



# **GUIDELINES ON LAND DISTURBING POLLUTION PREVENTION AND MITIGATION MEASURES (LD-P2M2)**



Department of Environment  
Ministry of Natural Resources and Environment  
Malaysia

## **Department of Environment, Malaysia**

Copyright 2017 DOE

This publication may be reproduced in whole or in part and in any form for educational or non-profit purpose without special permission from the copyright holder; provide acknowledgement of the source is made and a copy is sent to the Department of Environment. No use of this publication may be made for resale or any other commercial purpose whatsoever without prior permission in writing from the Department of Environment.

ISBN 978-983-3895-58-8

### **Design and printed by**

POLO ENTERPRISE

16, Block B, Jalan 17/1A,

46400 Petaling Jaya,

Selangor Darul Ehsan

Tel: 03-79574116

Email: poloent99@gmail.com

## **ACKNOWLEDGEMENT**

This guidelines is based on research conducted on the Land-Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2). The Consultant would like to express the utmost gratitude and appreciation to the Technical Committee which includes,

Jabatan Pengairan dan Saliran Malaysia

Jabatan Alam Sekitar Malaysia

Environment Institute of Malaysia (EiMAS)

for their cooperation and contribution throughout the study. Finally, the consultant would like to thank the bodies and individuals who assisted the work of the consultant with submissions and information.

## PREFACE

Indiscriminate discharge of sediment-laden waters into rivers and drainage is becoming frequent in Malaysia, and at times, resulting in flash floods which affect many sectors of our society causing public nuisance, property damage, injuries and at worst, fatalities in some cases. It is not uncommon nowadays to read in the media reports of traffic disruptions as well as submerged vehicles, temporary shutdown of water treatment plants, and increased sedimentation in rivers. This definitely will incur cost to the public as well as the Government.

One of the main contributors of these sediment-laden discharge waters is from the land disturbing activities at our development project sites, due to uncontrolled or ineffective management of erosion and sediment control measures. Looking ahead, emerging mega projects such as mass rapid transport, highways, high speed rails, agricultural development, hydroelectric dams, transmission lines, landfill, conversion of forest area, industrial estate development, mining and housing development that are currently ongoing or will be implemented soon will require more effective measures in dealing with erosion and sedimentation issues. This will need a concerted effort by all stakeholders, specifically the relevant project players such as project proponents, EIA consultants, designers, contractors, subcontractors, environmental officers, relevant government agencies and other supply chain.

In the last decade, the Department of Environment Malaysia has been striving to resolve the issues of erosion and sediment problems through the issuing of *Guidelines for Prevention and Control of Soil Erosion and Siltation in Malaysia 1996*, and *2<sup>nd</sup> Edition 2008* as well as legal venue through the *Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015* and *Section 34A of Environmental Quality Act 2012*. Of late, the Department of Environment has promoted and recognized competencies in erosion and sediment control Inspectors/Designers programmes developed by United States organisations, namely Certified Professional in Erosion and Sediment Control (CPESC- EnviroCert Inc.) and Certified in Erosion, Sediment and Stormwater Inspector (CESSWI - EnviroCert Inc.), and Certified Inspector in Sediment and Erosion Control (CISEC – CISEC Inc.).

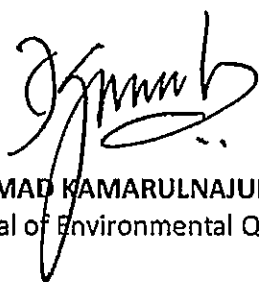
Recently, the Department of Environment (DOE) has embarked on a programme entitled “Guided Self-Regulation” (GSR), accompanied by the issuance of a set of environmental mainstreaming (EM) tools to be implemented in the organizations and industrial premises. It is DOE’s aspiration that these regulated sectors are “taken by the hand”, so to speak, towards achieving the goal of self-regulation through the infusion of environmental agenda at all levels of the organizational structure in these sectors, whereby environment is taken seriously by the top management of all companies and promulgating into collaborative efforts from all key personnel in the organization playing their role in an effective manner. This seriousness is then translated into policies, action plans, procedures, codes of practice and condition of approval, which are also aggressively implemented, resulting in a culture where environmental considerations are no longer purely because of regulatory pressures but because of internal belief and value system. Ultimately, the culture of self-regulation not only enhances regulatory compliance, but paves the way for pride in environmental excellence. Environmental Competency (EC) is one of the EM tools that covers the aforementioned competency programmes in the context of land disturbing

pollution prevention and mitigation measures focusing on erosion and sediment control, so as to demonstrate self-regulation in any project sites, and at the same time, representing a change agent to DOE.

At the present moment, this *Guidelines on Land Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2)* has been prepared primarily for the application into development projects that are classified as “Prescribed Activity” under the latest *Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015* enforceable under *Section 34A of Environmental Quality Act 1974 (Act 127)*.

The *Guidelines* is intended to guide the project players in their respective roles in the planning and management of erosion and sediment issues from construction project sites, by preventing, controlling and minimizing the effects from land disturbing activities in project sites. Nonetheless, it may also be beneficial to others who are concerned with environmental issues that may come from the general public, non-governmental organizations (NGOs), politicians, educational institutions in Malaysia. Benefits of this *Guidelines* are generally summarized as follows:

- Project Players:* Enhances the understanding of root issues contributing to erosion and sediment problems during land disturbing activities, and prescribes the procedures to be adopted by each party to control & manage these issues;
- Government Agencies:* Provides a common platform for Agencies’ use through National Blue Ocean Strategy for possible collaboration in dealing with erosion and sedimentation issues nationwide.
- Higher Institutions:* Promotes the initiative on more research & development (R&D) into resolving erosion and sediment issues in future construction practices;
- Political Arena:* Assists in emphasis on policy making or strengthening to address erosion and sediment issues nationally;
- NGOs:* Encourages wider collaboration with project stakeholders in the protection of the environment as well as the interests of affected receptors;
- Educational Institutions:* Raises the general environmental awareness of the younger population;
- General Public:* Contains broad information on the wide-reaching impacts of poorly managed land disturbing activities;



(DATO' DR.AHMAD KAMARULNAJUIB BIN CHE IBRAHIM)  
Director General of Environmental Quality  
Malaysia

## BACKGROUND

There has been an increase in concern with regard to soil erosion issues which resulted in sedimentation and deterioration of river water quality due to earthwork activities of development projects. The deterioration of river water quality brought about by soil erosion originating from surface water runoff, erosion and sedimentation requires more effective prevention and mitigation measures in the construction practices. In the context of current regulations, fundamental prevention practices which are more effective are needed to control pollution caused by surface runoff, erosion and sedimentation.

The effect of surface runoff resulting in soil erosion and sedimentation on the environment has long been one of the agenda of concern in Malaysia, particularly to the Department of Environment (DOE) which is entrusted with the task of ensuring a sustainable development. A review of the existing guidelines for the prevention and control of surface runoff, soil erosion and sedimentation is therefore timely and to be enhanced with pollution controls which are more practical and effective.

The first formal document to assist planners, practitioners and developers to control erosion was prepared by the DOE in 1978. The guidelines which were formulated at that time were produced to address the issues of surface runoff, erosion and sedimentation.

In 1992, various Government departmental agencies and academic institutions were called upon to identify activities that could cause erosion and sedimentation and to recommend measures to check these issues. The DOE Guidelines (1978) were reviewed and a new document entitled “Guidelines for the Prevention and Control of Soil Erosion and Siltation” was produced in 1978. It contained most of the 1978 guidelines together with additional new methodologies for the prevention of erosion.

Between 1994 and early 1996, the DOE produced guidelines relating to the preparation of environmental impact assessments (EIA) for each of the 19 prescribed activities listed in the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. Each of these documents contains general guidelines pertaining to the control of erosion and sedimentation.

Under the “Teras ke-4 RMKe-11” i.e., “Heading Toward Green Growth in the Main Focus Field (BFU) in Climate Change/Environment”, the Government has approved an allocation to execute the Strengthening Environmental Sustainability project (Project Code: P23072004114001) for 2016 and 2017. One of the project scopes which the DOE will need to execute is on Strengthening in Execution of EIA Procedures in Malaysia under Environmental Quality Act 1974 (Amendment 2012): Formation of Environmental Guidelines: Guidelines on Erosion and Sedimentation.

In connection with the DOE’s effort to foster the culture of self-regulation in the regulated sectors, mainstreaming the environmental agenda represents an important element in all the procedures executed by the DOE, including the EIA procedures. From the EIA perspective,

*environment mainstreaming* ought to be internalized and executed in all fields which are related with the development of EIA projects such as, in all levels of the developer's project organization structure; in all levels of the process development making project decision; and in all levels during project development phases (planning, construction and operation). Consideration, specification and details that are contained in this Guidelines are consistent with the mainstreaming spirit underlined in the latest EIA Guidelines.

In view of the above, this *Guidelines on Land Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2)* has been produced to introduce erosion and sedimentation control measures which are practical and effective to protect river water quality and to minimize the degradation and deterioration of the environment due to earthworks activities.

## AIM OF GUIDELINES

The *Guidelines on LD-P2M2* is a document to identify, cover and address matters relating to the prevention, mitigation and control of the discharge from the development area containing the major pollutant (suspended solids) resulting from land disturbing activities in an EIA project.

The *Guidelines on LD-P2M2* has been prepared to improve on the “*Guidelines For Prevention and Control of Soil Erosion and Siltation in Malaysia*” (DOE, Nov 2008), as well as to provide more details and understanding on the referred *LD-P2M2 Document* required for the submission of EIA Report and EMP.

The main purpose of this *Guidelines* is to integrate the established erosion and sedimentation control measures with the principles, techniques and methods in the execution of earthwork activities for developmental projects by controlling, preventing and minimizing the effect of pollution from erosion and sedimentation.

This *Guidelines* represents one of the efforts of environmental mainstreaming towards ensuring environmental sustainability.

As mentioned above, this *Guidelines* is not meant to replace but to enhance the existing guidelines/documents (*Manual Panduan Pemeriksaan BMPs (Best Management Practices) Untuk Kawalan Hakisan and Sedimen*, and *Guidelines For Prevention and Control of Soil Erosion and Siltation in Malaysia*), and to complement the existing methods that are currently being used by the relevant project parties.

This *Guidelines* aims to explain the usage and application of pollution prevention and mitigation measures prior to and during land disturbing activities, for the purposes of complying with the prescribed EIA Conditions of Approval.

## GUIDELINES USAGE

At the moment, the *Guidelines* has been prepared primarily for the application into development projects that are classified as Prescribed Activity under the latest Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015.

The proposed *Guidelines* is mainly intended to be used for the preparation of EIA Reports/Environmental Management Plans, as well as a tool for field inspection of EIA projects. The document has been prepared for a wide audience who are involved in land development planning, implementation and assessment, including Federal and State Government Departmental and Agency staff, as well as for the private sector including planners, developers, contractors and sub-contractors.

It is envisioned that this *Guidelines* is able to enhance the understanding of the DOE officers when undertaking assessment of information related to document, maps and drawings associated with project execution.

Additionally, the *Guidelines* aims to assist the project proponents and EIA consultants in the understanding of LD-P2M2, as well as in the preparation of the LD-P2M2 Document. It also standardizes the format of the LD-P2M2 Document that is required to be submitted at the EIA stage, and which includes maps, plans and drawings, information required and procedures for LD-P2M2 submission. Last but not least, this *Guidelines* should also assist the project proponent personnel, especially the Environment Officer in the supervision of the overall implementation of the LD-P2M2.

The chapters in this *Guidelines* are arranged in a logical sequence to explain the successive steps necessary to control and manage erosion and sedimentation problems.

**Chapter 1** gives an introduction on *what LD-P2M2 is* and the *driving forces behind the need for LD-P2M2*.

**Chapter 2** then presents the basic fundamentals of erosion and BMPs, including amongst others, *a summary of the existing Malaysian laws and regulation which encapsulate the requirements for controlling erosion and sediment in project sites; an understanding of the processes of erosion and sedimentation and highlights their resulted impacts; and the current methods used in quantifying and prediction of potential soil losses from land disturbing activities of development projects*. Additionally, *a discussion on the possible types of BMPs that are applicable in Malaysia* is also included in this chapter.

**Chapter 3** subsequently highlights a *list of potential land disturbing activities with selected examples*, whilst **Chapter 4** provides the readers with a basic understanding of *project implementation characteristics including the identification of project phases, project components, work breakdown structures, and work scheduling, staging & sequencing*.

**Chapter 5** discusses the aspects of project implementation including *techniques to apply the mitigation measures into the phases of the construction and the methodology for preparing a LD-P2M2 document* in accordance to DOE's requirements.

Lastly **Chapter 6** covers *IIM (Inspect, Install, Maintain); Compliance Monitoring, Impact Monitoring, Performance Monitoring; Reporting & Documentation; and Environmental Auditing*.

## CONTENT

	<b>PAGE</b>
<b>TABLE OF CONTENTS</b>	<b>i</b>
<b>LIST OF TABLES</b>	<b>vii</b>
<b>LIST OF FIGURES</b>	<b>viii</b>
<b>LIST OF APPENDICES</b>	<b>x</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1-1</b>
1.1 WHAT IS LD-P2M2 & LD-P2M2 DOCUMENT	1-1
1.2 WHY IS LD-P2M2 NEEDED	1-3
1.2.1 Environmental Quality Act (EQA)	1-3
1.2.2 Teras ke-4 RMKe-11	1-4
1.2.3 Self-Regulation	1-4
1.2.4 New EIA Guidelines	1-4
1.2.5 Loss of Amenity	1-6
1.2.6 Public Interest and Awareness	1-12
1.2.7 Remedy Costs	1-16
1.2.8 Project Concerns	1-17
1.2.9 Best Available Technologies (BAT)	1-19
1.2.10 JPS & ESCP	1-19
1.3 WHEN IS LD-P2M2 REQUIRED?	1-20
1.4 FRAMEWORK OF THIS GUIDELINES	1-24
<b>CHAPTER 2 FUNDAMENTALS OF EROSION AND BMPS</b>	<b>2-1</b>
2.1 LAWS, REGULATION AND OTHER GUIDELINES ON EROSION AND SEDIMENT	2-1
2.1.1 Environmental Quality Act (Amendment) 2012	2-1
2.1.2 Environmental Impact Assessment Guideline in Malaysia, 2016	2-1
2.1.3 Guidelines for Prevention and Control of Soil Erosion and Siltation in Malaysia, DOE, 1996	2-3
2.1.4 Certified Erosion, Sediment and Storm Water Inspector Manual, US Version, EnviroCert International, Inc., November 2011	2-4
2.1.5 Erosion and Sediment Control Planning and Design Manual, North Carolina Department of Environment and Natural Resources, 2013	2-5
2.1.6 Chapter 12 Erosion and Sediment Control, Manual Saliran Mesra Alam (MSMA), JPS, 2012	2-5
2.1.7 Summary	2-6
2.2 UNDERSTANDING EROSION	2-7
2.2.1 Erosion	2-7

	2.2.2 Sedimentation	2-8
2.3	ISSUES OF EROSION AND SEDIMENT	2-9
	2.3.1 Coordination & Communication	2-10
	2.3.2 Command & Control	2-11
	2.3.3 Issue of work program	2-11
	2.3.4 Construction activity	2-11
	2.3.5 Construction schedule	2-12
	2.3.6 Construction methodology (Method statement)	2-12
	2.3.7 Issue of planning	2-12
	2.3.8 Issue of work stages and project phasing	2-13
	2.3.9 Issue of work sequence	2-13
	2.3.10 Issue of site possession	2-13
	2.3.11 Issue of river/stream diversion	2-14
	2.3.12 Issue of river/stream crossing	2-14
	2.3.13 Issue of capacity building and logistic (physical/financial/fund)	2-14
	2.3.14 Issue of cost and benefit analyses (double handling and timeline)	2-14
	2.3.15 Issue of upholding Code of Practice in Earthwork	2-15
	2.3.16 Issue of construction (earthwork) team	2-15
	2.3.17 Issue of design change	2-15
	2.3.18 Issue of designer/preparer not the supervising consultant	2-16
	2.3.19 BMPs stocking	2-16
	2.3.20 Environment Officer level of authority	2-16
	2.3.21 BMPs not in place	2-17
2.4	CULTURE OF OUR CONSTRUCTION INDUSTRY	2-17
	2.4.1 Parties Contributing to Erosion and Sediment	2-18
	2.4.2 Perception of Project Parties	2-19
2.5	QUANTIFYING AND PREDICTING SOIL LOSS	2-19
2.6	FUNDAMENTALS OF BEST MANAGEMENT PRACTICES (BMPS)	2-19
	2.6.1 Basic Principles & Requirement	2-19
	2.6.2 Standards and Specifications for P2M2s	2-20
	2.6.3 Categories of BMPs	2-21

## **CHAPTER 3 IDENTIFYING LAND DISTURBING ACTIVITIES 3-1**

	3.1.1 DEFINITION	3-1
	3.1.2 Types of Land Disturbing Activities	3-1
3.2	SITE LAND CLEARING	3-2
	3.2.1 Practice Description	3-2
	3.2.2 Examples of Site Land Clearing	3-3
	3.2.3 Planning Considerations	3-5
	3.2.4 Applicable Minimum Standards Requirements	3-6
3.3	GRUBBING	3-10
	3.3.1 Practice Description	3-10

3.3.2	Examples of Grubbing	3-10
3.3.3	Planning Considerations	3-11
3.3.4	Applicable Minimum Standards Requirements	3-12
3.4	STRIPPING	3-12
3.4.1	Practice Description	3-12
3.4.2	Examples of Stripping	3-12
3.4.3	Planning Considerations	3-14
3.4.4	Applicable Minimum Standards Requirements	3-14
3.5	GRADING	3-16
3.5.1	Practice Description	3-16
3.5.2	Examples of Grading	3-16
3.5.3	Planning Considerations	3-17
3.5.4	Applicable Minimum Standards Requirements	3-17
3.6	RAISING OR SLOPING OF GROUND	3-18
3.6.1	Practice Description	3-18
3.6.2	Examples of Raising or Sloping of Ground	3-18
3.6.3	Planning Considerations	3-20
3.6.4	Applicable Minimum Standards Requirements	3-22
3.7	EXCAVATING	3-23
3.7.1	Practice Description	3-23
3.7.2	Examples of Excavating	3-24
3.7.3	Planning Considerations	3-27
3.7.4	Applicable Minimum Standards Requirements	3-28
3.8	TRENCHING	3-31
3.8.1	Practice Description	3-31
3.8.2	Examples of Trenching	3-32
3.8.3	Planning Considerations	3-35
3.8.4	Applicable Minimum Standards Requirements	3-36
3.9	FILLING & EMBANKMENT	3-38
3.9.1	Practice Description	3-38
3.9.2	Examples of Filling & Embankment	3-38
3.9.3	Planning Considerations	3-39
3.9.4	Applicable Minimum Standards Requirements	3-39
3.10	LOGGING	3-40
3.10.1	Practice Description	3-40
3.10.2	Examples of Logging	3-40
3.10.3	Planning Considerations	3-41
3.10.4	Applicable Minimum Standards Requirements	3-41
3.11	STORING OF MATERIALS	3-43
3.11.1	Practice Description	3-43
3.11.2	Examples of Storing of Materials	3-43
3.11.3	Planning Considerations	3-44
3.11.4	Applicable Minimum Standards Requirements	3-45
3.12	BLASTING	3-46

