnes) 12.71

YEAR 9 **Operational**

Catchment:	SRP 5	SRP 6	SRP 3	SRP 4	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
Work Duration:	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.6	0.7	1.2	0.42	3	3.6	2.12	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 5	SRP 6	SRP 3	SRP 4	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	90	90	90	90	90	90	40	90	40
%Clay	5	5	5	5	5	5	30	5	30
%Silt	5	5	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 5	SRP 6	SRP 3	SRP 4	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	100	100	160	140	240	300	170	130	120
Slope %	14	15	16	14	20	10.15	14	0.5	4
LS =	4.79	4.79	6.8	5.43	4.65	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 5	SRP 6	SRP 3	SRP 4	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
C =	1	1	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 5	53.81891	0.06	4.79	1	0.9	13.9	0.6	1	8.35	0.5	85	0.63
SRP 6	53.81891	0.06	4.79	1	0.9	13.9	0.7	1	9.74	0.5	85	0.73
SRP 3	53.81891	0.06	6.8	0.2	0.9	4.0	1.2	1	4.74	0.5	85	0.36
SRP 4	53.81891	0.06	5.43	0.2	0.9	3.2	0.42	1	1.33	0.5	85	0.10
SRP 10	53.81891	0.06	4.65	0.2	0.9	2.7	3	1	8.11	0.5	85	0.61
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	2.12	1	95.29	0.5	85	7.15
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 136.07

Estimated Total Net Sediment Loss(tonnes) 10.21

YEAR 10 **Overburden removal** **Operational**

Catchment:	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
Work Duration:	0.11	0.15	0.05	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.9	1	1.4	0.6	0.7	1.2	0.42	3	3.6	2.12	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	40	40	90	90	90	90	90	90	90	40	40	40
%Clay	30	30	5	5	5	5	5	5	5	30	30	30
%Silt	30	30	5	5	5	5	5	5	5	30	30	30
% Granular	96	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4	4
K=	0.37	0.37	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.37	0.37

Slope Length and Steepness Factor(LS)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	1	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	85	100	85	100	120	160	100	240	300	170	130	120
Slope %	88	15	88	14	25	16	14	20	10.15	15	0.5	4
LS =	61.95	4.79	61.95	4.79	11.79	6.8	4.79	4.65	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 10	SRP 11	SRP 12	DEB 13	SRP 12a
C =	0.6	1	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 7	53.81891	0.37	61.95	0.6	0.9	666.1	0.9	0.11	65.95	0.5	85	4.95
SRP 8	53.81891	0.37	4.79	1	0.9	85.8	1	0.15	12.88	0.5	85	0.97
SRP 9	53.81891	0.06	61.95	0.4	0.9	72.0	1.4	0.05	5.04	0.5	70	0.76
SRP 5	53.81891	0.06	4.79	0.2	0.9	2.8	0.6	1	1.67	0.5	85	0.13
SRP 6	53.81891	0.06	11.79	0.2	0.9	6.9	0.7	1	4.80	0.5	85	0.36
SRP 3	53.81891	0.13	6.8	0.2	0.9	8.6	1.2	1	10.28	0.5	85	0.77
SRP 4	53.81891	0.13	4.79	0.2	0.9	6.0	0.42	1	2.53	0.5	85	0.19
SRP 10	53.81891	0.06	4.65	0.2	0.9	2.7	3	1	8.11	0.5	85	0.61
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	2.12	1	95.29	0.5	85	7.15
DEB 13	53.81891	0.37	0.13	0.2	0.9	0.5	0.5	1	0.23	0.5	65	0.04
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 215.25

Estimated Total Net Sediment Loss(tonnes) 16.54

YEAR 11 Operational

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
Catchment:											
Work Duration:	1	1	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.9	1	1.4	0.6	0.7	1.2	0.42	3.6	1.21	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	90	90	90	90	90	90	90	90	40	90	40
%Clay	5	5	5	5	5	5	5	5	30	5	30
%Silt	5	5	5	5	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	85	100	85	100	120	160	100	300	170	130	120
Slope %	88	15	88	14	25	16	14	10.15	15	0.5	4
LS =	61.95	4.79	61.95	4.79	11.79	6.8	4.79	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
C =	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 7	53.81891	0.06	61.95	0.2	0.9	36.0	0.9	1	32.41	0.5	85	2.43
SRP 8	53.81891	0.06	4.79	0.2	0.9	2.8	1	1	2.78	0.5	85	0.21
SRP 9	53.81891	0.06	61.95	0.2	0.9	36.0	1.4	1	50.41	0.5	70	7.56
SRP 5	53.81891	0.06	4.79	0.2	0.9	2.8	0.6	1	1.67	0.5	85	0.13
SRP 6	53.81891	0.06	11.79	0.2	0.9	6.9	0.7	1	4.80	0.5	85	0.36
SRP 3	53.81891	0.13	6.8	0.2	0.9	8.6	1.2	1	10.28	0.5	85	0.77
SRP 4	53.81891	0.13	4.79	0.2	0.9	6.0	0.42	1	2.53	0.5	85	0.19
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	1.21	1	54.39	0.5	85	4.08
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 167.78