3.12.1 Practice Description	3-46
3.12.2 Examples of Blasting	3-46
3.12.3 Planning Considerations	3-47
3.12.4 Applicable Minimum Standards Requirements	3-47

## **CHAPTER 4 UNDERSTANDING PHASES IN A PROJECT** **4-1**

4.1 INTRODUCTION	4-1
4.1.1 Construction Planning	4-1
4.2 CONSEQUENCES FROM POOR PLANNING AND INADEQUATE PHASING	4-2
4.2.1 Example 1	4-2
4.2.2 Example 2	4-5
4.2.3 Example 3	4-6
4.2.4 Example 4	4-8
4.2.5 Example 5	4-8
4.2.6 Example 6	4-10
4.2.7 Discussion	4-11
4.3 PHASES IN A PROJECT	4-12
4.3.1 Meaning of “Phase”	4-12
4.3.2 Project Cycle	4-12
4.3.3 Distinction between “Development Phases” and “Project Phases”	4-19
4.3.4 Distinction between “Pre-Construction” and “Construction”	4-19
4.3.5 What is Work Breakdown Structure (WBS)	4-20
4.4 IDENTIFYING PHASES IN A PROJECT	4-22
4.4.1 Meaning of “Phases” in the Context of this Guidelines	4-22
4.4.2 Factors of Consideration in Phasing	4-22
4.4.3 Examples of Phasing	4-25
4.4.4 Summary	4-34
4.5 WORK BREAKDOWN STRUCTURES (WBS)	4-36
4.5.1 Meaning of WBS	4-36
4.5.2 Application to this Guidelines	4-36
4.6 IDENTIFYING PROJECT COMPONENTS	4-38
4.6.1 Conventional Way of Identifying Project Components	4-38
4.6.2 Application to this Guidelines	4-45
4.6.3 Example 1 – Proposed Sewage Treatment Works Project	4-46
4.6.4 Example 2 – Proposed Highway Project	4-47
4.6.5 Example 3 – Proposed Housing Development Project	4-51
4.6.6 Example 4 – Proposed Main Drainage Project	4-57
4.6.7 Example 5 – Proposed River Check Dam Project	4-62
4.6.8 Example 6 – Proposed Forest Development Project	4-65
4.6.9 Summary	4-69
4.7 IDENTIFYING PROJECT ACTIVITIES	4-70
4.7.1 Application to this Guidelines	4-70

4.7.2	Example 1 – Proposed Sewage Treatment Works Project	4-72
4.7.3	Example 2 – Proposed Highway Project	4-85
4.7.4	Example 3 – Proposed Housing Development Project	4-98
4.7.5	Example 4 – Proposed Main Drainage Project	4-104
4.7.6	Example 5 – Proposed River Check Dam Project	4-108
4.7.7	Example 6 – Proposed Forest Redevelopment Project	4-112
4.7.8	Summary	4-112
<b>4.8</b>	<b>IDENTIFYING ENVIRONMENTAL METHOD STATEMENTS</b>	<b>4-117</b>
4.8.1	Application to this Guidelines	4-117
<b>4.9</b>	<b>IDENTIFYING PROJECT SEQUENCES &amp; SCHEDULING</b>	<b>4-130</b>
4.9.1	Application to this Guidelines	4-130
4.9.2	Examples of Project Phasing, Sequences & Scheduling	4-131
4.9.3	Example 1 – Proposed Sewage Treatment Works Project	4-131
4.9.4	Other Examples	4-142
4.9.5	Summary	4-146
<b>CHAPTER 5</b>	<b>PROJECT IMPLEMENTATION TECHNIQUES</b>	<b>5-1</b>
5.1	OVERARCHING REQUIREMENTS	5-1
5.1.2	Legal Obligations	5-1
5.2	BASIC PRINCIPLES OF LD-P2M2	5-1
5.2.1	Minimum Standards Requirements of LD-P2M2	5-2
5.3	ROLES AND RESPONSIBILITIES OF PROJECT PARTIES	5-3
5.3.1	Who are Key Players?	5-3
5.3.2	Project Proponent	5-3
5.3.3	Consultants	5-4
5.3.4	Contractors	5-6
5.3.5	Environmental Officers (EO)	5-6
5.4	LD-P2M2 APPLICATION DURING PLANNING STAGE	5-8
5.4.1	How Project Proponents and Consultants Apply LD-P2M2	5-8
5.5	LD-P2M2 APPLICATION DURING CONSTRUCTION STAGE	5-10
5.5.1	How Project Proponents Apply LD-P2M2	5-10
5.5.2	How the Environmental Officers Apply LD-P2M2	5-11
5.5.3	How the Contractors Apply LD-P2M2	5-11
5.6	SITE APPLICATION PRACTICES	5-13
5.6.1	Usage of Project Information and P2M2s	5-13
5.6.2	Applying LD-P2M2 Basic Principles	5-22
5.7	PREPARING A LD-P2M2 DOCUMENT	5-30
5.7.1	General Guidelines for preparing a LD-P2M2 Document	5-30
5.7.2	Writing a LD-P2M2 Report	5-40
<b>CHAPTER 6</b>	<b>MONITORING, REPORTING AND DOCUMENTATION</b>	<b>6-1</b>
6.1	IMPORTANCE OF IIM	6-1

6.1.1	Install	6-2
6.1.2	Inspect	6-3
6.1.3	Maintain	6-7
6.2	TYPES OF MONITORING	6-7
6.2.1	General	6-7
6.3	COMPLIANCE MONITORING (CM)	6-8
6.3.1	Definition	6-8
6.4	IMPACT MONITORING (IM)	6-8
6.4.1	Definition	6-8
6.5	PERFORMANCE MONITORING (PM)	6-9
6.5.1	Definition	6-9
6.6	REPORTING & DOCUMENTATION	6-11
6.6.1	General	6-11
6.6.2	Master List of Installation	6-11
6.6.3	Installed P2M2 Verification	6-14
6.6.4	Follow-up Inspection	6-16
6.6.5	Maintenance Programme	6-18
6.6.6	Sampling Database	6-20
6.6.7	Analysis & Interpretation	6-20
6.6.8	Reporting	6-22
6.6.9	Photo Database	6-22
6.7	ENVIRONMENTAL AUDITING	6-22
6.7.1	Environmental Audit Program	6-22

### List of Tables

Table 1.1	Impacts of Erosion & Sediment	1-7
Table 1.2	Overall Issues	1-18
Table 3.1	Example of Land Clearing	3-3
Table 3.2	Example of Grubbing	3-11
Table 3.3	Example of Stripping	3-13
Table 3.4	Example of Land Grading	3-16
Table 3.5	Example of Ground Raising/Sloping	3-19
Table 3.6	Example of Excavating	3-24
Table 3.7	Example of Borehole Drilling	3-26
Table 3.8	Example of In-stream Works	3-27
Table 3.9	Example of Trenching	3-32
Table 3.10	Example of River Diversion or Crossing Activity	3-33
Table 3.11	Example of Dewatering Activity	3-34
Table 3.12	Examples of Filling/Embankment	3-38
Table 3.13	Examples of Logging	3-40
Table 3.14	Example of Material Storage	3-43
Table 3.15	Example of Blasting	3-46
Table 4.1	Project Activities for Main Drainage Project	4-104
Table 4.2	Project Activities for River Check Dam Project	4-109
Table 4.3	Project Activities for Forest Redevelopment Project	4-112
Table 4.4	List of EMS for STW Project	4-117
Table 4.5	Consideration Factors for Phasing STW Project	4-132
Table 4.6	Identified Land Disturbing Activities	4-133
Table 4.7	Project Sequence for Phase 1	4-138
Table 4.8	Project Sequence for Phase 2	4-139
Table 4.9	Project Sequence for Phase 3	4-140
Table 4.10	Project Sequence for Phase 5	4-141

## List of Figures

		<b>PAGE</b>
Figure 1.1	Elements of LD-P2M2	1-2
Figure 1.2	Needs for LD-P2M2	1-3
Figure 1.3	Examples of Amenity Losses	1-8
Figure 1.4	Examples of Public Disruptions	1-12
Figure 1.5	BMP Categories	1-19
Figure 1.6	Typical Project Flow	1-21
Figure 1.7	Progression of LD-P2M2 from Planning to Construction	1-22
Figure 1.8	LD-P2M2 During EIA Process Stage	1-23
Figure 1.9	LD-P2M2 After EIA Approval Stage	1-24
Figure 2.1	Parties Involved in Erosion & Sediment	2-18
Figure 4.1	Large Scale Earthworks with No Proper BMPs Installed	4-3
Figure 4.2	Effects of Erosion and Sedimentation on River Downstream	4-4
Figure 4.3	Damages to Vegetation from Soil Erosion	4-4
Figure 4.4	Vast Land Clearing with Lack of Phasing Planning	4-5
Figure 4.5	Massive Scouring of Ground Surface due to Erosion of Unprotected Surfaces	4-6
Figure 4.6	Impacts from Poor Planning in Phasing of Site Works	4-7
Figure 4.7	Erosion and Surface Runoff from a Poorly Managed Work Site	4-8
Figure 4.8	No Indication of Works Phasing Implemented	4-9
Figure 4.9	Erosion and Landslides Resulted from Lack of Activities Phasing	4-9
Figure 4.10	Erosion and Surface Runoff from a Poorly Managed Work Site	4-11
Figure 4.11	Typical Flow of a Project	4-13
Figure 4.12	Typical Pre-Site Activities	4-17
Figure 4.13	Purpose of Defining Activities in Project Management	4-20
Figure 4.14	Possible Phasing	4-26
Figure 4.15	Possible Phasing	4-30
Figure 4.16	Possible Phasing	4-32
Figure 4.17	WBS for Addressing Erosion and Sedimentation	4-37
Figure 4.18	Example of a Civil Engineering Project	4-39
Figure 4.19	Possible Component Breakdown of STW Project (based on disciplines)	4-42
Figure 4.20	Components of A Highway Project	4-44
Figure 4.21	A Simpler Alternative to Component Breakdown of STW Project	4-46
Figure 4.22	Layout of a New 10 km Highway Project	4-49
Figure 4.23	A Simpler Alternative to Component Breakdown of A Highway Project	4-50
Figure 4.24	Layout of A Housing Development Project	4-54
Figure 4.25	Components of A Housing Development Project	4-55
Figure 4.26	Alternative Component Breakdown of A Housing Development	4-56

	Project	
Figure 4.27	Components of Main Drainage Project	4-59
Figure 4.28	Conventional Breakdown of A Main Drainage Project	4-60
Figure 4.29	Alternative Component Breakdown of A Main Drainage Project	4-61
Figure 4.30	Components of A River Check Dam Project	4-63
Figure 4.31	Alternative Component Breakdown of A River Check Dam Project	4-64
Figure 4.32	Components of A Forest Redevelopment Project	4-67
Figure 4.33	Alternative Component Breakdown of A Forest Redevelopment Project	4-68
Figure 4.34	Identification of Possible Project Activities of STW Project	4-83
Figure 4.35	Identification of Possible Project Activities of STW Project	4-84
Figure 4.36	Possible Project Activities of a Highway Project	4-96
Figure 4.37	Identification of Possible Scope of Work of Highway Project	4-97
Figure 4.38	Possible Project Activities of a Housing Development Project	4-102
Figure 4.39	Possible Scope of Work of a Housing Development	4-103
Figure 4.40	Possible Project Activities of a Main Drainage Project	4-106
Figure 4.41	Possible Scope of Work of a Main Drainage Project	4-107
Figure 4.42	Possible Project Activities of a River Check Dam Project	4-110
Figure 4.43	Possible Scope of Work of a River Check Dam Project	4-111
Figure 4.44	Possible Project Activities of a Forest Redevelopment Project	4-115
Figure 4.45	Possible Scope of Work of a Forest Redevelopment Project	4-116
Figure 4.46	Environmental Method Statements for STW Project	4-121
Figure 4.47	Environmental Method Statements for Highway Project	4-122
Figure 4.48	Environmental Method Statements for Housing Project	4-124
Figure 4.49	Environmental Method Statements for Drainage Project	4-126
Figure 4.50	Environmental Method Statements for River Check Dam Project	4-128
Figure 4.51	Environmental Method Statements for Forest Redevelopment Project	4-129
Figure 4.52	Recommended Project Sequence for Phases of Work for STW Project	4-135
Figure 4.53	Proposed Phasing for Sewage Treatment Works Project	4-136
Figure 4.54	Proposed Project Sequence for Phase 1	4-137
Figure 4.55	Proposed Project Sequence for Phase 2	4-137
Figure 4.56	Proposed Phasing for Highway Project	4-143
Figure 4.57	Proposed Phasing for Housing Project	4-144
Figure 4.58	Proposed Phasing for Drainage Project	4-145
Figure 5.1	Information for LD-P2M2 Analysis	5-10
Figure 5.2	LD-P2M2 Implementation Framework	5-13
Figure 5.3	Weather/Rainfall Data and Related P2M2s	5-15
Figure 5.4	Runoff Velocity /Flow rate and Related P2M2s	5-16
Figure 5.5	Earthwork Volumes and Related P2M2s	5-17
Figure 5.6	Soil Characteristics and Related P2M2s	5-18
Figure 5.7	Erosion/Sedimentation Sensitive Receivers and Related P2M2s	5-19

Figure 5.8	Waste Management and Related P2M2s	5-20
Figure 5.9	List of P2M2s	5-21
Figure 6.1	Objectives of IIM	6-1
Figure 6.2	Types of Environmental Monitoring	6-8
Figure 6.3	Critical Record Types	6-11
Figure 6.4	Sample Master List of Installation Record	6-13
Figure 6.5	Sample of Installed P2M2 Verification Record	6-15
Figure 6.6	Sample Inspection Record	6-17
Figure 6.7	Sample Maintenance Programme record	6-19
Figure 6.8	Sample Analysis	6-21

### List of Appendices

Appendix A	Issue relating Erosion and Sedimentation
Appendix B	Minimum Standard Requirement of Pollution and Prevention Control
Appendix C	Culture of Our Construction Industry
Appendix D	Sample Worksheet to quantify Soil Loss and Sediment Yield
Appendix E	BMPs
Appendix F	Guiding on Managing Erosion and Sediment Control
Appendix G	Data for Sample LD-P2M2 Document
Appendix H	Inspection Checklists
Appendix I	Sample Of Strategic Plan For Erosion And Sediment Reduction And Remediation Measures At An Active Construction Site

### Abbreviations

5-Ws, 1-H	What, Why, Where, Who, When and How
ATS	Active Treatment System
BATs	Best Available Technologies
BFU	Main Focus Field ( <i>Bidang Fokus Utama</i> )
BMPs	Best Management Practices
BSI	British Standards Institute
CISEC	Certified Inspector in Sediment and Erosion Control
CESSWI	Certified in Erosion, Sediment and Stormwater Inspector
CPESC	Certified Professional in Erosion and Sediment Control
CM	Compliance Monitoring
COA	Conditions of Approval
CPM	Critical Path Method
DOE	Department of Environment
EIA	Environmental Impact Assessment

EM	Environmental Mainstreaming
EO	Environmental Officer
EP	Environmental Policy
EPMC	Environmental Performance Monitoring Committee
EPMD	Environmental Performance Monitoring Document
EQA	Environmental Quality Act 1974
ESCP	Erosion and Sediment Control Plan
HVF	High Visibility Fencing
IIM	Inspect, Install, Maintain
IM	Impact Monitoring
JPS	Department of Drainage and Irrigation
LD-P2M2	Land Disturbing Pollution Prevention and Mitigation Measures
MSMA	Manual Saliran Mesra Alam
MUSLE	Modified Universal Soil Loss Equation
P2M2s	Pollution Prevention and Mitigation Measures
PBT	Local Authority
PE	Professional Engineer
PM	Performance Monitoring
PMD	Performance Monitoring Document
PMR	Performance Monitoring Report
PP	Project Proponent
RECPs	Rolled Erosion Control Products
ROW	Right of Way
STW	Sewage Treatment Works
TNB	Tenaga Nasional Berhad
TRM	Turf Reinforcement Mat
USLE	Universal Soil Loss Equation
WBS	Work Breakdown Structure

## CHAPTER 1

### INTRODUCTION

#### 1.1 WHAT IS LD-P2M2 & LD-P2M2 DOCUMENT?

In the context of this *Guidelines on Land Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2)*, “Land Disturbing” (LD) refers to “any project development that is subject to Section 34A EQA 1974” which can possibly involve activities such as clearing of trees or vegetation, excavating, raising or sloping of ground, stripping, grading, grubbing, trenching, excavating, filling, logging, storing of materials and blasting.

In other word, “land disturbing” also means any activity that changes the physical conditions of land form, vegetation and hydrology, and during the process, creates bare soil, or otherwise may cause erosion or sediment issues.

“Pollution Prevention and Mitigation Measures” (P2M2) refer to the “Best Management Practices (BMPs) that include activities, facilities, measures, planning or procedures used to minimize accelerated erosion and sedimentation as well as other pollutants resulting from land disturbing activities and to manage runoff water to protect and maintain the quality of soil or inland or Malaysian waters and the existing and designated uses of waters before, during, and after land disturbing activities”.