Estimated Total Net Sediment Loss(tonnes) 16.37

YEAR 12 Operational

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
Catchment:											
Work Duration:	1	1	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.9	1	1.4	0.6	0.7	1.2	0.42	3.6	1.21	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	90	90	90	90	90	90	90	90	40	90	40
%Clay	5	5	5	5	5	5	5	5	30	5	30
%Silt	5	5	5	5	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	85	100	85	100	120	160	100	300	170	130	120
Slope %	88	15	88	14	25	16	14	10.15	15	0.5	4
LS =	61.95	4.79	61.95	4.79	11.79	6.8	4.79	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 3	SRP 4	SRP 11	SRP 12	DEB 13	SRP 12a
C =	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section	USLE Parameters R	K	LS	C	P	A Soil Loss	Area(ha)	Works Duration	Est Gross Sediment	Sediment Delivery	Sediment Control	Net Sediment
SRP 7	53.81891	0.06	61.95	0.2	0.9	36.0	0.9	1	32.41	0.5	85	2.43
SRP 8	53.81891	0.06	4.79	0.2	0.9	2.8	1	1	2.78	0.5	85	0.21
SRP 9	53.81891	0.06	61.95	0.2	0.9	36.0	1.4	1	50.41	0.5	70	7.56
SRP 5	53.81891	0.06	4.79	0.2	0.9	2.8	0.6	1	1.67	0.5	85	0.13
SRP 6	53.81891	0.06	11.79	0.2	0.9	6.9	0.7	1	4.80	0.5	85	0.36
SRP 3	53.81891	0.13	6.8	0.2	0.9	8.6	1.2	1	10.28	0.5	85	0.77
SRP 4	53.81891	0.13	4.79	0.2	0.9	6.0	0.42	1	2.53	0.5	85	0.19
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	1.21	1	54.39	0.5	85	4.08
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 167.78

Estimated Total Net Sediment Loss(tonnes) 16.37

YEAR 13 Operational

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
Catchment:									
Work Duration:	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.9	1	1.4	0.6	0.7	3.6	1.21	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	90	90	90	90	90	90	40	90	40
%Clay	5	5	5	5	5	5	30	5	30
%Silt	5	5	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	85	100	85	100	120	300	170	130	120
Slope %	88	15	88	14	25	10.15	15	0.5	4
LS =	61.95	4.79	61.95	4.79	11.79	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
C =	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section			USLE Parameters			A Soil	Area(ha)	Works	Est Gross	Sediment	Sediment	Net
	R	K	LS	C	P	Loss		Duration	Sediment	Delivery	Control	Sediment
SRP 7	53.81891	0.06	61.95	0.2	0.9	36.0	0.9	1	32.41	0.5	85	2.43
SRP 8	53.81891	0.06	4.79	0.2	0.9	2.8	1	1	2.78	0.5	85	0.21
SRP 9	53.81891	0.06	61.95	0.2	0.9	36.0	1.4	1	50.41	0.5	70	7.56
SRP 5	53.81891	0.06	4.79	0.2	0.9	2.8	0.6	1	1.67	0.5	85	0.13
SRP 6	53.81891	0.06	11.79	0.2	0.9	6.9	0.7	1	4.80	0.5	85	0.36
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	1.21	1	54.39	0.5	85	4.08
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 154.97

Estimated Total Net Sediment Loss(tonnes) 15.41

YEAR 14

Operational

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
Catchment:									
Work Duration:	1	1	1	1	1	1	1	1	1
Working Area(ha):	0.9	1	1.4	0.6	0.7	3.6	1.21	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	90	90	90	90	90	90	40	90	40
%Clay	5	5	5	5	5	5	30	5	30
%Silt	5	5	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	85	100	85	100	120	300	170	130	120
Slope %	40	7	40	14	25	10.15	15	0.5	4
LS =	20.02	1.54	20.2	4.79	11.79	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

	SRP 7	SRP 8	SRP 9	SRP 5	SRP 6	SRP 11	SRP 12	DEB 13	SRP 12a
C =	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section			USLE Parameters			A Soil	Area(ha)	Works	Est Gross	Sediment	Sediment	Net
	R	K	LS	C	P	Loss		Duration	Sediment	Delivery	Control	Sediment
SRP 7	53.81891	0.06	20.02	0.2	0.9	11.6	0.9	1	10.47	0.5	85	0.79
SRP 8	53.81891	0.06	1.54	0.2	0.9	0.9	1	1	0.90	0.5	85	0.07
SRP 9	53.81891	0.06	20.2	0.2	0.9	11.7	1.4	1	16.44	0.5	70	2.47
SRP 5	53.81891	0.06	4.79	0.2	0.9	2.8	0.6	1	1.67	0.5	85	0.13
SRP 6	53.81891	0.06	11.79	0.2	0.9	6.9	0.7	1	4.80	0.5	85	0.36
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	1.21	1	54.39	0.5	85	4.08
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 97.17