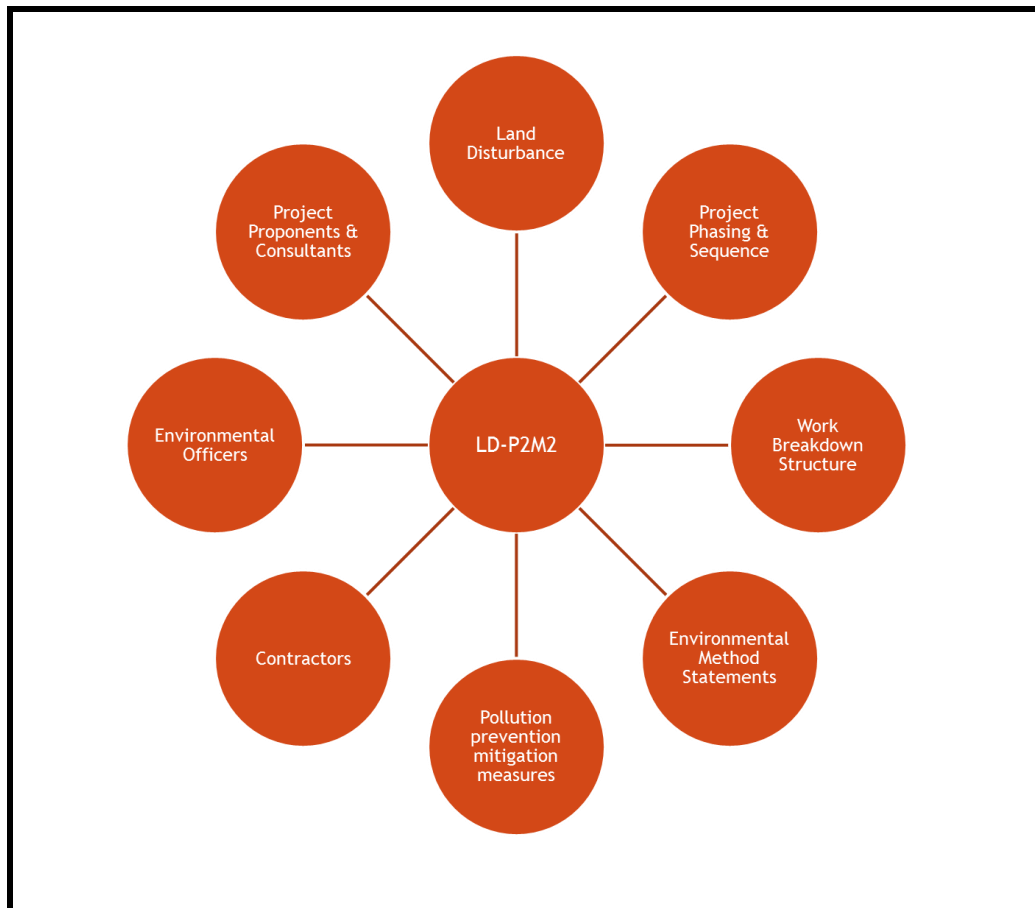
Taken collectively then, “Land Disturbing Pollution Prevention and Mitigation Measures”, or simply LD-P2M2 refers to: “the use of construction methods, processes, materials, and practices that is intended to prevent, reduce, or eliminate the generation of pollutants at the source (development site) during any land-disturbing activity, through the protection of natural resources by preservation and conservation, reduction of waste generation and releases or discharges of pollutants to land, air, and water, and incorporation of best management practices (BMPs) and techniques to attain compliance with the conditions stipulated in the EIA approval conditions (Conditions of approval-COA)”.

The key objectives of LD-P2M2 are as follows:

- ➔ To commit Project Proponents to address soil erosion and sedimentation at an earlier stage of the Project, namely, at the EIA stage, so that adequate planning and resources are factored into the later stages such as design and construction;
- ➔ To commit Project Proponents to review in more detail their construction sequencing and site operations prior to award of construction contracts, in regard to land disturbing activities which may result in soil erosion and sedimentation;

- ➔ To assist the site operators involved in the land disturbing activities, especially the Environment Officer, in supervising the overall implementation of LD-P2M2 that include the installation, inspection and maintenance (2I's1M) of pollution prevention and mitigation measures as well as in preparing the required documentation and reports (photographs, data collections and corrective actions) on 2I's1M.

Following on from the above, the major elements of LD-P2M2 are shown in **Figure 1.1**.



**Figure 1.1: Elements of LD-P2M2**

The analysis of and findings on LD-P2M2 are ultimately documented in the LD-P2M2 Document which can be described as follows:

- This is a project-specific document to be prepared by the EIA Consultant at the EIA/EMP stage, to address and detail out all the elements that are required for applying the concept of LD-P2M2 into the project development.
- The focus of a LD-P2M2 Document will be on the *prevention, mitigation and control of the discharge from the development area containing the major pollutant (suspended solids) resulting from the project's land disturbing activities.*

## 1.2 WHY IS LDP2M2 NEEDED?

In Malaysia, especially due to events related to erosion and sediment arising from construction projects that have occurred in recent times, various factors are perceived to be the **driving forces** for the need to formally formulate and implement the concept of LD-P2M2 into the EIA projects, at least at this initial stage. **Figure 1.2: Needs for LD-P2M2** below shows diagrammatically the myriad of driving forces as mentioned earlier.

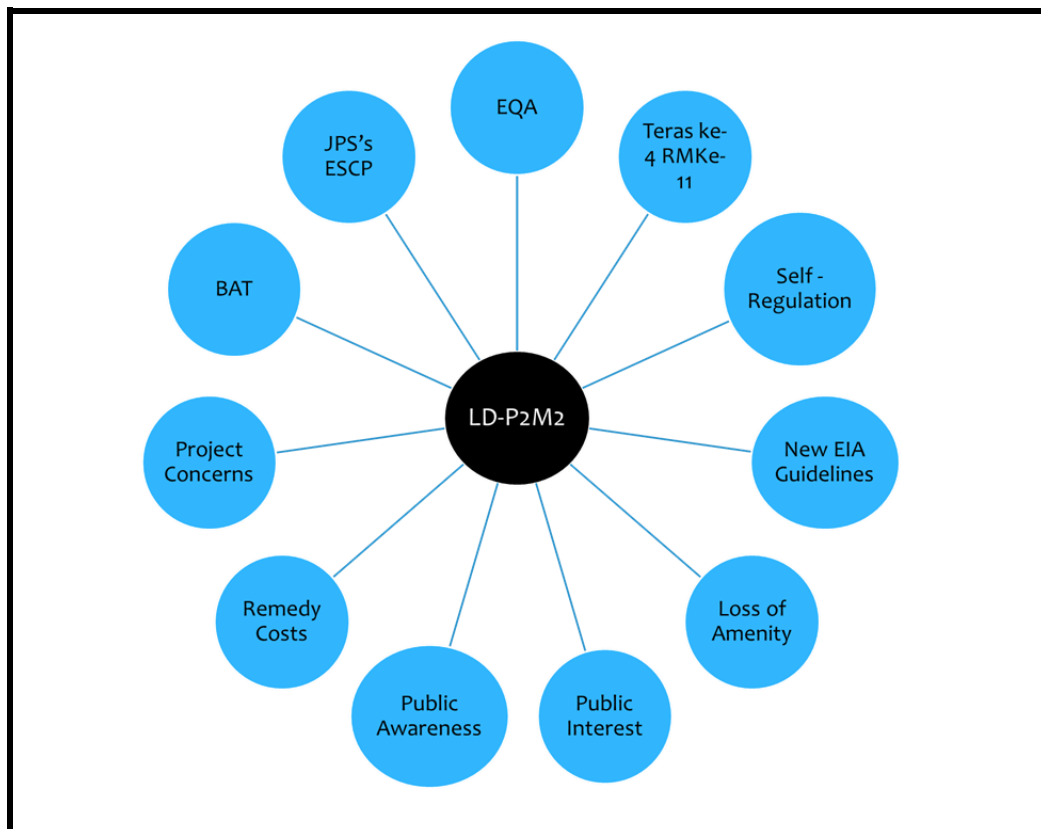


Figure 1.2: Needs for LD-P2M2

### 1.2.1 Environmental Quality Act (EQA)

Section 34A of the EQA stipulates that an EIA report shall be undertaken in accordance with the guidelines as prescribed by the Director General, and shall contain “the proposed measures that shall be undertaken to prevent, reduce or control the adverse impact on the environment.” This Section further stipulates that the person carrying out the prescribed activity “shall provide sufficient proof that the conditions attached to the report (if any) are being complied with and that the proposed measures to be taken to prevent, reduce or control the adverse impact on the environment are being incorporated into the design, construction and operation of the prescribed activity.”

In summary, there are currently existing laws and regulation in the Malaysian construction practice that prohibit the acts of polluting the environment as a result from erosion and sediment issues generated from site activities.

### **1.2.2 “Teras ke-4 RMKe-11”**

Under the Government’s “Heading Toward Green Growth in the Main Focus Field (BFU) in Climate Change/Environment” programme, an allocation has been approved to strengthen the Execution of EIA Procedures in Malaysia under Environmental Quality Act 1974 (Amendment 2012): Formation of Environmental Guidelines: Guidelines on Erosion and Sedimentation. The introduction of LD-P2M2 hence is in line with the above national planning goal.

### **1.2.3 Self-Regulation**

In the strive to solicit active participation of all project parties in their roles in relation to environmental protection, including erosion and sediment control, DOE has adopted the “self-regulation” policy, i.e., by ensuring mainstreaming of environmental agenda as an integral part and parcel of all the procedures implemented by the DOE, including the EIA procedure. With this, all levels of the project developer’s organizational structure, the project development decision making process, and the project development phases (planning, construction, and operation) are required to be well versed on their project-related environmental issues, as well as to ensure constant regulatory compliance of the project by, amongst other things, monitoring the environmental performance and effectiveness of pollution prevention and mitigation measures (P2M2s) of the project through the project-appointed “Environmental Performance Monitoring Committee” (EPMC).

In this regard, the LD-P2M2 Guidelines will need to be well balanced as well as comprehensive so that all parties using this document have a common understanding pertaining to land-disturbing pollution prevention and mitigation measures.

This self-regulation approach is expected to complement the existing “command & control” practices by the DOE.

### **1.2.4 New EIA Guidelines**

In the latest “*Environmental Impact Assessment Guideline in Malaysia, 2016*”, specific reference to the prevention of erosion and sediment discharges from a construction site is included which essentially included the following:

*“The EIA procedure, a preventive strategy of the DOE also needs to embrace the environmental mainstreaming and self-regulation goal in order to enhance its effectiveness in mitigating the adverse impacts from development projects on the environment at every stage of the EIA procedure. Self-regulation culture in EIAs means that the Project Proponent will be charged with full responsibility and accountability for taking environmental friendly options and instituting effective pollution prevention and mitigation measures (P2M2) and self-demonstration of regulatory compliance of the EIA procedure at all stages of project implementation.”*

The Guideline also directly holds the Project Proponent to be legally responsible *“towards ensuring regulatory compliance of his project with the EIA procedure at all stages of project planning and implementation.”* The Project Proponent is also tasked to allocate sufficient funds for every stage of project planning and implementation, and amongst others, *“for implementation of Environmental Management Plan (EMP) including temporary pollution prevention and mitigation measures (P2M2). P2M2 shall be those which can be described as state of the art technologies, best available technologies (BATs), or industry best practices.”*

The other elements under the new EIA Guideline that would drive the increase effort in controlling erosion and sediment issues are summarized below:

Clause Section 34A (1): *“The Minister, after consultation with the Council, may by order prescribe any activity which may have significant environmental impact as prescribed activity.”*

Clause Section 34A (2): *“Any person intending to carry out any prescribed activity shall appoint a qualified person to conduct an environmental impact assessment and to submit a report thereof to the Director General in the manner as the Director General may prescribe.”*

Clause Section 34A (2C): *“The report shall be in accordance with the guidelines as the Director General may prescribe and shall contain: (a) an assessment of the impact such activity will have or is likely to have on the environment; and (b) the proposed measures that shall be undertaken to prevent, reduce or control the adverse impact on the environment.”*

Clause Section 34A (7): *“If the Director General approves the report, the person carrying out the prescribed activity, in the course of carrying out such activity, shall provide sufficient proof that the conditions attached to the report (if any) are being complied with and that the proposed measures to be taken to prevent, reduce or control the adverse impact on the environment are being incorporated into the design, construction and operation of the prescribed activity.”*

Q

Clause Section 34AA: *“(1) The Director General may issue a prohibition order or stop work order to the person carrying out the prescribed activities –*

- a. without the approval under subsection 34A(3);*
- b. who violates any conditions attached to the approval of the report; or*
- c. which in the opinion of the Director General are being carried out in a manner that is likely to cause environmental damage.*

*(2) The prohibition order or stop work order may be issued for the purpose of preventing the prescribed activities from continuing –*

- a. either absolutely or conditionally;*
- b. for such period as the Director General may determine; or*
- c. until requirements to remedy as the Director General may direct have been complied with.”*

Also stated in DOE’s guidelines is the following: *“All activities subject to EIA Order, 2015 which involve land disturbing or site preparation activities are required to prepare a LD-P2M2 as part of the EMP submission requirement. Non-compliance with the specifications stipulated in this Guidelines may be a cause for the rejection of the EMP or will cause a delay in the EMP processing.”*

In this regard, the implementation of LD-P2M2 is in tandem to assist the Project Proponent and Contractor to meet the objectives of the new EIA Guidelines.

### **1.2.5 Loss of Amenity**

The term “amenity” is also defined as “facility”, “convenience”, “comfort”, “service” or “feature”. In the context of public amenities, they could be either natural features, such as parks, rivers, lakes, etc., or manmade such as roads, reservoir, water treatment plants and so on. Although all construction projects are confined within the prescribed works boundaries or right of way (ROW), the impacts of erosion and sediment in the more serious cases unfortunately extend beyond the limits of the project sites, and inevitably impose negative impacts to the public amenities located outside of these boundaries.

The direct physical and environmental impacts from the effects of erosion and sedimentation can be summarized as follows:



**Table 1.1: Impacts of Erosion & Sediment**

<b><i>Physical Effects</i></b>
<ul style="list-style-type: none"> <li>▪ Costly damage to aquatic areas and to private and public lands.</li> <li>▪ Obstruction of stream channels and navigable rivers.</li> <li>▪ Increase in flood crests resulting in flood damages.</li> <li>▪ Functionally impair storm water conveyances such as culverts and piping systems from sediment influx.</li> <li>▪ Loss in storage capacity of municipal and industrial water supply reservoirs.</li> <li>▪ Impairment of recreational impoundment.</li> <li>▪ Decrease in navigability of channels.</li> </ul>
<b><i>Environmental Impacts</i></b>
<ul style="list-style-type: none"> <li>▪ Eroded soil contains nitrogen, phosphorus, and other nutrients, and when carried into water bodies, triggers algal blooms that reduce water clarity, deplete oxygen, lead to fish kills, and create odors.</li> <li>▪ Erosion of stream banks and adjacent areas destroys streamside vegetation that provides aquatic and wildlife habitats.</li> <li>▪ Excessive deposition of sediments in streams smothers the bottom fauna, seals stream beds, and destroys fish spawning habitat.</li> <li>▪ Turbidity from sediment reduces in-stream photosynthesis, which leads to reduced food supply and habitat.</li> <li>▪ Turbidity increases the amount of sunlight absorbed in water, raising stream temperatures.</li> <li>▪ Suspended sediment abrades and coats aquatic organisms.</li> <li>▪ Erosion removes the smaller and less dense constituents of topsoil which hold nutrients that plants require for healthy establishment. The remaining subsoil is often hard, rocky, infertile, and droughty; thus making reestablishment of vegetation difficult.</li> <li>▪ Eroded soil in aquatic environment reduces both the kinds and the amounts of organisms present in an aquatic system.</li> </ul>

The loss of amenities associated with the above impacts is shown in the following few examples.

Q

## GUIDELINES ON LD-P2M2

	<p><b>Example 1(a):</b> Effects of sediment in the river seen in this water treatment plant, where the polluted river serves as the raw water source for the plant. Root cause of reservoir pollution tracked back to the plant intake point, where incoming water quality exceeded the acceptable limits.</p>
	<p><b>Example 1(b):</b> The plant had to be shut down for days to facilitate cleanup of its storage reservoir.</p>



**Example 2:**  
Heavily polluted reservoir of a hydroelectric plant, diminishing the reservoir's design storage capacity.



**Example 3:**  
Loss of use of rivers as an amenity due to high loads of silt in river waters.



**Example 4:**  
Another heavily polluted river due to eroded sediment.





**Example 5:**  
Heavy sedimentation to a river located adjacent to a massive land clearing site.



**Example 6:**  
Temporary loss of use of a public road due to sediment being carried onto the road surface.



**Example 7:**  
Another polluted river? No, this is a road under heavily sediment-laden runoff after a rainfall. Evidently, the road acted as a drainage path to transport sediment to the drainage system.



**Example 8:**  
Disruption to road users due to highly silted runoff from an adjacent hillside.



**Example 9:**  
Gradual encroachment of silt materials onto residential areas.



**Example 10:**  
Concentrated discharge into storm water system will cause blockage to the drains and costly to maintain.



**Figure 1.3: Examples of Amenity Losses**

### 1.2.6 Public Interest and Awareness

Impacts of erosion and sedimentation which affect populated areas will inevitably raise the public interest and awareness, particularly if private properties are damaged or in even more drastic cases, fatalities or injuries resulted from these impacts. This heightened interest and awareness of the public poses the pressure for more effort in controlling the current construction practices in dealing with erosion and sedimentation. Additionally, the continued deterioration of the river quality in Malaysia due to eroded soils from project sites is receiving a great amount of attention from the relevant authorities.

The selected examples below highlight the frequent concerns faced by the public in recent times.



Q

	<p><b>Example 1(b):</b> Another part of the same town above subject to flood waters, causing major disruption to affected road users.</p>
	<p><b>Example 2:</b> Another township under flood waters knowingly due to serious cases of erosion at the upper catchment of the area, resulting in large scale property damages.</p>
	<p><b>Example 3:</b> Discharge of sediment-laden waters from a construction in a urban area, causing major disruption to affected road users.</p>

Q

	<p><b>Example 4:</b> Discharge of sediment-laden waters to a major roadway, causing major disruption to road users.</p>
	<p><b>Example 5:</b> Discharge of sediment-laden waters from an open construction site, resulting in dangerous road conditions.</p>
	<p><b>Example 6:</b> Another example of dangerous road conditions due to sediment-laden runoff.</p>

Q




	<p><b>Example 7(a):</b> Significant mudflow causing major damages to properties.</p>
	<p><b>Example 7(b):</b> More photos of damages to public properties.</p>
	<p><b>Example 7(c):</b> More photos of damages to public properties.</p>

Figure 1.4: Examples of Public Disruptions

### 1.2.7 Remedy Costs

Many economic impacts of erosion and sedimentation are hard to quantify. How can a dollar value be assigned to loss of aquatic habitat or diminished water clarity? Other impacts may be readily quantified, for example the cost of dredging and disposing of the accumulated sediment in a silted-up reservoir. Other economic impacts include the following:

- a. Excessive sediment accumulation reduces reservoir storage capacity and more frequent sediment removal is required.
- b. The cost of building new reservoirs to replace lost reservoir capacity is high. Increasing land values and lack of available sites are making this alternative much less feasible.
- c. Sediment deposited into streams reduces flow capacity, interferes with navigation, and increases the risks of flooding. Regular maintenance dredging is required.
- d. Erosion severely diminishes the ability of the soil to support plant growth. To restore this ability is costly.
- e. Listing additional wildlife as endangered species increases time and fees for permitting, design, and construction in the affected watersheds. Some costs are directly assessed to specific projects while many other costs are distributed statewide by spending additional monies for habitat restoration.
- f. The cost of filtering muddy water in preparation for domestic or industrial use becomes excessive. There are added expenses of water purification.

A feel of the magnitude of remedy costs of the impacts of erosion and sedimentation is best illustrated by the following cost summary incurred to clean up the Sultan Abu Bakar reservoir, one of the hydroelectric station assets belonging to Tenaga National Berhad (TNB) in the state of Pahang:

No	Input Required	
1	Dredging Expenses 2005 - 2009	RM80,000,000.00
2	Maintenance Dredging Cost / Month	RM 155,000.00 / Month
3	Amount of Silt Collected under Maintenance Dredging / Year	86,000 m3
4	No of operation of Hollow Jet Valve (2005 - 2009)	10
5	Trash Collection / Month (ton)	6 ton / month
6	Rubbish / Debris Cleaning Cost / Month	RM 13,000.00 / Month
	Note :	
	Lake Storage Capacity	6.9 mil m3
	Lake Designed Storage	4.3 mil m3
	Actual Live Storage Before Dredging	1.1 mil m3
	Actual Live Storage After Dredging	2.5 mil m3

Source: TNB Generation

### 1.2.8 Project Concerns

One of the key project concerns driving the need for LD-P2M2 is that currently, projects are typically awarded before the specific issues potentially faced by construction projects in dealing with erosion and sediment in their sites have been adequately studied during the planning stage. As a result of this, provision for adequate budget or requirements for the necessary mitigation measures to be implemented on site could not be timely included into the tendering process by the project proponent nor incorporated into the Contractor's construction budget. With LD-P2M2, which is required to be resolved as early as during the submission of EIA report, this should allow sufficient time for the appropriate resources needed for the pollution prevention and mitigation measures to be included into the tender documentation.

Also related to project concerns, the issues of erosion and sediment have been observed and documented over the years by DOE based on inspections of the various projects in Malaysia. In 2011, when DOE first published the *“Manual Panduan Pemeriksaan BMPs (Best Management Practices) Untuk Kawalan Hakisan and Sedimen”*, the top ten non-compliances of erosion and sediment control were identified as follows:

- a. *Too much soil exposed at one time.*
- b. *Missing and/or misunderstanding of erosion and sediment control.*
- c. *Poor temporary stockpiles and BMPs maintenance.*
- d. *Inadequate BMP maintenance.*
- e. *No BMPs to minimize vehicle tracking onto the road.*

Q

- f. *Dewatering and other pollutant discharges.*
- g. *Poorly managed washouts – concrete, paint, stucco.*
- h. *Inadequate self-inspections.*
- i. *Inadequate updating of EMP/ESCP.*
- j. *Improper solid and hazardous wastes management.*

In the recent years, the above list has expanded to include a more comprehensive account of the overall issues resulting in erosion and sediment non-compliances on project sites, including the following:

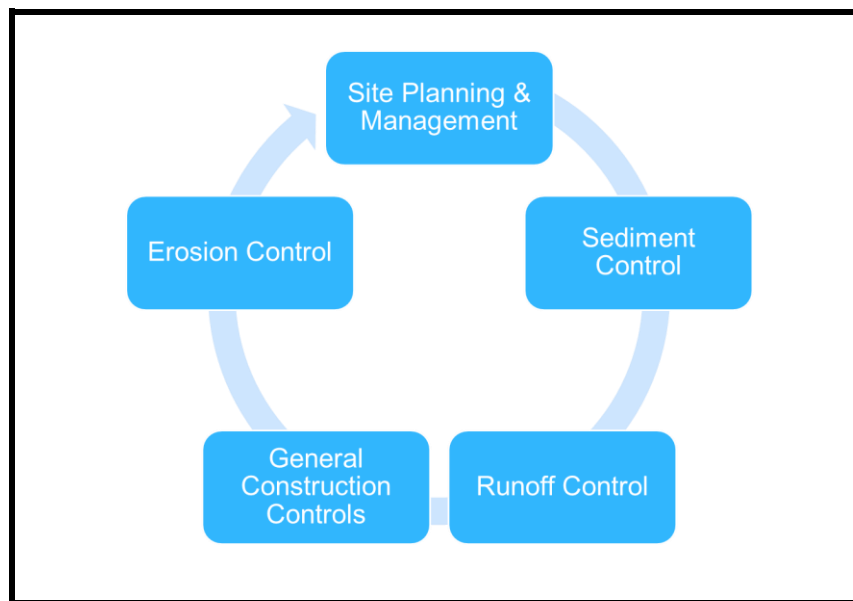
**Table 1.2: Overall Issues**

Overall Issues of Erosion and Sediment
<ul style="list-style-type: none"> <li><input type="checkbox"/> Coordination &amp; Communication</li> <li><input type="checkbox"/> Command &amp; Control</li> <li><input type="checkbox"/> Issue of work program</li> <li><input type="checkbox"/> Construction activity</li> <li><input type="checkbox"/> Construction schedule</li> <li><input type="checkbox"/> Construction methodology (Method statement)</li> <li><input type="checkbox"/> Issue of planning</li> <li><input type="checkbox"/> Issue of work stages</li> <li><input type="checkbox"/> Issue of project phasing</li> <li><input type="checkbox"/> Issue of work sequence</li> <li><input type="checkbox"/> Issue of site possession</li> <li><input type="checkbox"/> Issue of river/stream diversion</li> <li><input type="checkbox"/> Issue of river/stream crossing</li> <li><input type="checkbox"/> Issue of capacity building and logistic (physical/financial/fund)</li> <li><input type="checkbox"/> Issue of cost and benefit analyses (double handling and timeline)</li> <li><input type="checkbox"/> Issue of upholding Code of Practice in Earthwork</li> <li><input type="checkbox"/> Issue of construction (earthwork) team having common practice of Excavation (cut &amp; fill) Team, Stabilization Team and Permanent Drainage Team while in short of Temporary Drainage Team.</li> <li><input type="checkbox"/> Issue of design change</li> <li><input type="checkbox"/> Issue of erosion and sediment control measures designer/preparer not the supervising consultant at jobsite.</li> <li><input type="checkbox"/> BMPs stocking</li> <li><input type="checkbox"/> Environment Officer level of authority</li> <li><input type="checkbox"/> <b>BMPs NOT IN PLACE!</b></li> </ul>

Further elaboration of the above overall issues is contained in Chapter 2 of this *Guidelines*.

### 1.2.9 Best Available Technologies (BAT)

Well established BAT for addressing erosion and sediment are currently available in the market but it is fair to say that the full potential and benefits of them are not being fully taken advantage of in most of the project sites. Chapter 2 of this *Guidelines* will present a comprehensive list of these BAT, which are covered under one of more of the following categories:



**Figure 1.5: BMP Categories**

### 1.2.10 JPS & ESCP

The following discussion gives some insight on how the current practice of involving JPS' ESCP into EIA projects may also play a role in driving the direction for LD-P2M2. First of all, it should be reiterated herein that the LD-P2M2 Document is required to be submitted as part of the EIA Report for DOE's approval, and subsequently to be submitted together with the Environmental Management Plan, and to be stipulated in the EIA's Conditions of Approval (COA).

As indicated at the beginning of this Guidelines, the LD-P2M2 Document is not meant to replace the existing erosion and sediment control plans (ESCP), such as those required by the Department of Drainage and Irrigation (JPS), or the functional aspects of the ESCP.

For EIA projects, even though the Consultants are now not required to attach the ESCP with the EIA Report submission (as was done previously) but rather to include the LD-P2M2 Document with the submission, the Department of Drainage

and Irrigation (JPS) can still require an ESCP to be submitted for an EIA project, if it so desires, through the common practice when the project application is made by the Project Proponent to the One Stop Centre (OSC) of the local government. For non-EIA projects, JPS continues the same practice for the Project Proponent or Contractor to submit an ESCP for their project, and such ESCP is enforceable by JPS and/or the Local Authority (PBT).

With the LD-P2M2 document being submitted as part of the EIA Report, DOE will have a control over the document pertaining to the erosion and sediment control measures and to hold project parties accountable for inaction on site for EIA Projects. The LD-P2M2 document is formulated at the EIA stage and implemented at the construction stage, and one of the main emphases of LD-P2M2 is on the progressive states of the site and interim BMPs are expected to be highlighted. Where site conditions or construction methods change significantly on site, the Contractor is required to update the previously approved LD-P2M2 document (prepared at the EIA stage) for resubmission to DOE. The resubmission of the LD-P2M2 document directly to and for DOE's approval allows the Department's project officers to be informed of the site changes more expeditiously, and thus enhancing the effectiveness of DOE's site inspections.

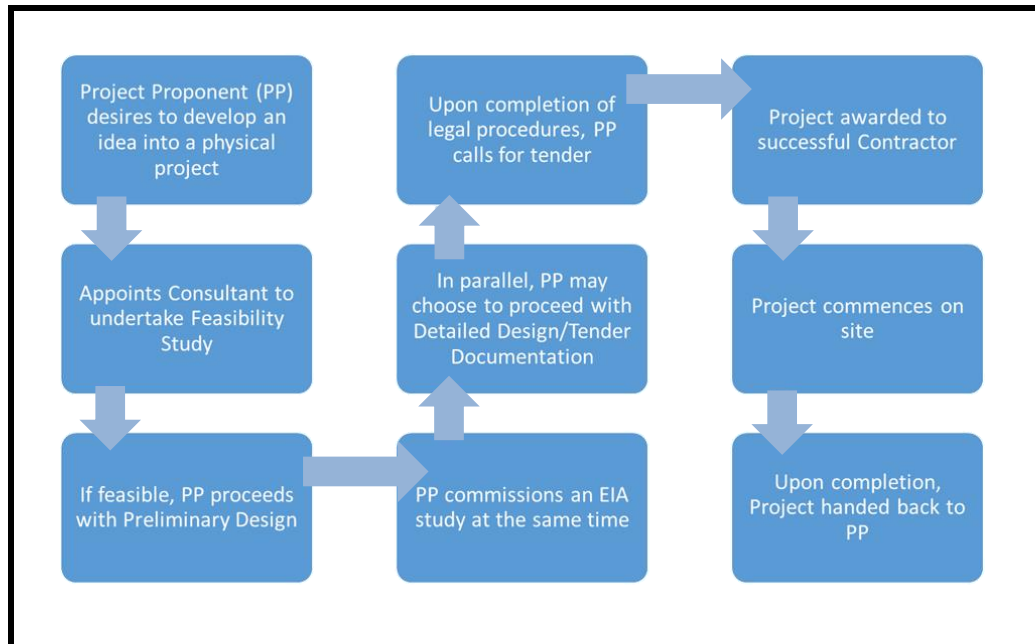
In a way, the implementation of LD-P2M2 may somewhat relieve the load on JPS' manpower requirements to review iterative resubmission of ESCPs (if the Contractor upholds his commitment to revise the approved ESCP in view of changing/evolving site conditions) for the same project. With LD-P2M2, this also reduces DOE's dependence to summon JPS' technical personnel to be witnesses in proceeding case.

Part of the LD-P2M2 substances are based on the *Guidelines of Erosion and Sediment Control* published by JPS, e.g., the fundamental, principle, standard and specification of erosion and sediment control measures. As such, the gathered technical information during the EIA study and reported under the LD-P2M2 document will definitely be useful for designing the ESCP. In the event of an ineffective LD-P2M2 document, the effective ESCP can be used instead, by requesting the Project Proponent to revise the LD-P2M2 document according to the effective one. Lastly, with LD-P2M2, this will avoid issues of competency or certified DOE inspector to inspect project with reference to ESCP, since the DOE inspectors are not certified to the technicality of the ESCP which is designed by Professional Engineer (PE).

### 1.3 WHEN IS LD-P2M2 REQUIRED?

The birth of all projects almost always commences from the same starting point, i.e., the Project Proponent's need or desire for a "product". "Project Proponent" in this context can be a private entity or government institutions or semi-government bodies. In the case

of a civil engineering project, this “product” can be in many forms, such as an entirely new development project (either residential, commercial or industrial), utility facilities (such as sewage treatment plants, water treatment plants, power stations, major drainage or sewerage schemes, etc.), agricultural projects (such as oil palm plantation, etc.), new infrastructural networks (such as highways, bridges, canals, airports, ports, etc.), and so on. Most, if not all, of these projects (requiring an EIA study to be conducted) will have to go through a typical flow as shown in **Figure 1.6**.



**Figure 1.6: Typical Project Flow**

With regard to the preparation of the LD-P2M2 Document, the EIA Guidelines (issued by DOE in 2016) stipulates that this document shall be submitted as part of the EIA Report, as covered in the following clauses in the EIA Guidelines:

- Clause 2.3.3 Adherence to DOE Guidelines
- Clause 6.4 Preparation of Land Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2)
- Appendix 4 – Guidance Document for the Preparation of the Document on Land Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2)<sup>1</sup>

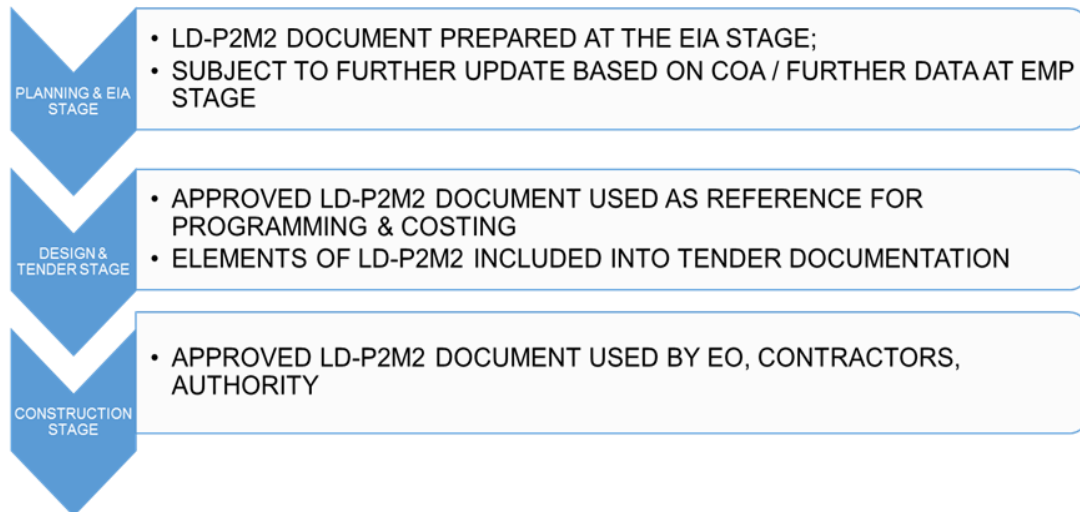
The process flow of the LD-P2M2 Document and its usage is illustrated below in **Figure 1.7**, noting the essential key points as follows:

- LD-P2M2 is initiated at the early stage of an EIA project and should be carried forward through to the end of the site works;

<sup>1</sup> To be replaced by this *Guidelines*

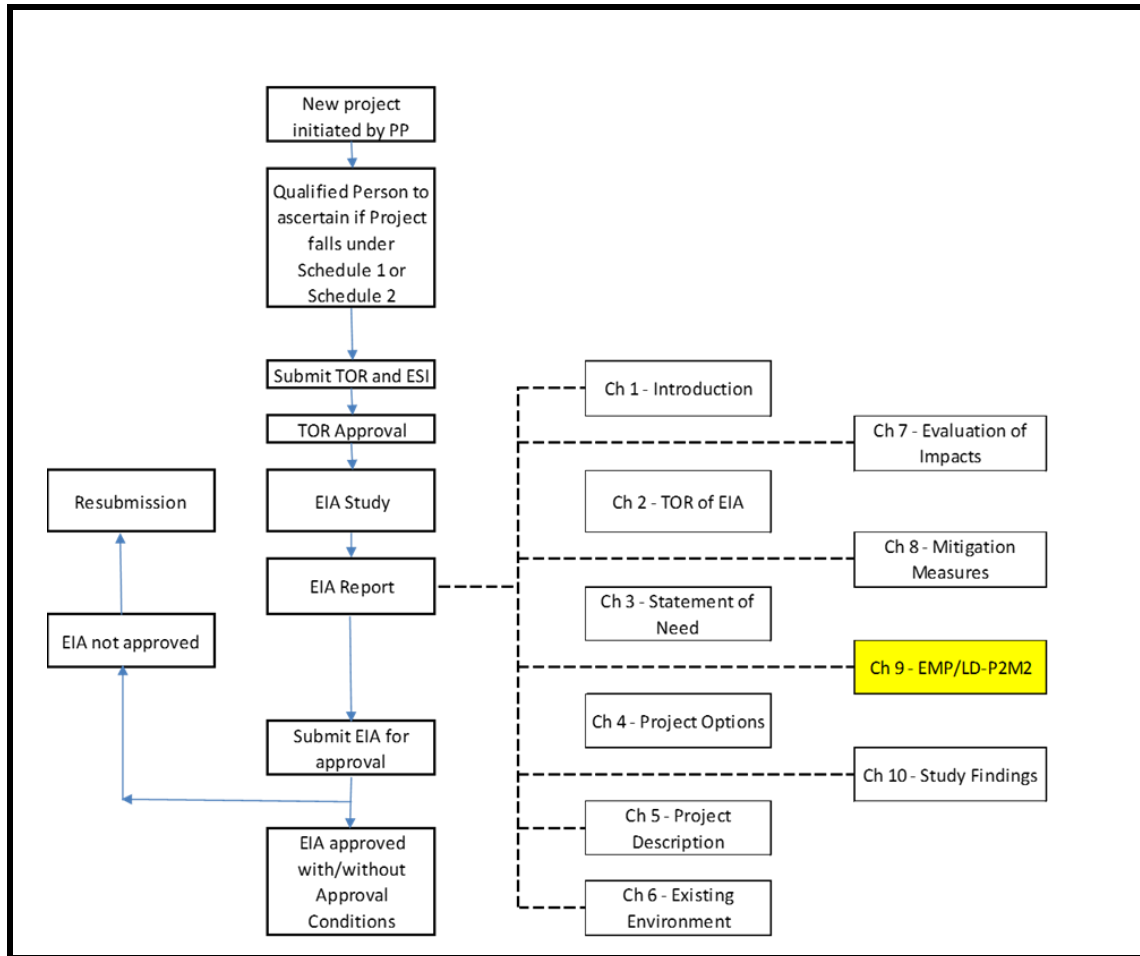
Q

- Owing to the interlocking relationships between the different stages of the project's life, as well as between the different key players, the LD-P2M2 Document should be a common basis that could be used by all parties in managing erosion and sediment issues.