Estimated Total Net Sediment Loss(tonnes) 8.52

YEAR 15

Operational

	SRP 7	SRP 8	SRP 9	SRP 11	SRP 12	DEB 13	SRP 12a
Catchment:							
Work Duration:	1	1	1	1	1	1	1
Working Area(ha):	0.9	1	1.4	3.6	1.21	0.5	0.8

Working Equation A = R x K x LS x C x P R x K x LS x C x P where A = soil loss(tonnes/ha/year)

Rainfall Erosion Index (R)

R = $0.000828(P)^{2.2}1.7$ where: 6hr 2yr Rainfall Event P= 42.5 mm

R = 53.81891

Soil Erobability Index(K) (From triangular Nomograph)

	SRP 7	SRP 8	SRP 9	SRP 11	SRP 12	DEB 13	SRP 12a
%Sand	90	90	90	90	40	90	40
%Clay	5	5	5	5	30	5	30
%Silt	5	5	5	5	30	5	30
% Granular	96	96	96	96	96	96	96
%Organic	4	4	4	4	4	4	4
K=	0.06	0.06	0.06	0.06	0.37	0.06	0.37

Slope Length and Steepness Factor(LS)

	SRP 7	SRP 8	SRP 9	SRP 11	SRP 12	DEB 13	SRP 12a
Length m	85	100	85	300	170	130	120
Slope %	40	7	40	10.15	15	0.5	4