**Figure 1.7: Progression of LD-P2M2 from Planning to Construction**

The following **Figure 1.8** and **Figure 1.9** illustrate “physically” where the LD-P2M2 Document will be needed. In the first figure, it shows that the initial LD-P2M2 Document shall be formulated during the EIA report stage, and to be submitted as part of the overall EIA report to DOE for approval. It is acknowledged that at this point in time, some of the information may not be available to the PP and EIA Consultant (such as Contractor’s work methodologies, resources involved in the works, etc.) and some parts of the LD-P2M2 Document may indeed be written based on “best practices” or the preparer’s experience. In such instances, it is advisable to include the assumptions used for preparing these parts of the document. On the other hand, notwithstanding the above, there will be various information that will be made available in the course of the EIA study that will be useful for preparation of the LD-P2M2 Document, such as, data on topography, climate, project components, soil information, sensitive receivers, to name a few. The initial LD-P2M2 Document prepared using these data provides a large degree of information to the Project Proponent and his engineering consultants in terms of the associated P2M2s that are anticipated as well as their possible costing.



**Figure 1.8: LD-P2M2 During EIA Process Stage**

Following the approval of the EIA report and issuance of the EIA Conditions of Approval (COA) by DOE, an updated LD-P2M2 Document will be submitted together with the EMP to DOE for approval. Typically, at this point in time, the PP or EIA Consultant would have received more detailed information on the project works to enable the LD-P2M2 Document to be refined or updated with new information. As shown in **Figure 1.8**, other windows for revising the currently LD-P2M2 Document still exist even after the contract has been awarded to the Contractor.

One can start to appreciate the flexibility of this LD-P2M2 process, in that DOE regards the document (even after it has been approved) to be a “live” one (just like the EMP) and can be subject to refinement and upgrade when justifiable. As such, the Project Proponent or the Contractor are given the flexibility to revise the approved LD-P2M2 Document to suit the evolving site conditions (if previously not accounted for) or change in design or construction methodologies. The resubmission of the revised LD-P2M2 Document allows DOE’s project officers to be informed of these site changes more expeditiously, and thus enhancing the effectiveness of DOE’s site inspections.

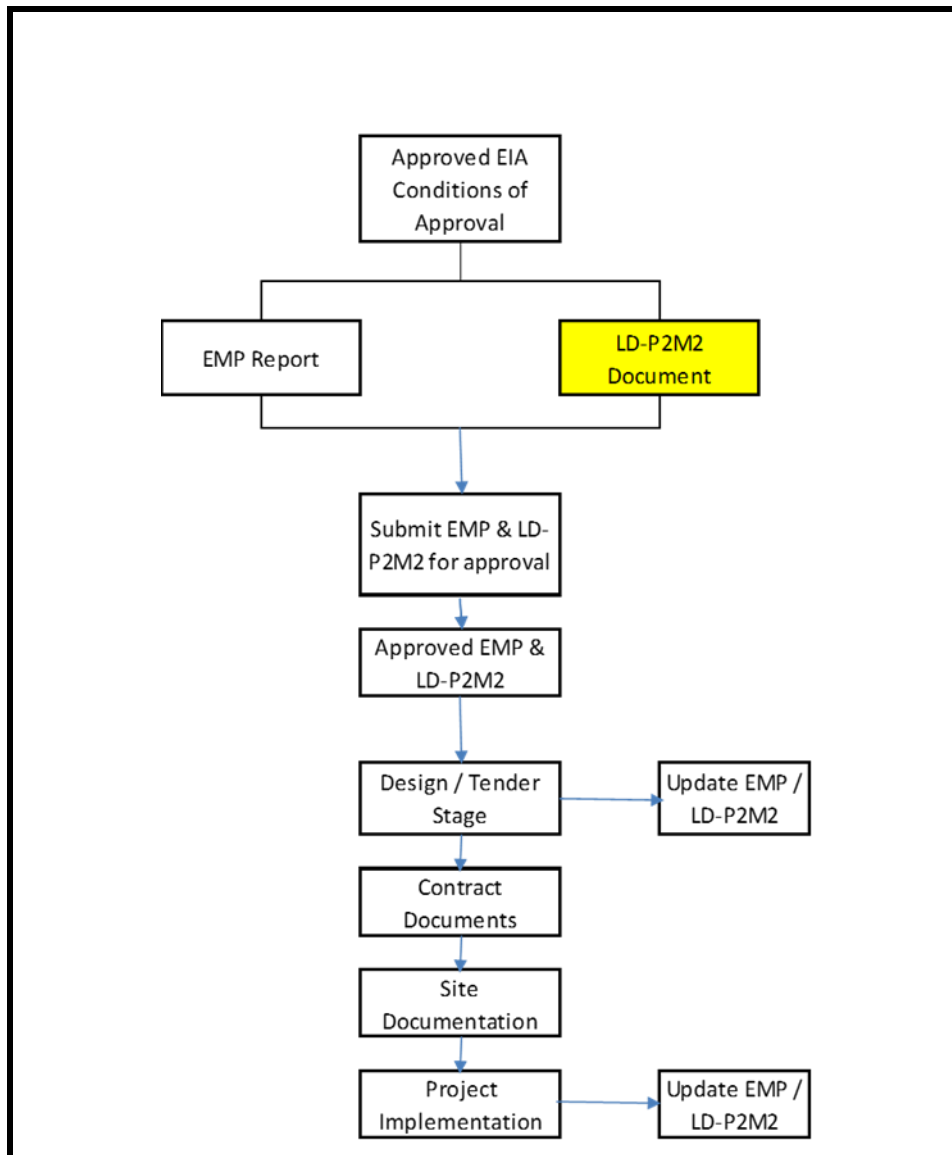


Figure 1.9: LD-P2M2 after EIA Approval Stage

#### 1.4 FRAMEWORK OF THIS GUIDELINES

In view of the above discussion, it is recognized that in order to tackle the problems of erosion and sediment at project development sites, there is a need to gain further understanding of various specific related topics, namely, the fundamentals of erosion and sediment, best management practices (BMPs) and their application, essence of land disturbing activities, phases of construction, to name a few.

In this regard, the framework for this *Guidelines* covered the domains of the “5-Ws” (What, Why, Where, Who and When) and “1-H” (How) of the LD-P2M2 document to include the following objectives:

- To provide a brief description and requirements of EQA, EIA, Prescribed Activities, EIA Process;

- To provide a brief background on past groundwork by DOE and other authorities on erosion control;
- To provide a brief history on evolution on DOE's efforts on erosion controls;
- To describe LD-P2M2 and the associated *Guidelines on LD-P2M2*;
- To describe the relevance of LD-P2M2 for EIA projects only;
- To describe all those major Land Disturbing activities throughout a project;
- To highlight the current problems with poor construction practices which result in serious erosion and sediment discharge issues;
- To highlight the gap analysis of the current practices with other practices elsewhere;
- To highlight potential improvement areas in addressing erosion within context of Malaysia;
- To provide the benefits & advantages of LD-P2M2;
- To describe a project's process;
- To illustrate how changing site conditions affect erosion;
- To describe how understanding the critical path method (CPM) in addressing erosion;
- To describe roles of Project Proponent, EIA Consultants, Design Engineers, Environmental Officers, Environmental Auditors, Main Contractors, Sub Contractors, Enforcement Authorities in implementing LD-P2M2;
- To describe step by step actions needed when formulating LD-P2M2;
- To provide guidelines on how to identify input data when preparing a LD-P2M2 document;
- To provide guidelines on how to estimate erosion quantities;
- To provide guidelines on how to identify sediment discharge patterns;
- To provide guidelines on how to mitigate and control erosion and sediment discharges;
- To provide guidelines on how to monitor and audit performance of the prescribed BMPs and mitigation measures; and
- To provide guidelines on how to implement LD-P2M2 at different stages of a project.

Subsequently, this *Guidelines* is organized in a logical sequence to provide the understanding as mentioned above as follows:

**Chapter 1: Introduction**

**Chapter 2: Fundamentals of Erosion and BMPs**

**Chapter 3: Identifying Land Disturbing Activities**

**Chapter 4: Identifying Phases in A Project**

**Chapter 5: Project Implementation Techniques**

**Chapter 6: Monitoring, Reporting & Documentation**

## CHAPTER 2

### FUNDAMENTALS OF EROSION AND BMPs

#### 2.1 LAWS, REGULATION AND OTHER GUIDELINES ON EROSION AND SEDIMENT

This section presents a review of the current legal framework within which the construction industry in Malaysia is working under, with regard to the prevention of erosion and sedimentation in their projects. In addition, some related existing guidelines are also discussed to explore the limitations, constraints and opportunities in these guidelines on the process for prevention of erosion and sedimentation, to be addressed in the Guidelines.

##### 2.1.1 Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015 and Section 34A of Environmental Quality Act (Amendment) 2012

*Section 34A* of the EQA stipulates that an environmental impact assessment (EIA) shall be conducted by a qualified person for any prescribed activity and submitted to the Director General for his approval. The EIA report shall be undertaken in accordance with the guidelines as prescribed by the Director General, and shall contain “*the proposed measures that shall be undertaken to prevent, reduce or control the adverse impact on the environment.*” This Section further stipulates that the person carrying out the prescribed activity “*shall provide sufficient proof that the conditions attached to the report (if any) are being complied with and that the proposed measures to be taken to prevent, reduce or control the adverse impact on the environment are being incorporated into the design, construction and operation of the prescribed activity.*”

Based on the review of the existing legal framework currently being implemented in Malaysia in relation to the pollution of the environment due to erosion and sediment discharges, it is evident that sufficient mechanisms are in place by the Director General to prevent and monitor the event of environmental pollution of this nature from any construction sites or premises. This is more pronounced for those prescribed activities whereby an EIA report shall be required to be approved prior to commencement of the site works and to adequately address the means to prevent, reduce or control the possibility of environmental pollution due to erosion and sediment discharges to the inland or Malaysian waters.

##### 2.1.2 Environmental Impact Assessment Guideline in Malaysia, 2016

Pursuant to *Part IV, Section 34A* of the above Act, pertinent excerpts from the “*Environmental Impact Assessment Guideline in Malaysia, 2016*” which are

relevant to the prevention of erosion and sediment discharges from a construction site are reproduced below:

*“The EIA procedure, a preventive strategy of the DOE also needs to embrace the environmental mainstreaming and self-regulation goal in order to enhance its effectiveness in mitigating the adverse impacts from development projects on the environment at every stage of the EIA procedure. Self-regulation culture in EIAs means that the Project Proponent will be charged with full responsibility and accountability for taking environmental friendly options and instituting effective pollution prevention and mitigation measures (P2M2) and self-demonstration of regulatory compliance of the EIA procedure at all stages of project implementation.”*

*“Legal responsibility rests on the shoulders of the Project Proponent hence he shall be totally committed towards ensuring regulatory compliance of his project with the EIA procedure at all stages of project planning and implementation. The Project Proponent is the key driver for ensuring the success self-regulation approach in environmental management through the mainstreaming of environmental agenda throughout his project implementation phases. The project proponent shall ensure top-down organizational commitment to environmental regulatory compliance to all personnel, at all levels of the organization, including the registered EIA consultant, the EO, the contractors, and other parties involved in the project implementation.”*

*“Allocating sufficient funds for all steps in the EIA process and every stage of project planning and implementation with itemized budget required for water quality monitoring, air quality and noise monitoring, for comprehensive site survey and investigation of the specific existing site conditions, for implementation of Environmental Management Plan (EMP) including temporary pollution prevention and mitigation measures (P2M2). P2M2 shall be those which can be described as state of the art technologies, best available technologies (BATs), or industry best practices.”*

*“The investor whose project has been planned on sound environmental principles right from the start might be safeguarded against environmental costs once the project has been implemented. EIA being a preventative-planning tool helps to avoid costly remedial actions by taking proactive measures also helps to protect the investment.”*

The above is in line with the intent of the Act in an attempt to address erosion and sediment issues in the construction industry. In essence, the key objectives of LD-P2M2 are not distinctly different from DOE's previous erosion control and sediment documents or requirements. The topic on soil erosion and siltation prevention and control is not a new subject in DOE, with various guidelines

issued on the very subject. In fact, DOE has kept up with the evolution of this subject, which culminated in the issue of various document and articles, as discussed in the following sections.

### **2.1.3 Guidelines for Prevention and Control of Soil Erosion and Siltation in Malaysia, DOE, 1996**

This document was prepared after an overall review of the first document on erosion and siltation was issued by DOE in 1978, namely the “Guidelines for Prevention and Control of Erosion and Siltation (also referred to as ANNEX I), as well as the review of its latter version, the “Guidelines for Prevention and Control of Erosion and Siltation (also referred to as ANNEX III) issued by DOE in 1992. The main purpose of the 1996 Guidelines is to “*provide a checklist of existing information pertaining to soil erosion and sedimentation so that developmental activities can be planned and executed in a judicious manner with minimum degradation*”<sup>1</sup>.

It is also acknowledged in this document that the Guidelines “are not a substitute for professional experience, training and local knowledge”.

**Coverage of Document:** The salient topics covered by this 1996 Guidelines include: *Erosion and Sedimentation Processes; Procedural Stages for Erosion and Sediment Control; Guidelines for the Prevention and Control of Soil Erosion and Sedimentation; Erosion and Sediment Prevention and Control Measures; and Some Indicative Costings for Erosion and Sediment Control.*

**Strength of Document:** The 1996 *Guidelines for Prevention and Control of Soil Erosion and Siltation in Malaysia* serves as a useful document to provide some background information on the process of erosion and sedimentation typically encountered in projects undertaken in Malaysia. It also goes as far to generically cover the possible erosion risks for the “List of Prescribed and New Activities” under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. Additionally, it also outlines the procedures in preparing an Erosion and Control Plan (ESCP) and provides a variety of pictorial examples of drainage control measures, erosion control measures and sediment control measures. Last but not least, the 1996 Guidelines also presented some factors to be considered during the costing of erosion control measures.

**Gap Analysis:** Although the 1996 *Guidelines for Prevention and Control of Soil Erosion and Siltation in Malaysia* represent a good overall technical document to address erosion and sedimentation matters, it could be perceived to be more suited for persons who already possess professional experience, training and local knowledge in the fields of design and construction. The Guidelines acknowledges

---

<sup>1</sup> Guidelines for Prevention and Control of Soil Erosion and Siltation in Malaysia, DOE, 1996

the importance maintaining the robustness of an erosion and sediment control programme, but does not provide further illustrations or examples on how this programme evolves with the construction sequence and activity scheduling. One of the common pitfalls of past ESCPs is the assumption that once an ESCP is approved by JPS prior to works commencement, then the process completes. On the contrary, the ESCP should be treated like an EMP whereby the latter is a “live” or dynamic document (as opposed to a static one) and subject to revision whenever there are significant changes to the project. In this regard, this is one of the improvement areas that would be considered during the formulation of the *Guidelines on LD-P2M2*.

#### **2.1.4 Certified Erosion, Sediment and Storm Water Inspector Manual, US Version, EnviroCert International, Inc., November 2011**

This document was prepared by EnviroCert International, Inc. to facilitate the CESSWI programme and certification which meets the USEPA’s requirements for registration of “Qualified Personnel” in the United States.

*Coverage of Document:* The salient topics covered in this Manual include: *US Rules and Regulations; Safety; Communication; Documentation; Inspector Duties; Plan Management; and Best Management Practices.*

*Strength of Document:* As the title of this document suggests, the Manual is more tailored for personnel who are involved in the inspection or provision of erosion, sediment and stormwater mitigation measures on a project site. It provides detailed procedures for an inspector to be prepared before, during and after site inspection on matters related to erosion. The CESSWI Manual also included a variety of proven BMPs covering *site planning and management, erosion controls, sediment controls, runoff controls, good housekeeping/materials management, and post-construction management.*

*Gap Analysis:* Although the 2011 *CESSWI Inspector Manual* represents a useful handbook for persons involved in the inspection of a site pertaining to erosion and sediment pollution, the document does not cover the earlier stages of the project, i.e. the consideration of erosion during the planning and design stages of the project. Additionally, limited discussion is found in the Manual to address the progressive state of a project site and how to address these changing site conditions in erosion and sediment controls. Another important point to note is that this Manual has been written within the context of the US regulation on environmental protection.

### 2.1.5 Erosion and Sediment Control Planning and Design Manual, North Carolina Department of Environment and Natural Resources

This document was prepared as a cooperative effort between the North Carolina Sedimentation Control Commission, North Carolina Department of Environment and Natural Resources and the North Carolina Department of Transportation, to cover effectively all land-disturbing activities (except agriculture and mining) in North Carolina.

**Coverage of Document:** The salient topics covered by this Manual include: *Processes and Principles of Erosion and Sedimentation; Vegetative Considerations; Preparing the Erosion and Sedimentation Control Plan; Overview of Erosion and Sedimentation Control Practices; and Practice Standards and Specifications.*

**Strength of Document:** This Manual serves as a useful document to provide guidelines in the design of BMPs used in the United States (USA). Although there is some mention on the importance of construction scheduling in Chapter 4 of the Manual, it would appear that the manual was more tailored for civil engineers who are assumed to have some engineering background. For practices in the USA, much information has been included on the typical standards and specifications for the BMPs that may be deployed. Again, a variety of examples of possible erosion and sediment control measures is contained within the manual.

**Gap Analysis:** It is noted that this Manual has been written within the context of the US regulation on environmental protection. Although certain aspects of the standards and specifications may be reviewed for its appropriateness to be used in Malaysia, much of the practices have been written for USA application. In addition, the North Carolina appears to be tailored for the use of persons with engineering background. One of the important factors that need to be considered during the formulation of the *Guidelines on LD-P2M2* will be that it should be a user-friendly document and easily understood also by persons without engineering background.

### 2.1.6 Chapter 12 Erosion and Sediment Control, Manual Saliran Mesra Alam (MSMA), JPS, 2012

This chapter was prepared by the Department of Irrigation and Drainage (JPS) to provide relevant guidelines and procedures for reduction and control of erosion and sedimentation during project development in order to minimize land, water quality and environmental degradation.

**Coverage of Document:** The salient topics covered by this chapter include: *Erosion and Sedimentation Processes; Erosion and Sediment Control Principles;*

*Design Guidelines for Erosion and Sediment Control BMPs; and Preparation of Erosion and Sediment Control Plan (ESCP).*

**Strength of Document:** This document is a useful reference to provide guidelines in the handling of erosion and sedimentation issues in the context of Malaysian practices. This chapter not only introduces the characteristics of rainfall and soil properties that are suited for use in Malaysia, it also discusses examples of erosion and sediment control BMPs that are typically applied in the local context. Lastly, an overview of the steps to be considered during the preparation of an ESCP for several stages of the project is also included, namely the planning, design and construction phases.

**Gap Analysis:** Under the subsection *12.5.4.1 Site Inspection & Monitoring* in this **Chapter 12**, it is mentioned that the monitoring programme should consist of regular inspection to determine, amongst others, “changes in drainage patterns, whereby all runoff whether disturbed or natural flows should be ensured to be well managed, including those runoff arising from changes in drainage patterns due to earthwork or to other unanticipated manner”. Additionally, it is also noted that during the course of construction, “unexpected schedule changes, phasing changes, staging area modification, off-site drainage impacts, and repeated failures of design controls” must be made known and “the ESCP revised accordingly”. Despite the above being mentioned, there is however limited elaboration on how the above issues should be mitigated during the planning and design phases, i.e., prior to commencement of construction works. Additionally, this document does not include appropriate BMPs that are endorsed by any parties. During the formulation of the *Guidelines on LD-P2M2*, this gap will need to be addressed by inclusion of topics that deal with CPM as well as understanding construction sequences and drawings.

### **2.1.7 Summary**

It is seen from the above that although much has been written on the subject of erosion and sediment in the construction practice, there is still a gap on how issues such as “unexpected schedule changes, phasing changes, staging area modification, off-site drainage impacts, and repeated failures of design controls” should be mitigated during the planning and design phases, i.e., prior to commencement of construction works. There is also limited discussion to address the progressive state of a project site and how to address these changing site conditions in erosion and sediment controls. Although some of the literature acknowledges the importance of maintaining the robustness of an erosion and sediment control programme, they however do not provide further illustrations or examples on how this programme evolves with the construction sequence and activity scheduling. In this regard, the LD-P2M2 seeks to take into account the

above gaps in order to minimize the impacts of erosion and sediment in our construction sites.



## 2.2 UNDERSTANDING EROSION



There are currently numerous literatures that discuss in detail the phenomena of erosion and sedimentation, and it is not the intention of this *Guidelines* to reproduce such discussion herein. Nevertheless, for the purposes of completeness, the description for some of the commonly used terms throughout this *Guidelines on LD-P2M2* is included below. In the context of this *Guidelines*, erosion caused by snow and wind is not considered since it is not relevant in Malaysia.

### 2.2.1 Erosion

In simple terms, erosion can be described as follows:

1. **Raindrop** erosion leads to **sheet** erosion.
2. **Sheet** erosion leads to **rill** erosion.
3. **Rill** erosion leads to **gully** erosion.
4. **Gully** erosion leads to **channel** erosion.



<p><b>Raindrop Erosion</b></p> <p>Raindrops detach soil particles and splash them into the air. These detached particles are then vulnerable to stormwater runoff.</p>	 <p><i>Raindrop erosion.</i></p>
<p><b>Sheet Erosion</b></p> <p>Sheet erosion is the uniform removal of soil in thin layers by the forces of raindrops and overland flow. It can cover large areas of sloping land and can be recognized by either soil deposition at the bottom of a slope, or by the presence of light - colored subsoil appearing on the surface. If left unattended, sheet erosion will gradually remove the nutrients and organic matter which are important to agriculture and eventually lead to unproductive soil.</p>	 <p><i>Sheet erosion</i></p>

<p><b>Rill Erosion</b></p> <p>As the flow changes from a shallow sheet to a concentrated flow, the velocity and turbulence of the flow increases. The energy of the concentrated flow is able to detach and transport soil particles. This action begins to cut into the soil mantle and form tiny channels. Rills are small, but well-defined channels that are only a few inches deep.</p>	 <p><i>Rill erosion</i></p>
<p><b>Gully Erosion</b></p> <p>Rills gradually come together to form gullies. Whereas rill erosion can be eliminated or repaired fairly easily, gully erosion requires major work to regrade and stabilize</p>	 <p><i>Gully erosion</i></p>
<p><b>Channel Erosion</b></p> <p>As runoff in rills and gullies moves downstream, it enters channels that are also susceptible to erosion through bank cutting and degradation. Channels continually adjust and change, degrading and widening, in response to increased runoff from urbanization.</p>	 <p><i>Channel erosion</i></p>

**2.2.2 Sedimentation**

Wind and water pick up soil particles to deposit them elsewhere. This is the process of sedimentation. In a river, sediment moves slowly downstream especially during high flows following rainfall. This can cause property damage, increase maintenance costs, impair habitat and water quality.

In lakes and reservoirs it can accelerate eutrophication and loss of storage. No erosion control plan can be 100 percent effective; therefore, erosion and sediment control measures must also put in place designed to capture eroded sediments before their conveyance off site.

	<p>Heavy sedimentation in upstream waters can wipe out aquatic habitat like in this stream from Lojing Hills</p>
	<p>Poor control of logging operations and illegal logging has led to serious river damage as shown in Sg Rajang here</p>

### 2.3 ISSUES OF EROSION AND SEDIMENT

To understand the concept underlying the application of LD-P2M2, foremost, it will be useful to review the list of overall issues of erosion and sediment which was previously touched on in Chapter 1.

Overall Issues of Erosion and Sediment
<ul style="list-style-type: none"> <li><input type="checkbox"/> Coordination &amp; Communication</li> <li><input type="checkbox"/> Command &amp; Control</li> <li><input type="checkbox"/> Issue of work program</li> <li><input type="checkbox"/> Construction activity</li> <li><input type="checkbox"/> Construction schedule</li> <li><input type="checkbox"/> Construction methodology (Method statement)</li> <li><input type="checkbox"/> Issue of planning</li> <li><input type="checkbox"/> Issue of work stages</li> </ul>

- Issue of project phasing
- Issue of work sequence
- Issue of site possession
- Issue of river/stream diversion
- Issue of river/stream crossing
- Issue of capacity building and logistic (physical/financial/fund)
- Issue of cost and benefit analyses (double handling and timeline)
- Issue of upholding Code of Practice in Earthwork
- Issue of construction (earthwork) team having common practice of Excavation (cut & fill) Team, Stabilization Team and Permanent Drainage Team while in short of Temporary Drainage Team.
- Issue of design change
- Issue of erosion and sediment control measures designer/preparer not the supervising consultant at jobsite.
- BMPs stocking
- Environment Officer level of authority
- BMPs NOT IN PLACE

### 2.3.1 Coordination & Communication

This is probably one of the more significant contributions to erosion and sediment issues on site. More often than not, the expectation and requirement on dealing with land disturbance activities for an EIA project are not adequately or clearly expressed between Project Proponent and Contractor, and even within the Contractor's internal project team. In this regard, the LD-P2M2 Document, to be prepared in the early stage of the project, namely during the EIA stage, will serve as a reference document for all project parties involved to understand and identify site constraints, areas of concern, problem areas, designated and potential discharge points of runoffs, and to develop early planning on how, what, why, where and when to effectively implement the pollution prevention and mitigation measures at the development site. The LD-P2M2 Document also seeks to standardize the information to be highlighted, by including the minimum standard requirements of pollution prevention and mitigation measures (as discussed in Chapter 5) that will be adopted, applied, and implemented in the process of carrying out land disturbing activities at the development site for all EIA projects. Particularly with regard to this issue of coordination & communication, the relevant minimum standard requirements are generally covered under the following areas:

- ❖ *Scheduled Site Meeting*
- ❖ *Site Inspections*
- ❖ *Maintenance*

### 2.3.2 Command & Control

Traditionally, the project parties are generally reactive towards the issues of erosion on their project sites. At site, deficiency or non-compliances may be spotted and called out by the site management but the question is: how many times are these instructions actually attended to or followed through? Although there may be the element of “command” from the site management but it would appear a lack of “control” to see through the “command”. Many times, actions are only taken to address these issues only after a citation is issued by the authorities from site inspection or a public complaint has been received. In this regard, the LD-P2M2 is in line with DOE’s proposed *self-regulation policy* requiring all parties (project proponent, consultants, contractors and environmental officers) to increase their vigilance and efforts to address erosion and sediment issues much earlier before the site activities commence, and to prevent these issues from occurring during the project. The minimum standards requirements of P2M2 in this regard are covered by the following clause:

- ❖ *Establishment of Environmental Performance Monitoring Committee (EPMC) and Performance Monitoring Documentation*

### 2.3.3 Issue of work program

Conventionally, the Contractor’s work program is more concern with “getting the work done” and even when the program does include reference to tasks dealing with erosion and sediment, the extent of such activities is either with limited details or too general to allow a more precise estimate of the site events to pre-empt erosion and sediment from occurring. In this regard, the LD-P2M2 Document seeks to breakdown the project into a dedicated work breakdown structure (WBS) which focuses more on land disturbance activities that are likely to generate erosion and sediment. This allows a supplementary work program to be prepared to predict with a higher level of confidence the types and details of application of P2M2s into the project. The minimum standards requirements of P2M2 in this regard is covered by the following clause:

- ❖ *Schedule of Phasing, Staging and Sequencing*

### 2.3.4 Construction activity

Similar to the above, the Contractor conventionally is more interested to get to the end point, and this resulted in simultaneous work activities taking place on the site

and in many cases, with little or poor planning towards addressing erosion and sediment issues. In this regard, the concept of LD-P2M2 puts the onus on all the project parties to conduct their construction activities in a more systematic manner, particularly on land disturbing activities, so as to have a better control over the potential effects of these activities. Again, this issue is covered by the minimum standards requirements of P2M2 relating to *Schedule of Phasing, Staging and Sequencing*.

### 2.3.5 Construction schedule

Conventionally, the lack of project construction scheduling to cater for all major land-disturbing activities which include work zones, phasing of construction within the work zones, staging and sequencing within the phases of construction that coincides with the installation of P2M2s represents a major reason for the issues of erosion and sediment in our construction practice. In this regard, the concept of LD-P2M2 which emphasizes one the minimum standards requirements of P2M2 relating to *Schedule of Phasing, Staging and Sequencing* attempts to overcome this issue.

### 2.3.6 Construction methodology (Method statement)

Method Statements are commonly used in construction projects, and most times, they are a “must”. However, the current practice in Malaysia focuses primarily on “technical” method statements that are more concerned with the methodologies to complete the tasks to arrive to the final products, and limited efforts have been expanded into producing “environmental method statements”. In this regard, the LD-P2M2 Document seeks to include environmental method statements which target those tasks that are needed throughout the land disturbing activities through the implementation of the “minimum standard requirements” of pollution prevention and mitigation measures. The minimum standards requirements of P2M2 in this regard is covered by the following clause:

❖ *Project Activity and Implementation*

### 2.3.7 Issue of planning

This issue is somewhat along the same line of the above issues for work programme, scheduling and activities, but also extends to the lack of planning in terms of management of the site from the perspective of its surrounding environment. In LD-P2M2, one of the basic principles emphasizes *integration of project design with site constraints*, which requires careful planning of site management and implementation of pollution prevention and mitigation measures. During implementation, the LD-P2M2 Document shall be used as a reference document especially for the Environment Officer (EO) to understand and identify

site constraints, areas of concern, problem areas, designated and potential discharge points of runoffs, and to develop early planning on how, what, where, why, and when to effectively implement the pollution prevention and mitigation measures at the development site. The successful application of the minimum standards requirements of P2M2 relating to *Construction Markers, Stream/Drainageway/Waterway/Watercourse Buffers, Perimeter Control, Runoff Management, Temporary or Permanent Watercourse Diversion and/or Crossings, Temporary Stabilization, and Stockpile Soil Management* to a large degree depends very much on the adequacy of planning efforts prior to their usage.

### **2.3.8 Issue of work stages and project phasing**

Again, another long time “mistake” committed by major projects which involve extensive land disturbing activities is in the lack of project staging and phasing, which ultimately resulted in large tract of land cleared of its natural vegetation and suffering the consequences of erosion and sediment issues. In this regard, the LD-P2M2 Document seeks to focus on ways to parcel the project implementation into phases to ensure the amount and duration of soil exposed (from the land disturbing activities) to erosion is reduced as much as practicable at any one time by implementing and maintaining the suitable BMPs in coordination with the sequence of construction activities, as required as one of the minimum standards requirements of P2M2 relating to *Schedule of Phasing, Staging and Sequencing*.

### **2.3.9 Issue of work sequence**

The lack or “wrong” work sequence executed on site will inevitably lead to erosion and sediment control issues, which sometimes render the problem too difficult or very costly to be remedied. In this regard, the LD-P2M2 Document seeks to identify the respective work sequence in tandem with project phasing so that the relevant project parties are clear on how the project activities should proceed in the right order, and the necessary P2M2s to be implemented at any particular point in time during the site works. The concept of LD-P2M2 which emphasizes the minimum standards requirements of P2M2 relating to *Schedule of Phasing, Staging and Sequencing* attempts to overcome this issue.

### **2.3.10 Issue of site possession**

Confusion caused by issue of site possession such as overlapping possession dates or ambiguity in the right-of-way can be mitigated or minimised, again, through the application of the minimum standards requirements of LD-P2M2 relating to *Schedule of Phasing, Staging and Sequencing*.

### **2.3.11 Issue of river/stream diversion**

The worst thing which can happen during a river/stream diversion works is the lack of planning and foresight given to potential erosion and sediment issues. Once the existing river/stream has been rerouted to the diversion channel, nothing effective much can be done to the now “live” river/stream which will continuously carry eroded materials to the downstream side. In this regard, the LD-P2M2 Document seeks to include the appropriate environmental method statements through the implementation of “minimum standard requirements” covered under the following clause:

- ❖ *Temporary or permanent watercourse diversion*

### **2.3.12 Issue of river/stream crossing**

Similarly, lack of planning and mitigation measures on erosion and sediment issued before and during the construction of river/stream crossing may ultimately result in a continuous erosion of the river sides, creating impacts to the downstream side of the river/stream. In this regard, the appropriate “minimum standard requirements” in LD-P2M2 seeks to provide the following:

- ❖ *Temporary or permanent watercourse crossing*

### **2.3.13 Issue of capacity building and logistic (physical/financial/fund)**

The lack of resources being a reason for why BMPs are not provided or installed should not be an issue in the future, by instituting that the LD-P2M2 Document is a legal pledge to be made by the Project Proponent to take efforts, measures, actions or due diligence in accomplishing the overarching goal of protecting the environment and in mitigating the environmental impact in the process of implementation of the proposed development. As a result, the PP shall be responsible for the implementation of the LD-P2M2 which shall incorporate the P2M2s identified to be installed at the land disturbing development areas into the design, construction and operation stage of the development project as stipulated in Section 34A (7) of the EQA.

### **2.3.14 Issue of cost and benefit analyses (double handling and timeline)**

The “minimum standard requirements” on *Schedule of Phasing, Staging and Sequencing* should pre-empt this issue, along with the requirement that the LD-P2M2 shall incorporate the P2M2s identified to be installed at the land disturbing development areas into the design, construction and operation stage of the development project as stipulated in Section 34A (7) of the EQA.

### 2.3.15 Issue of upholding Code of Practice in Earthwork

Although the *BSI British Standards BS 6031 2009: Code of practice for earthworks* is almost always included in the contract Specifications for most civil engineering project that would involve extensive or significant land disturbing activities, the physical practices encountered on project sites at times do not comply with the guidelines, recommendations and even requirements as stipulated under the code. In this regard, Chapter 4 of this *Guidelines* will recapture the relevant excerpts from *BSI British Standards BS 6031 2009: Code of practice for earthworks* on erosion and sediment controls for reference.

### 2.3.16 Issue of construction (earthwork) team having common practice of Excavation (cut & fill) Team, Stabilization Team and Permanent Drainage Team while in short of Temporary Drainage Team

The key problem with the above issue is that whilst the work teams are basically complete to deal with the permanent works construction, no one is basically tasked to address erosion and sediment issue which will inevitably occur during their works. Even the *Stabilization Team* is likely to be focussing on the ‘permanent’ stabilization as required in the contract drawings and specification. In this regard, the LD-P2M2 which emphasizes on *Schedule of Phasing, Staging and Sequencing*, and *environmental method statements* shall clearly show the need for implementation of temporary BMPs.

### 2.3.17 Issue of design change

Changes in project design and construction methods during the execution of the construction works are not uncommon and typically accepted, due to sometimes unforeseen circumstances on the site or late add-ons by the Project Proponent. That is why it is important to have a LD-P2M2 Document that is in-place at the start of the contract works to document the planning and proposed implementation of the P2M2 based on the original intent of the Project Proponent’s design. As shown later in this chapter, the LD-P2M2 Document will be subject to being updated as necessary, particularly to address design changes and evolving site conditions. In any case, the *Standards and Specifications for P2M2s* will remain to be consistent through the change process, whereby it is stated under the minimum standards requirement that all P2M2s shall be designed, constructed, installed, and maintained in accordance with good engineering practices and applicable design specifications, and that their application onsite shall be in accordance with the various standards and specifications of the Department of Irrigation and Drainage (DID), amongst others.

### **2.3.18 Issue of erosion and sediment control measures designer/preparer not the supervising consultant at jobsite**

In today's construction practice, there is currently no requirement or stipulation for the Contractor or the Project Proponent to reengage the designer or preparer of the erosion and sediment control plans or reports in a supervisory role during the execution of the project on site. This lack of continuity in the knowledge transfer between the planning stage and construction stage of the project may sometimes be one of the causes of site issues, possibly due to loss of information or misinterpretation of the original designer's intention. In this regard, it is required that the LD-P2M2 Document shall be "prepared and signed by a DOE registered consultant who holds a certification as a professional in erosion and sediment control issued by the Department of Environment" and that the Environment Officers have to be certified by DOE and officially appointed or engaged by the PP to be responsible for environmental performance of the project.

### **2.3.19 BMPs stocking**

It is a common phenomenon whereby during a site inspection (be it by the EO or authorities), it is found that BMPs are lacking or wrongly installed on site. At this point, when the contractor is urged to immediately rectify the non-compliance, it is not uncommon for him to reply as such: "*We don't have the materials*" or "*It will take us two or more weeks to get the materials to site*". What should be realised is that during the time while waiting for the "materials to come to site", erosion is continuing and unquantifiable amount of sediment is being discharged to the sensitive receivers. In this regard, to overcome this time gap, it will be required that the Contractor to keep in his site inventory of between 10 to 20% of those BMP materials which are not off-the-shelf items. An example of such provision can be the establishment of a temporary nursery on site to have readily, at least, a small supply of cover crops to be used in emergency periods.

### **2.3.20 Environment Officer level of authority**

In this regard, all activities subject to EIA Order, 2015 which involve land disturbing or site preparation activities are required to prepare a LD-P2M2 as part of the EMP submission requirement, and the LD-P2M2 Document is to be used as a reference document especially for the Environment Officer (EO) to understand and identify site constraints, areas of concern, problem areas, designated and potential discharge points of runoffs, and to develop early planning on how, what, where, why, and when to effectively implement the pollution prevention and mitigation measures at the development site. To this end, the EO refers to the person who has been certified by the DOE and officially appointed or engaged by the PP to be responsible for environmental performance of the project.