LS =	20.02	1.54	20.2	2.13	6.27	0.13	0.7

Vegetation cover factor and Erosion control Practise(C and P)

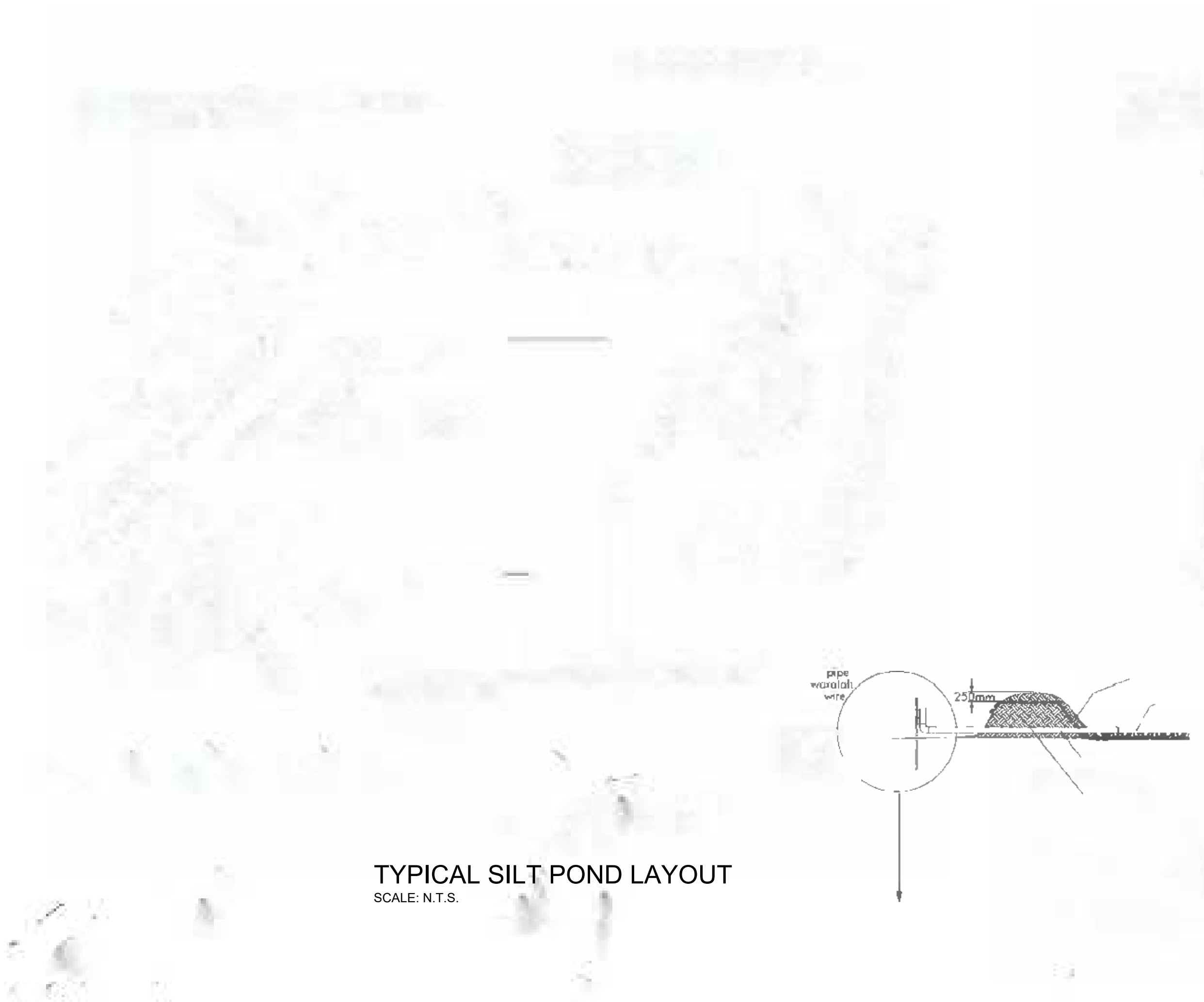
	SRP 7	SRP 8	SRP 9	SRP 11	SRP 12	DEB 13	SRP 12a
C =	0.2	0.2	0.2	0.2	0.4	0.2	0.4
P =	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Section			USLE Parameters			A Soil	Area(ha)	Works	Est Gross	Sediment	Sediment	Net
	R	K	LS	C	P	Loss		Duration	Sediment	Delivery	Control	Sediment
SRP 7	53.81891	0.06	20.02	0.2	0.9	11.6	0.9	1	10.47	0.5	85	0.79
SRP 8	53.81891	0.06	1.54	0.2	0.9	0.9	1	1	0.90	0.5	85	0.07
SRP 9	53.81891	0.06	20.2	0.2	0.9	11.7	1.4	1	16.44	0.5	70	2.47
SRP 11	53.81891	0.06	2.13	0.2	0.9	1.2	3.6	1	4.46	0.5	85	0.33
SRP 12	53.81891	0.37	6.27	0.4	0.9	44.9	1.21	1	54.39	0.5	85	4.08
DEB 13	53.81891	0.06	0.13	0.2	0.9	0.1	0.5	1	0.04	0.5	65	0.01
SRP 12a	53.81891	0.37	0.7	0.4	0.9	5.0	0.8	1	4.01	0.5	85	0.30