### 2.3.21 BMPs not in place

The cumulative effect of all or some of the issues discussed above taking place during the pre-construction and/or construction stage of a project will ultimately result in BMPs not installed or implemented on site. In addition to the minimum standards requirements of LD-P2M2 already discussed above, the following standards requirements are also needed to be stipulated in the LD-P2M2 Document:

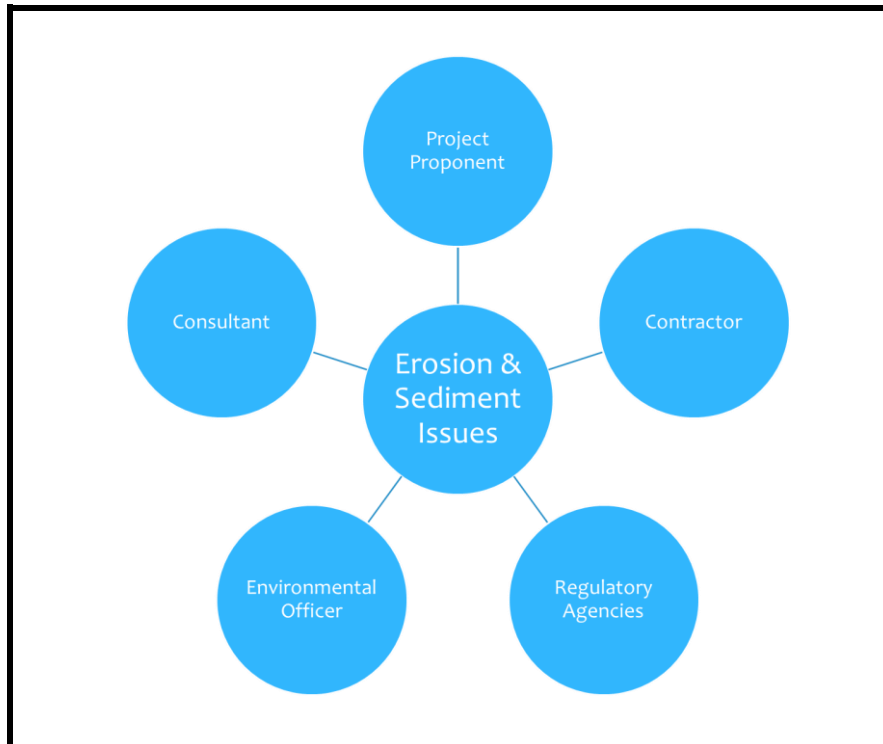
- ❖ *Construction Markers*
- ❖ *Stabilized Construction Entrance*
- ❖ *Stream/drainage way/waterway/watercourse buffers*
- ❖ *Perimeter Control*
- ❖ *Sediment Basin/Trap*
- ❖ *Runoff Management*
- ❖ *Temporary or permanent roadways*
- ❖ *Temporary Stabilization*
- ❖ *Stockpile Soil*
- ❖ *Spoil Management Area (Disposal Area)*
- ❖ *Dewatering practices*
- ❖ *Active Treatment System (ATS)*
- ❖ *Discharge*
- ❖ *Corrective Actions*

Graphical illustrations of the above issues relating to erosion and sediment are included in **Appendix A**, whilst more details on the minimum standards requirements are presented in **Appendix B** of this *Guidelines*.

## 2.4 CULTURE OF OUR CONSTRUCTION INDUSTRY

### 2.4.1 Parties Contributing to Erosion and Sediment

The major parties who may either directly or indirectly contribute to or are involved in the issues of erosion and sedimentation in an EIA project are shown below.



**Figure 2.1: Parties Involved in Erosion & Sediment**

The Project Proponent (PP) is directly involved in these issues even though he is not actually ‘executing’ the works at the site, because by nature of his status, he is the ultimate owner of the project. The PP is responsible for the preparation and submission of the EIA report, and in this report, he has declared his commitment to protect the environment and to keep any potential environmental pollution resulting from the project implementation to the acceptable levels or as stipulated in the conditions of approval of the approved EIA report. During project execution, it is not uncommon for the PP to also appoint an Environmental Officer (EO) to represent the PP in the monitoring and auditing the performance of environmental compliance of the project. In turn, the EO needs to suitably experienced and knowledgeable in all matters of environmental management, including those related to erosion and sediment control, to properly monitor, review, audit and correct the performance and effectiveness of the P2M2s implemented on site.

In most cases, the PP will engage external and qualified Consultants to undertake the EIA study, and to perform the other engineering tasks such as design and construction supervision. Traditionally, the issues on erosion and sediment have not been given much attention by these consultants, and one of the reasons being limited construction information is available prior to the tender process. Another likely reason may have been the misconception that dealing with erosion and sediment issues on site should primarily be the responsibility of the Contractor who is executing the works on site. Such perception will need to be changed soon, because with implementation of LD-P2M2 along with *self-regulation*, all parties

will be accountable for erosion and sediment issues, right from the EIA stage and though the design and tendering process of the project.

Many times, the Contractor who is ultimately executing the project on site gets all the blame if some untoward events occur relating to his site activities. To overcome such adversarial relationship between the Contractor and Project Proponents (and his Consultants), the LD-P2M2 can be used as a referencing platform for all parties to at least have an overall understanding on the requirements and expectation for addressing erosion and sediment issues. The key to this common understanding of LD-P2M2 is the “minimum standard requirements” on P2M2s that are expected to be implemented into the project.

Regulatory agencies such as DOE make frequent site inspections to EIA projects during the implementation phase, either under a periodic inspection schedule or adhoc site visits. The involvement of such agencies would primarily be to assess the compliance (or non-compliance) to the COA of the approved EIA reports, as well as to gain some general assessment of the site’s overall environmental performance via visual observations. Where non-compliances are encountered, such agencies may consider to take further actions by virtue of the powers and duties delegated to the agencies under the appropriate legislation.

#### **2.4.2 Perception of Project Parties**

In **Appendix C**, a summary of the perception from various project parties pertaining to erosion and sediment control has been tabulated to reflect the current culture of the construction industry.

### **2.5 QUANTIFYING AND PREDICTING SOIL LOSS**

It is not the intention of this *Guidelines* to recapture the theories behind the techniques in quantifying and predicting soil loss from erosion process, and the resulting sediment yield. However, a sample calculation worksheet for the above has been included in **Appendix D** for reference to this aspect.

### **2.6 FUNDAMENTALS OF BEST MANAGEMENT PRACTICES (BMPS)**

#### **2.6.1 Basic Principles & Requirement**

The focus of the LD-P2M2 is on the prevention, mitigation and control of the discharge from the development area containing the major pollutant (suspended solids) resulting from land disturbing activities. Controlling the sediment-laden

runoffs means to control the discharge of other pollutants that may contain in the sediment strains such as nutrients, bacteria, oxygen demanding materials, heavy metals, petroleum hydrocarbons and synthetic organics. Everyone involved with land disturbing activity shall make the most of the following basic principles in every stage of development when implementing the pollution prevention and mitigation measures:

- *Integrate project design with site constraints.*
- *Preserve and stabilize drainage ways.*
- *Minimize the extent and duration of disturbance.*
- *Control runoff flows onto, through and from the site in stable drainage structures.*
- *Install perimeter controls.*
- *Stabilize disturbed areas promptly in a timely manner.*
- *Protect steep slopes.*
- *Use sediment controls to prevent off-site damage.*
- *Protect inlets, storm drain outfalls, and culverts.*
- *Provide access and general construction controls.*
- *Inspect and maintain best management practices and control measures.*
- *Employ experienced and competent personnel and consistently conduct relevant training.*

## 2.6.2 Standards and Specifications for P2M2s

All P2M2s shall be designed, constructed, installed, and maintained in accordance with good engineering practices and applicable design specifications. Application of all P2M2s onsite shall be in accordance with standards and specifications indicated, specified, stated, depicted and set forth in:

- a. Department of Irrigation and Drainage – DID 2010. Guideline for Erosion and Sediment Control in Malaysia
- b. Department of Irrigation and Drainage – DID. 2000. Urban Storm Water Management Manual for Malaysia
- c. Erosion and Sediment Control Planning and Design Manual issued by North Carolina Department of Environment and Natural Resources<sup>2</sup>
- d. Best Management Practices for Construction and Maintenance Activities issued by North Carolina Department of Transportation<sup>3</sup>

<sup>2</sup> Note: This manual can be accessed at <https://enviro.doe.gov.my/>

<sup>3</sup> Note: This manual can be accessed at <https://enviro.doe.gov.my/>

### 2.6.3 Categories of BMPs

This section lists the suitable BMPs that are applicable for use in Malaysia, consisting of five categories in different applications namely, *Site Planning and Management*; *Erosion Control*; *Runoff Control*, *Sediment Control*; and *General Construction Control*. A comprehensive collection of the examples for each of the above categories is contained in **Appendix E**, as well as a presentation of a recent initiative by the DOE to observe and study the effectiveness of certain BMPs in the market.

#### 2.6.3.1 Site Planning and Management

- *Biomass*
- *Preserve Existing Trees & Vegetation*
- *Resource On-Site Rocks*
- *Stockpile Topsoil*
- *Salvage Trees (Translocation)*
- *Establish Nursery*

#### 2.6.3.2 Erosion Control

- *Land Grading – Terracing*
- *Soil Roughening*
- *Mulching & Hydromulching*
- *Hydroseeding*
- *Turfing*
- *Temporary Cover Geotextile Mat*
- *Temporary Plastic Sheet Cover*
- *Seeding*
- *Re-Vegetation*
- *Hydromulch-Hydroseed*
- *Rolled Erosion Control Product*

#### 2.6.3.3 Runoff Control

- *Diversion*
- *Check Dam*
- *Dissipator*
- *Pipe Slope Drain*
- *Temporary Cut-off Drain*
- *Soil Retention*
- *Flume / Chute*
- *Rolling Dip*

- *Inlet Protection*
- *Outlet Protection*
- *Level Spreader*
- *Riprap*

#### **2.6.3.4 Sediment Control**

- *Wash Trough and Stabilized Entrance/Exit*
- *Construction Road Stabilization*
- *Brush Barrier*
- *Silt Fence*
- *Sediment Basin / Trap*
- *Fiber Rolls / Wattles*
- *ATS – Polymer*
- *Application of FLOC LOG*
- *Turbidity Curtain*

#### **2.6.3.5 General Construction Control**

- *Street Cleaning*
- *Water Browser*
- *Secondary Containment System*
- *Sanitation*
- *Concrete Washout*

## CHAPTER 3

### IDENTIFYING LAND DISTURBING ACTIVITIES

#### 3.1 DEFINITION

##### 3.1.1 Types of Land Disturbing Activities

The definition of “Land Disturbing” has been given in **Chapter 3** to mean “*any project development that is subject to Section 34A EQA 1974*” which can possibly involve activities such as clearing of trees or vegetation, grubbing, stripping, grading, raising or sloping of ground, excavating, trenching, filling, logging, storing of materials and blasting. In other word, “land disturbing” also means any activity that changes the physical conditions of land form, vegetation and hydrology, and during the process, creates bare soil, or otherwise may cause erosion or sediment issues”. It can be taken that land disturbing activities will involve any clearing, excavation, grading or manipulation of the natural terrain which exposes soils to erosion hazards or alters the natural condition of the site.

It should be cautioned that the term “land disturbing” should not be used loosely to equate it to the words “earthwork” or “earthworks” as utilized in the practice of civil engineering. In the civil engineering practice, the words “earthwork” or “earthworks” have their own dedicated definition; in accordance with the *BSI British Standards BS 6031:2009 Code of practice for earthworks*, the meanings of these two terms are given as below:

“earthwork” - *work of excavating, or the raising or sloping of ground*

“earthworks” - 1) *structures formed by the excavating, raising or sloping of ground, e.g. embankments, cuttings or remediated natural slopes*

2) *civil engineering process that includes extraction, loading, transport, transformation/improvement, placement and compaction of natural materials (soils, rocks), and/or secondary or recycled materials, in order to obtain stable and durable cuttings, embankments or engineered fills*

It is clear from the above definitions then that “land disturbing” in the context of this *Guidance Document* therefore has a wider coverage than the typical “earthwork” or “earthworks” typically used in civil engineering. Nonetheless, the *British Standards BS 6031:2009* does contain a variety of recommendations targeted to the planning, design and construction of earthworks which are also pertinent to the subject of LD-P2M2. A brief discussion of these relevant excerpts from the *British Standards BS 6031:2009* is included in Appendix A.

The overall objective of this *Guidance Document* is to ensure that good quality LD-P2M2 Documents are prepared by competent professionals and that the LD-P2M2s are effectively implemented to mitigate and minimize environmental and pollution impacts of the land disturbing activities. The LD-P2M2 shall incorporate the P2M2s identified to be installed at the land disturbing development areas into the design, construction and operation stage of the development project as stipulated in Section 34A (7) of the EQA. The P2M2s shall be effective in preventing, reducing and controlling pollution as well as preventing non-compliant pollution discharges from reaching any water bodies.

## **3.2 SITE LAND CLEARING**

### **3.2.1 Practice Description**

In a nutshell, site clearing consists of the activities to prepare the work area by removing all trees, brush, buildings, and other objectionable material and obstructions that may interfere with the construction works. In this regard, site clearing is also considered to be a “pre-construction” activity.

Clearing shall consist of the cutting, taking down, removing, and disposal of everything above ground level including demolition and disposal of structures. Consequently, the clearing materials may include but not limited to organic wastes such as trees, stumps, logs, bushes, undergrowth, long grasses, crops, and vegetation, as well as inert wastes such as soil, demolished concrete structures, terraces, ditches, etc.

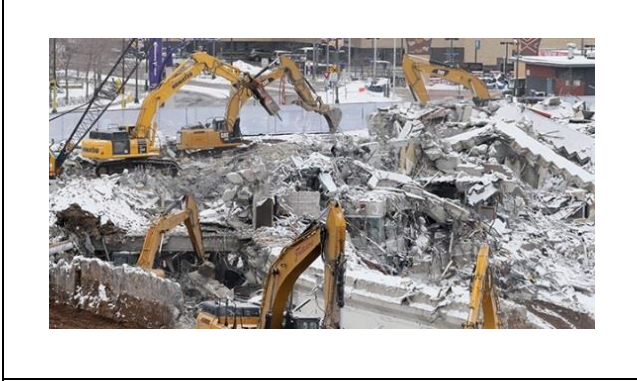
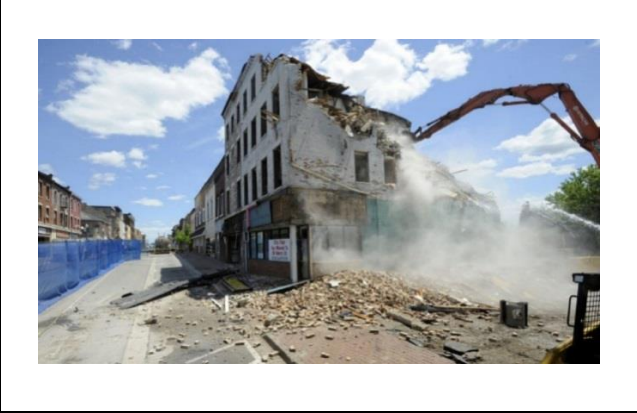
**3.2.2 Examples of Site Land Clearing**

The following figures illustrate typical land disturbing activity involving site land clearing. Unless otherwise specified, the depicted photos below are selected and collated from DOE's database.

**Table 3.1: Example of Land Clearing**



GUIDELINES ON LD-P2M2



### 3.2.3 Planning Considerations

Prior to any land disturbing activity relating to site clearance, an initial assessment of the site should be conducted to identify sensitive environmental areas or uses that require protection, which may include:

- ❖ Forested or vegetated areas including sensitive flora and fauna;
- ❖ Aquatic habitats such as plants and animals if areas to be cleared contain rivers or streams;
- ❖ Human sensitive receptors, for example if works areas are near to residential homes, schools, hospitals, religious institutions; and
- ❖ Other sensitive receivers such as streams, rivers, lakes, public amenities (parks, recreational grounds, treatment works).

In addition, the following information should preferably be available for analysis at the EIA stage, and becomes necessary before construction commences:

- ❖ Map of soil types together with their characteristics such as erosion potential, soil test erodibility, soil hydrologic group, percentage of dispersible material (fine clay) to determine the type and effectiveness of erosion and sediment mitigation measures to be implemented;
- ❖ Climate, weather patterns, rainfall data and stream flows, particular for the purposes of avoiding land disturbing activities during the wet and rainy periods;
- ❖ Topography and natural geographic features (including whether site is in a floodplain, site runoff velocity and flow rate, both pre and during development), and changes to the topography of the site during each stage of the project, to ensure the LD-P2M2 plans have captured these changes and the need to upgrade or amend the P2M2s implementation;
- ❖ Construction programme showing sequences and timing of the key land disturbing activities;
- ❖ Map of existing vegetation identifying areas to be retained to allow suitable perimeter controls and buffer zones to be provided;

- ❖ Anticipated excavation depth for the proposed land disturbing activity, to not only make use of the data on soil characteristics on determining types and effectiveness P2M2 but to also prepare for dewatering and treatment requirements;
- ❖ Details of areas of cleared land at each stage of the development, and period of time that each section will be exposed;
- ❖ Description of adjacent areas, such as streams, lakes, residential areas, and roads that might be affected by the land disturbance;
- ❖ Changes to drainage and identification of sources of clean and contaminated stormwater;
- ❖ Calculation of stormwater flows within micro-catchments within the site, for each stage of the project;
- ❖ Location of stockpiles, haul roads and cuts, particularly for those work sites located near sensitive areas such as rivers, public roads, other sensitive areas, etc; and
- ❖ Nature and location of works that will occur in near proximity, say 20m of a natural waterway or other sensitive environmental area.

#### 3.2.4 Applicable Minimum Standards Requirements

In view of the above illustrations and planning consideration discussed, the pertinent basic principles as mentioned in **Chapter 3** that need to be taken into account when implementing the pollution prevention and mitigation measures for this land disturbing activity include the following :

- a) *Integrate project design with site constraints.*
- b) *Preserve and stabilize drainage ways.*
- c) *Minimize the extent and duration of disturbance.*
- d) *Control runoff flows onto, through and from the site in stable drainage structures.*
- e) *Install perimeter controls.*
- f) *Stabilize disturbed areas promptly in a timely manner.*
- g) *Protect steep slopes.*

- h) *Use sediment controls to prevent off-site damage.*
- i) *Protect inlets, storm drain outfalls, and culverts.*
- j) *Provide access and general construction controls.*
- k) *Inspect and maintain best management practices and control measures.*

In addition, the minimum standards requirements that may be relevant to this land disturbing activity include the following:

- a. ***Schedule of Phasing, Staging and Sequencing***, whereby as a minimum, the project schedule shall be prepared prior to commencement of site works to include the following key activities:
  - ✓ Identification of project components and associated project activities;
  - ✓ Division of overall project into manageable phases and work zones;
  - ✓ Survey of work zones and areas for P2M2s implementation;
  - ✓ Identification of site and work zone boundaries, including interfaces with surrounding projects or facilities and clearance extent;
  - ✓ Identification of BMPs and implementation schedule;
  - ✓ Undertaking of clearing works, and identification of relevant BMPs that are needed to be upgraded or replaced due to changing site conditions;
  - ✓ Formulation of a project sequencing programme or a critical path method (CPM) to fit in the elements of pollution prevention and mitigation measures for each phase, stage and sequence of project development.
- b. ***Scheduled Site Meeting*** prior to start of any site clearing activities to be attended by PP, project EO, project contractors and/or sub-contractors to discuss in detail all of the relevant scopes of work that have relevance to pollution prevention and mitigating measures.
- c. ***Construction Markers*** to physically mark on site to show the limit of the: site clearance works from any drainage way/waterway/watercourse within project site; areas not to be worked or disturbed, and buffer area or/and existing vegetation meant for temporary or permanent preservation and for protection. The construction markers can comprise fences, signs, tapes, flags or other similar marking device.
- d. ***Stabilized Construction Entrance*** by providing all entrance/exit roads to the site to be stabilized and paved for a suitable distance from where these access roads join the existing paved roads or public road.