Sediment Generation Potential 90.70

Estimated Total Net Sediment Loss(tonnes) 8.04

Appendix B

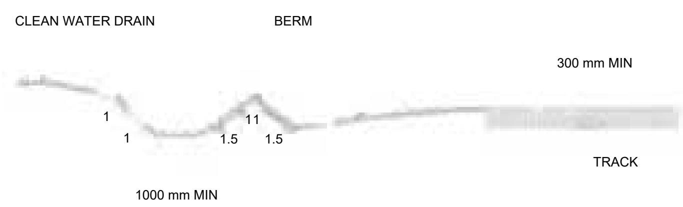


TYPICAL SILT POND LAYOUT
SCALE: N.T.S.

DECANTING EARTH BUND
SCALE: N.T.S.

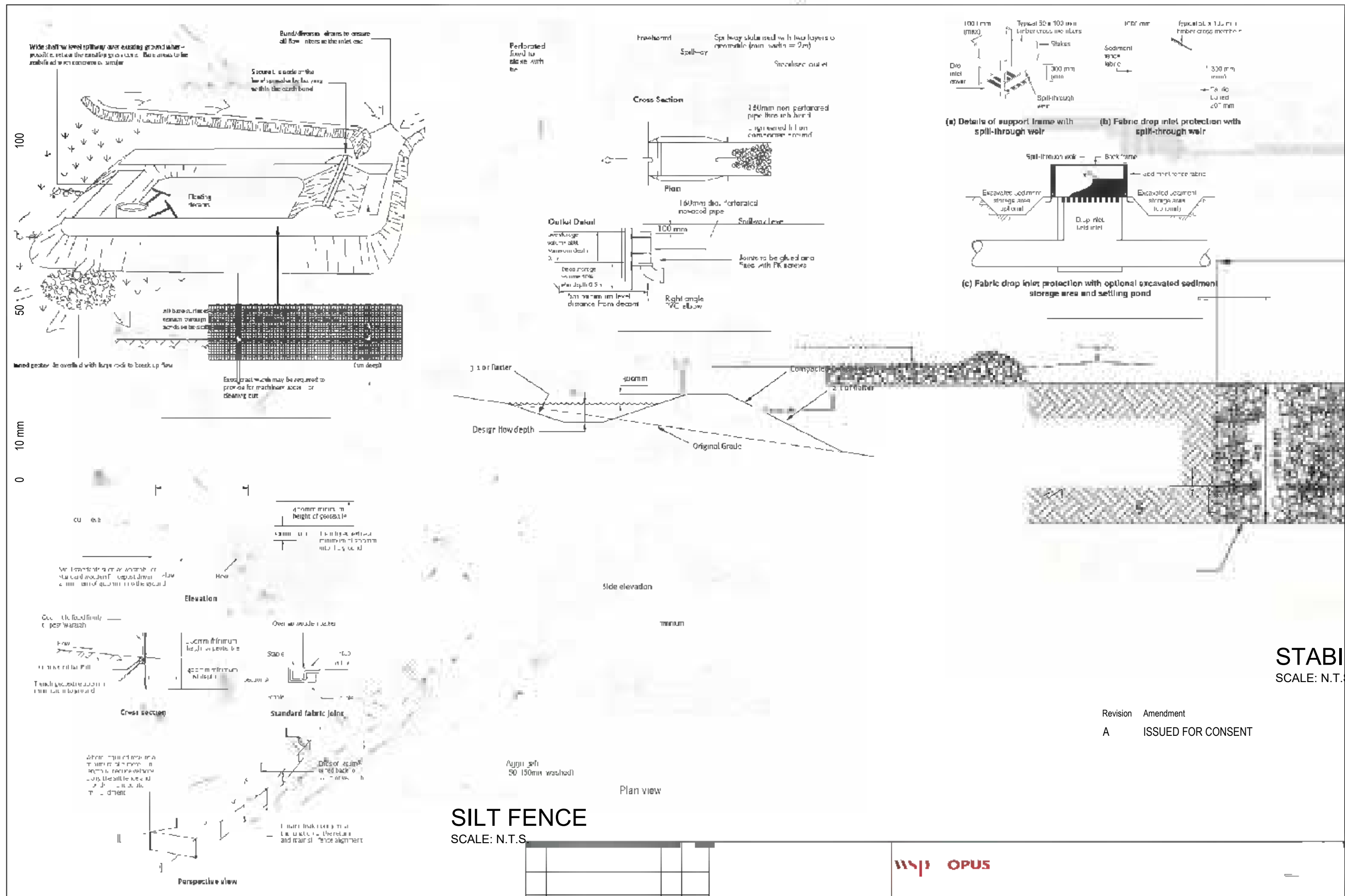
DROP INLET PROTECTION
SCALE: N.T.S.

DIRTY WATER DIVERSION BUND
SCALE: N.T.S.

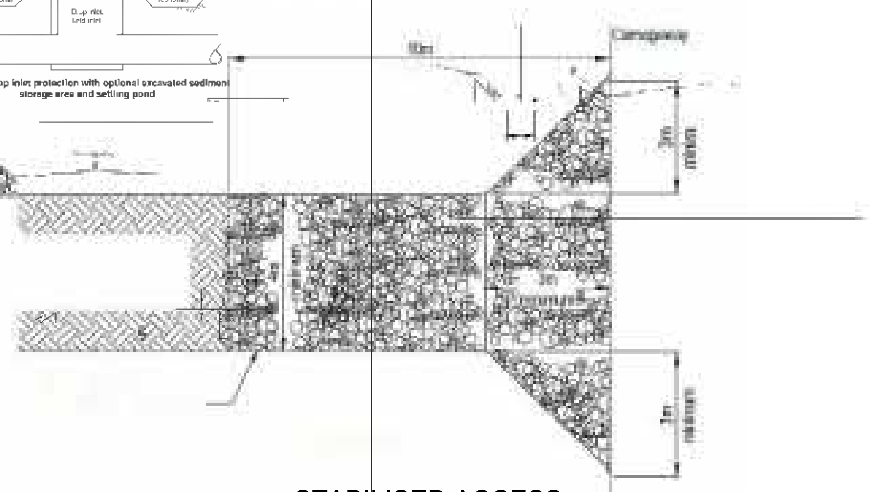


CENTRAL CLEAN WATER DRAIN AND BERM
SCALE: N.T.S.

2m MAXIMUM



SILT FENCE
SCALE: N.T.S.



STABILISED ACCESS
SCALE: N.T.S.

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR CONSENT		20/07/2018

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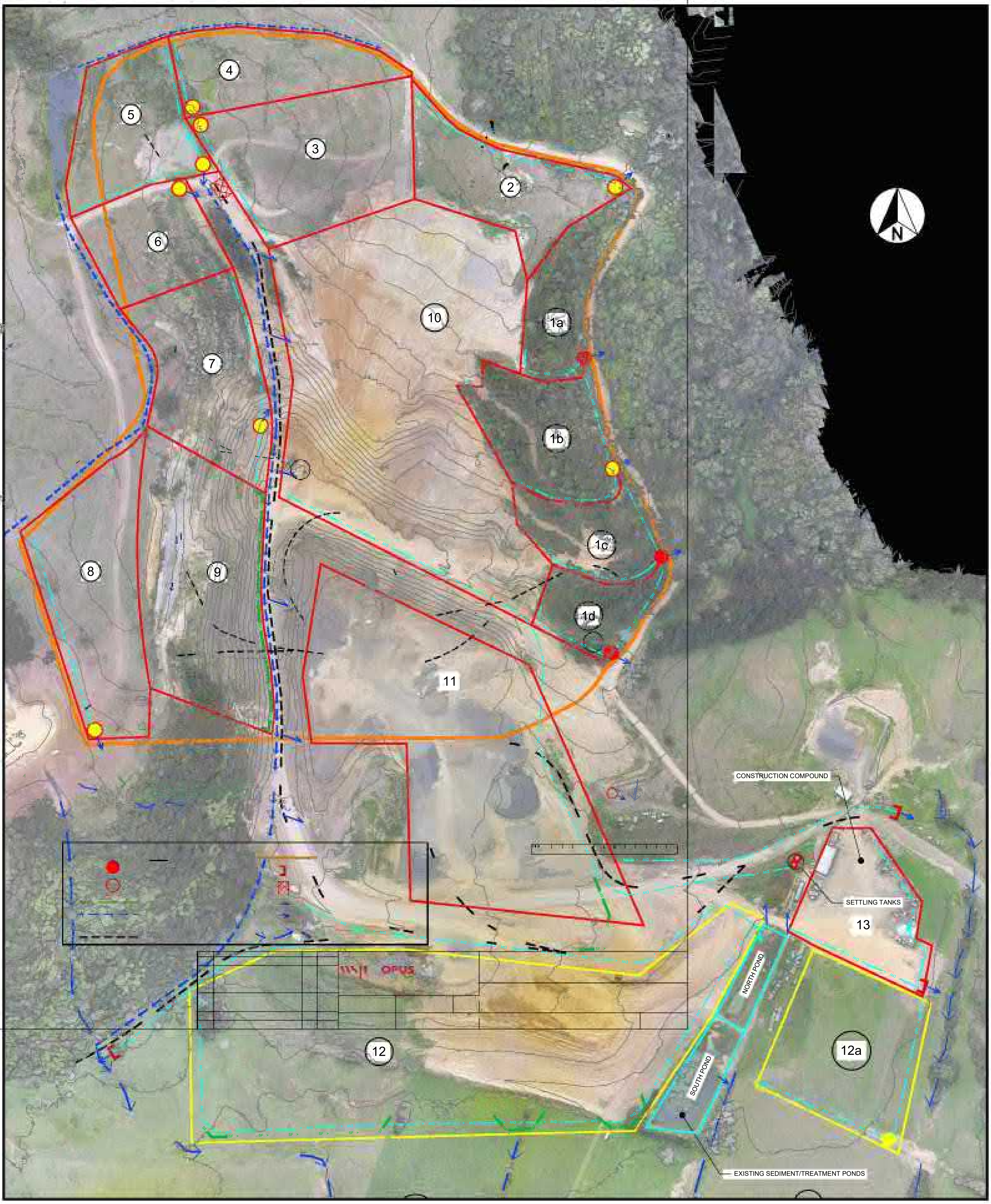
Designed: ANDREW BOLDERO
Approved
Approved Date
Drawn: S.A
Scales: 1:2000(A1) 1:4000(A3)

Project
McPHERSON RESOURCES LTD
McPHERSON QUARRY
POKENO

Sheet
ESCP
EROSION AND SEDIMENT CONTROL DETAILS

Project No.: 3-39019.00
Sheet. No.: C22
Revision: ----

Original Sheet Size A1 [841x594] Plot Date 2018-08-24 at 10:12:58 AM Path O:\env\heavy_industry\mcpherson_quarry\dwgs\3-39019.00 quarry\(C) Civil+Civil3D\3-39019.00-C02_ESCP DETAILS.dwg C22



KEY

DECANTING EARTH BUND
SEDIMENT RETENTION POND
SILT FENCE
CLEAN WATER DIVERSION
DIRTY WATER DIVERSION
HAUL ROUTE
STAGE 1 BOUNDARY
U SHAPED SEDIMENT TRAP
STABILISED ACCESS
WATER CUT OFF DRAIN
SRP/DEB OUTLET
WATER COURSE

DRAWING IN PROGRESS
PLOTTED ON 2018-8-23 AT 9:54 AM

Revision	Amendment	Approved	Revision Date

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Project: McPHERSON RESOURCES LTD
McPHERSON QUARRY
POKENO

Sheet: ESCP
STAGE 1

Designed | Approved | Approved Date
Drawn | Scales | Project No. 3-39019.00 | Sheet No. C20 | Revision A

Original Sheet Size A1 [841x594] Plot Date 2018-08-23 at 9:54:19 AM Path O:\env\heavy_industry\mcpherson_quarry\dwgs\3-39019.00 quarry\(C) Civil+Civil3D\3-39019.00-C01_ESCP.dwg stage 1

Appendix C

U-Shaped Sediment Traps

SEDIMENT CONTROL TECHNIQUE

Photo supplied by Catchments & Creeks Pty Ltd

Photo 1 – U-shaped sediment trap within a wide drainage swale

Key Principles

1. Primarily used to collect the coarser sedime… sized particles and thus there is usually r… passing through the fence.
2. Functions by temporarily ponding sediment… coarser sediment particles to settle.
3. Critical design parameters are the design flo… spill-through weir, and the shape and fall of… width of the sediment trap.
4. It is critical that the ends of each wing wal… 100mm) than the crest elevation of the spill-t…
5. When located within a table drain, the a… governed by restrictions placed on the loca… Typically, it is not advisable to disturb the co… of a sediment fence, or the placement of… allowed. In such cases, a sandbag flow div… narrow U-shaped sediment trap (refer to Figu…
6. Critical operational issues include:
   (i) ensuring the width of the sediment trap is…
   (ii) ensuring all flow is directed into the sedim…

Design of spill-through weir

Where appropriate, spill-through weirs should be
prevent flows bypassing around the structure, an

The required width (W) of the spill-through weir d
weir flow equation for a rectangular spill-through
as being tabulated in Table 2.

Q =

where: Q = Design flow rate (usually 0.5 time
W = Weir width [m]
H = Hydraulic head = height of upstre

Table 2 — Flow rates passing o

Hydraulic head, H (m)	Spill-throu				
	0.3	0.5	1.0	1.5	
0.10	0.016	0.027	0.054	0.081	0
0.15	0.030	0.049	0.099	0.148	0
0.20	0.046	0.076	0.152	0.228	0
0.25	0.064	0.106	0.213	0.319	0
0.30	0.084	0.140	0.279	0.419	0
0.35	0.106	0.176	0.352	0.528	0
0.40	0.129	0.215	0.430	0.645	0

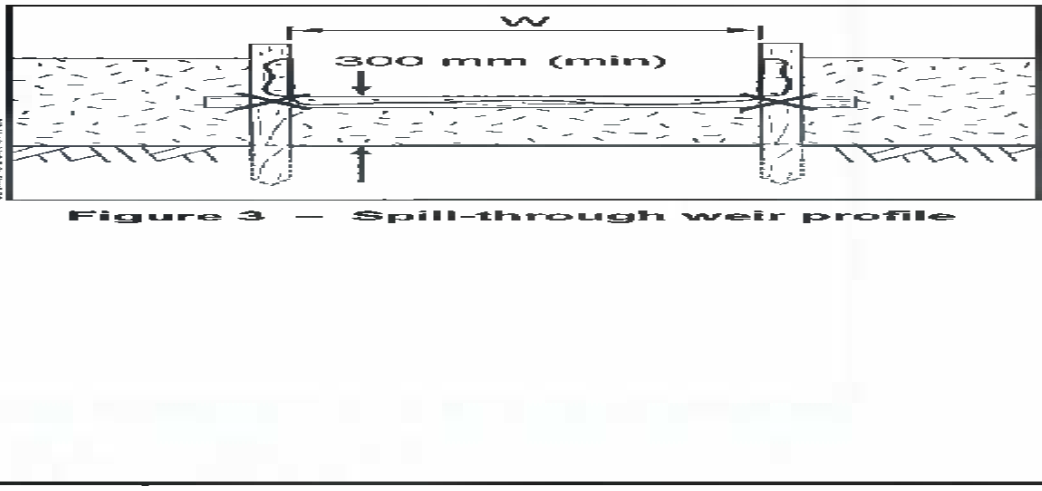
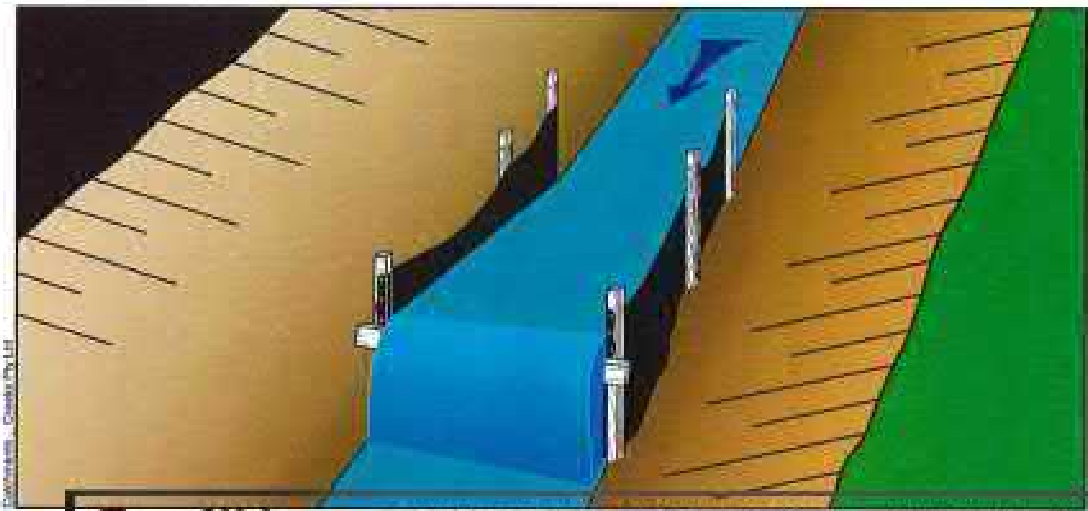


Figure 3 — Spill-through weir profile



… sediment traps (Figure 6) use the fall in the height of the spill-through …

Type AU (narrow) … of each wing w… Figure 6 — Type AU sediment …

Type BU (wide) sediment traps (Figure 7) use the gradient of … ends of each wing wall above the height of the spill-through weir

Figure 7 — Type B…

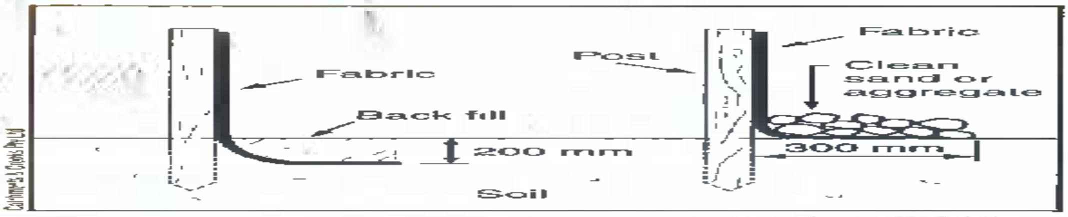
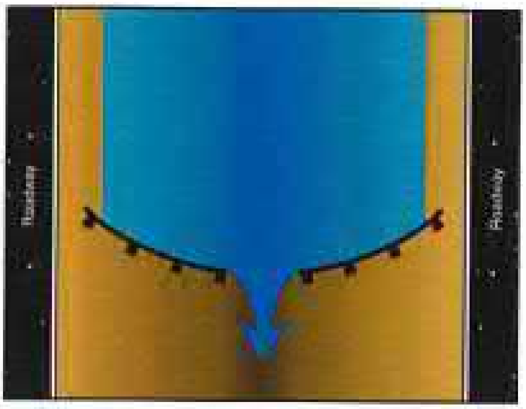
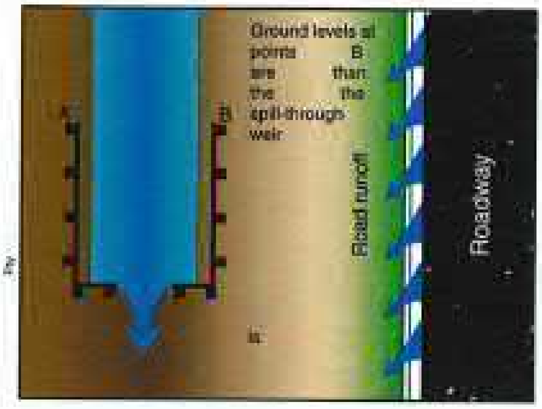


Figure 8 — Trenching fabric …





placed
sediment
lled
ould not by

incorporating
outlet chute
formed from

Photo 5 — U-shaped sediment trap within a steep table drain

Description

A sediment trap formed from typical sediment fence materials, but heavily curved in a U-shape.

The sediment trap is designed such that the essential 'ponding' is confined between the two wing walls of the sediment trap.

Purpose

Used as a coarse trap sediment within minor drainage swales and roadside table drains.

Limitations

Application is generally limited to steep drains with a gradient exceeding 5%.

The design flow rate is limited by the available width of the spill-through weir.

Potential service life of around 6 months.

Advantages

Reasonably easy to install.

Controls sediment runoff close to the source of the erosion.

A highly visible sediment control measure.

Generally more effective, durable and cheaper than straw bale sediment traps.

Disadvantages

The spill-through weir is often incorrectly installed.

Can be difficult to appropriately bury the bottom of the fabric within the shoulder of the road.

Common Problems

Often incorrectly installed in a 'straight' alignment instead of a U-shape.

Ends of the fence not turned up the slope to prevent flow bypassing

The spill-through weir is set too low (<300mm), or not placed within the low point of the fence.

Excessive spacing of support posts.

Fabric not adequately attached to the support posts.

Special Requirements

The crest of the spill-through weir must be at least 300mm high, and must be below the ground level at the ends of the wing walls.