- e. ***Stream/drainage way/waterway/watercourse buffers*** to be provided by maintaining a 20 meter buffer between the site clearance activities and any watercourses; or by providing a vegetated buffer that is less than 20 meters between site clearance activities and any watercourse in combination with additional erosion and sediment controls; or install suitable erosion and sediment controls in combination with all possible perimeter controls.
- f. ***Perimeter Control*** shall be first constructed and made operational before the site clearing activities are executed, and may include filter or perimeter berms, silt fences, sediment traps, sediment basins, construction entrance, temporary diversion dikes or earth bunds and diversion drains that control discharges from the site.
- g. ***Sediment Basin/Trap*** shall be first constructed and made operational before site clearing activities are executed, including the provision of vertical silt marker for the purpose of measuring the depth of accumulated sediment to facilitate maintenance program.
- h. ***Runoff Management*** such as key runoff control measures shall be first constructed and made operational before the site clearing activities are executed. The runoff control measures shall include but is not limited to temporary earth drain, diversion channel and conveyance system that control flows and discharges from and within the site and to be combined with installation of interval check dams along the channel to reduce the runoff velocity.
- i. ***Temporary or permanent watercourse diversion*** provided for existing watercourses that might be physically affected by the site clearing works shall be protected either by using rock lined channel bed with protected side slope using Turf Reinforcement Mat (TRM) or plastic sheeting, or by installing plastic sheeting canvas along the channel with extend across the side slope in combination with constructed check dams or sump slot checks.
- j. For ***temporary or permanent watercourse crossing*** such as culvert or bridge, the surface of the filling material (if earth is used) on the inlet and outlet end of the culvert or abutment of the both sides of the bridge shall be covered with appropriate materials such as rocks, Rolled Erosion Control Products (RECPs) and plastic sheeting or turf. In addition, the approach distance of 10 metres or any suitable distance from both sides of the watercourse crossing shall be installed with sediment fence or equivalent along the sides, together

with gravels or stone pad and water bar to prevent sediment traction onto the crossing that may potentially enter the stream.

- k. Temporary or permanent roadways* shall be provided with runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion for conveying runoff to stabilized area or into sediment treatment P2M2s prior to discharge.
- l. Temporary Stabilization* shall be applied to exposed areas within fourteen (14) days after final formation level is reached on any portion of the site. Otherwise, temporary soil stabilization shall be applied within seven (7) days to exposed areas that may not be at final grade but will remain unattended for longer than fourteen (14) days. Temporary stabilization is typically achieved by subjecting the exposed soils or disturbed areas with a temporary vegetative and/or non-vegetative protective cover to prevent erosion and sediment loss, and may include temporary seeding, geotextiles, mulches, and other techniques to reduce or eliminate erosion until further construction activities take place to re-disturb this area.
- m. Stockpile Soil Management* by restricting stockpiles area to be located away at a minimum distance of 20 metres from any watercourse. Additionally, the stockpiled soil shall be protected from contact with runoff water (including run-on) using a temporary perimeter control such as berms, dikes, fiber rolls, silt fences, sandbag and gravel bags.
- n. Spoil Management Area (Disposal Area)* by restricting any disposal area to be located away at a minimum distance of 20 metres from any watercourse. All disposal areas shall be protected from contact with runoff water (including run-on) using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbags and gravel bags. All anticipated runoff flowing from any disposal area shall be drained into a sediment trap/basin prior to discharge.
- o. Dewatering practices* for accumulated runoff water from excavations, trenches, foundations, vaults, or other similar points of accumulation shall include treating effectively the dewatered runoff water using sediment basins / traps, dewatering tank treatment system, active treatment system, bag or sand filters prior to discharge.

- p. Active Treatment System (ATS)* shall be implemented whenever recommended by the consultant or instructed by the Director General of DOE, by treating the runoffs using a mechanical system with the application of coagulants and flocculants to promote the settling of suspended solids out of the aqueous phase. ATS system is most appropriate if the project site has been found to have violated the total suspended solids discharge standard stipulated in the EIA approval conditions (COAs) or analysis of soil investigation in the project site shows that the dispersible fine-grained clays contain more than 10% of dispersible material.
- q. Discharge* of all runoff water from any land-disturbing activities such as land site clearing shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

### **3.3 GRUBBING**

#### **3.3.1 Practice Description**

Land site clearing and grubbing sometimes may be undertaken in one operation. Whilst site clearing essentially removes most of the aboveground natural or manmade obstacles to prepare the work areas, grubbing on the other hand, provides for additional preparation of the work area by removing the remaining stumps, roots, and other obstructions which exist on or in the ground in all areas designated for grubbing.

#### **3.3.2 Examples of Grubbing**

The following figures illustrate typical land disturbing activity involving grubbing.

**Table 3.2: Example of Grubbing**



**3.3.3 Planning Considerations**

Complete grubbing may not be required under embankments where the fill height above natural ground, as measured to subgrade or embankment slope elevation, exceeds a certain depth as specified in the contract specifications or drawings.

However, where for those areas where a structure must be built, subdrainage trenches are to be excavated, unsuitable material is to be removed, or where hillsides or existing embankments are to be terraced, then complete grubbing is most certainly required. Additionally, grubbing is important to the structural quality of the roadway and every effort should be made to obtain a thorough job. Grubbing should be completed at least in advance of grading operations.

### **3.3.4 Applicable Minimum Standards Requirements**

The applicable minimum standards requirements for grubbing shall be similar to those prescribed for land site clearing mentioned above.

## **3.4 STRIPPING**

### **3.4.1 Practice Description**

Stripping is normally applied to the topsoil, particularly prior to the commencement of other earthworks. In terms of sequence of construction, topsoil stripping typically comes after “land site clearing” (to remove the ‘large natural or manmade obstruction), but before “grading” or “grubbing”. In particular topsoil is to be stripped from any areas to be covered by paving, structures, fill, within the limits of clearing for underground services. Grass shall normally be stripped together with topsoil. Unless otherwise directed, soils shall not be stripped from around existing trees closer than a distance equal to twice the radius of the trees crown measured from the trunk. Additionally, stripping topsoil shall consist of removal of the topsoil to a depth of 150mm below ground level, or to the bottom of the grassroots zone., whichever is deeper.

### **3.4.2 Examples of Stripping**

The following figures illustrate typical land disturbing activity involving stripping of topsoil.

Table 3.3: Example of Stripping





### 3.4.3 Planning Considerations

As the main purpose of topsoil stripping is primarily to save the topsoil for future reuse, stripping should be limited only those areas that will be affected by the proposed construction or development. As mentioned above, the depth of normal stripping of the topsoil should be to a depth of 150mm below ground level, or to the bottom of the grassroots zone whichever is typically between 125 – 150mm, but deeper depths may be satisfactory if the soil is suitable and undercutting is allowable in locations such as buildings, water-impoundment structures, roadways, etc. Appropriate sediment-control measures such as sediment barriers, sediment basins, inlet protection, etc., should be in place before the topsoil is stripped. Stripping should not be done on areas intended to support conventional, on-site effluent, disposal lines (field lines).

### 3.4.4 Applicable Minimum Standards Requirements

The minimum standards requirements shall incorporate the following:

- a. *Schedule of Phasing, Staging and Sequencing*, particularly the identification of site and work zone boundaries, stripping extent, BMPs and implementation schedule, and a project sequencing programme to fit in the elements of pollution prevention and mitigation measures for each phase, stage and sequence of project development.

- b. *Scheduled Site Meeting*** prior to start of any topsoil stripping activities to be attended by PP, project EO, project contractors and/or sub-contractors to discuss in detail all of the relevant scopes of work that have relevance to pollution prevention and mitigating measures.
- a. *Construction Markers*** to physically mark on site to show the limit of the topsoil stripping works from any drainage way/waterway/watercourse within project site, and buffer area or/and existing vegetation meant for temporary or permanent preservation and for protection.
- b. *Stream/drainage way/waterway/watercourse buffers* and *Perimeter Controls*** to be provided by maintaining appropriate buffers or suitable erosion and sediment controls between the topsoil stripping activities and any watercourses.
- c. *Sediment Basin/Trap*** shall be first constructed and made operational before topsoil stripping activities are executed, including the provision of vertical silt marker for the purpose of measuring the depth of accumulated sediment to facilitate maintenance program.
- d. *Runoff Management*** such as key runoff control measures shall be first constructed and made operational before the topsoil stripping activities are executed.
- e. *Temporary Stabilization*** shall be applied to exposed areas within fourteen (14) days after final formation level is reached on any portion of the site. Otherwise, temporary soil stabilization shall be applied within seven (7) days to exposed areas that may not be at final grade but will remain unattended for longer than fourteen (14) days.
- f. *Stockpile Soil Management* and *Spoil Management Area (Disposal Area)*** by restricting stockpiles area to be located away at a minimum distance of 20 metres from any watercourse and protected from contact with runoff water (including run-on). by restricting any disposal area to be located away at a minimum distance of 20 metres from any watercourse.
- g. *Discharge*** of all runoff water shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

**3.5 GRADING**

**3.5.1 Practice Description**

“Grading” typically occurs after land site clearing, grubbing and topsoil stripping, and it involves the reshaping of the ground surface to provide suitable topography for buildings, facilities, and other land uses; to control surface runoff; and to minimize soil erosion and sedimentation, both during and after construction. The practice of grading can be applied to existing topography which is required to be modified to prepare for another land use. It can also be used to adapt proposed development to the existing landscape to reduce the erosion potential of the site and the cost of installing erosion- and sediment control measures. In some instances, other practices such as diversions can be used to reduce the length of continuous slopes and reduce erosion potential.

**3.5.2 Examples of Grading**

The following figures illustrate typical land disturbing activity involving land grading.

**Table 3.4: Example of Land Grading**





**3.5.3 Planning Considerations**

A detailed plan should be developed for all land grading activities, to show the areas to be disturbed, the areas of cut, areas of fill, and the finished elevation for all graded areas. The grading plan should also indicate the means for protection of existing vegetation where possible, especially around natural drainageways. Grading activities should be scheduled to minimize the area disturbed at any one time during the construction process. The plan should include provisions for stabilizing disturbed areas immediately after final grading is completed. Provisions should also be made to protect existing underground utilities.

**3.5.4 Applicable Minimum Standards Requirements**

Due to the similarity of the nature of this land disturbing activity to the precedent activities including stripping and site clearing, albeit for different reasons, the minimum standards requirements will also be quite similar, including the following: *Schedule of Phasing, Staging and Sequencing; Scheduled Site Meeting; Construction Markers; Stream/drainage way/waterway/watercourse buffers; Perimeter Controls; Sediment Basin/Trap; Runoff Management; Temporary Stabilization; Stockpile Soil Management; Spoil Management Area (Disposal Area); and Discharge.*

### **3.6 RAISING OR SLOPING OF GROUND**

#### **3.6.1 Practice Description**

In simple terms, raising or sloping of ground consists of the activities to prepare work areas which are connected or adjacent to one another but with differing platform elevations. There are many reasons for creating platforms at different levels of which one could be for architectural reason, but it is more likely they are more of functional or engineering reasons. Regardless the reasons, to raise or slope the ground constitutes a land disturbing activity, because the final platforms will need to be “carved out” from the existing ground topography.

This land disturbing activity is likely to involve some of physical actions previously covered for “land site clearing”, such as cutting, taking down, removing, and disposal of everything above ground level including demolition and disposal of structures, except that the raising or sloping of the ground will further involve more ‘cutting’ of the ground to form the raised platform or slopes. In this regard, raising or sloping of the ground is also considered to be a “pre-construction” activity.

This land disturbing` activity is expected to generate a larger volume of inert materials such as excavated soil, on top of some clearing materials.

#### **3.6.2 Examples of Raising or Sloping of Ground**

The following figures illustrate typical land disturbing activity involving raising or sloping of ground. Unless otherwise specified, the depicted photos below are selected and collated from DOE’s database.

Table 3.5: Example of Ground Raising/Sloping



### 3.6.3 Planning Considerations

As indicated earlier, some form of land site clearing activities would have been provided to the work site prior to the further raising or sloping of the ground, to form the desired platform levels as per the construction drawings. Assuming planning considerations have previously been given to the site clearing works, the consideration that would be applicable to this subsequent land disturbing activity may include further assessment of this particular works area to identify the specific sensitive environmental areas or uses that require protection, which may include:

- ❖ Forested or vegetated areas immediately adjacent to the slope areas;
- ❖ Aquatic habitats such as plants and animals adjacent to earthwork or at the toe of the lower slopes;
- ❖ Human sensitive receptors, particularly at the lower work areas or toe of the sloped area;
- ❖ other sensitive receivers such as streams, rivers, lakes, public amenities (parks, recreational grounds, treatment works);

- ❖ location to stockpile soil materials to be located away from sensitive receivers and adequately covered or protected from erosion or runoff; and
- ❖ types of sediment and runoff controls depending on soil type.

The following information would assist in the above planning considerations:

- ❖ Soil types together with their characteristics such as erosion potential, soil test erodibility, soil hydrologic group, percentage of dispersible material (fine clay) at the particular earthwork areas to form the raised platforms or slopes, so as to determine the type and effectiveness of erosion and sediment mitigation measures to be implemented;
- ❖ Since the velocity and flow rates of any potential surface runoffs from the disturbed areas for this land disturbing activity could likely be high, because of sloping grounds (compare to flatter ground for site clearing works only), it will be important to avoid this land disturbing activity during the wet and rainy periods;
- ❖ Construction programme showing sequences and timing of the key land disturbing activities;
- ❖ Map of existing sensitive receivers to be retained or protected to allow suitable perimeter controls and buffer zones to be provided;
- ❖ Requirements for dewatering and treatment capacity based on extent of works area to be disturbed, as well as details and period of time disturbed areas will be exposed;
- ❖ Changes to drainage and identification of sources of clean and contaminated stormwater, as well as description of adjacent areas, such as streams, lakes, residential areas, and roads that might be affected by the stormwater;
- ❖ Location of stockpiles, haul roads and cuts, particularly for those work sites located near sensitive areas such as rivers, public roads, other sensitive areas, etc; and
- ❖ Nature and location of works that will occur in near proximity, say 20m of a natural waterway or other sensitive environmental area.

### 3.6.4 Applicable Minimum Standards Requirements

The incorporation of the pertinent basic principles for this land disturbing activity will inevitably include the following minimum standards requirements:

- a. Schedule of Phasing, Staging and Sequencing*, particularly the identification of site and work zone boundaries, ground raising/sloping extent, BMPs and implementation schedule, and a project sequencing programme to fit in the elements of pollution prevention and mitigation measures for each phase, stage and sequence of project development.
- b. Scheduled Site Meeting* prior to start of any land disturbing activities to be attended by PP, project EO, project contractors and/or sub-contractors to discuss in detail all of the relevant scopes of work that have relevance to pollution prevention and mitigating measures.
- c. Construction Markers* to physically mark on site to show the limit of the: ground raising/sloping works from any drainage way/waterway/watercourse within project site; areas not to be worked or disturbed, and buffer area or/and existing vegetation meant for temporary or permanent preservation and for protection.
- d. Stream/drainage way/waterway/watercourse buffers and Perimeter Controls* to be provided by maintaining appropriate buffers or suitable erosion and sediment controls between the ground raising/sloping activities and any watercourses.
- e. Sediment Basin/Trap* shall be first constructed and made operational before ground raising/sloping activities are executed, including the provision of vertical silt marker for the purpose of measuring the depth of accumulated sediment to facilitate maintenance program.
- f. Runoff Management* such as key runoff control measures shall be first constructed and made operational before the ground raising/sloping activities are executed.
- g. Temporary Stabilization* shall be applied to exposed areas within fourteen (14) days after final formation level is reached on any portion of the site. Otherwise, temporary soil stabilization shall be applied within seven (7) days

to exposed areas that may not be at final grade but will remain unattended for longer than fourteen (14) days.

- h. Stockpile Soil Management and Spoil Management Area (Disposal Area)* by restricting stockpiles area to be located away at a minimum distance of 20 metres from any watercourse and protected from contact with runoff water (including run-on) by restricting any disposal area to be located away at a minimum distance of 20 metres from any watercourse.
- i. Dewatering practices* for accumulated runoff water from excavations shall include treating effectively the dewatered runoff water using sediment basins / traps, dewatering tank treatment system, active treatment system, bag or sand filters prior to discharge.
- j. Active Treatment System (ATS)* shall be implemented if the works has violated the total suspended solids discharge standard stipulated in the EIA approval conditions (COAs) or analysis of soil investigation in the project site shows that the dispersible fine-grained clays contain more than 10% of dispersible material.
- k. Discharge* of all runoff water shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

### 3.7 EXCAVATING

#### 3.7.1 Practice Description

“Excavation” means the mechanical removal of earth material, whether the purpose is to form a deep cavity for underground construction or a trench for utilities laying. This land disturbing activity involves the process of moving earth, rock or other materials with tools, machineries, equipment or explosives, and can include earthwork, trenching, wall shafts, tunneling and basement works.

**3.7.2 Examples of Excavating**

The following figures illustrate typical land disturbing activity involving site land clearing. Unless otherwise specified, the depicted photos below are selected and collated from DOE's database.

**Table 3.6: Example of Excavating**





Another form of specialized excavation works which also involves the removal of earth from underground for the purposes of constructing foundation works is “borehole drilling”. In this special type of excavation works, the dedicated equipment used for the earthmoving is a rotary drilling machine, where a drill bit is attached to a length of connected drill pipe. The drill bit will be made of tough metals such as tungsten, and as the drill is rotated the bit grind up the rock. The drill fluids (sometimes bentonite is used and also referred to as drilling mud) are circulated through the drill string into the borehole and back to the surface and carries (flush) the broken pieces (cuttings) upwards and out of the hole. This fluid also serves as a formation stabilizer preventing possible cave-in of unstable sands or crumbly rock before the well casing or well screen is installed. Furthermore, this fluid acts as drill bit lubricant. In general, bored piles offer the most economical foundation as they can be constructed in a wide choice of diameters, typically ranging from 300mm to 1800mm, and to depths of up to 70m.

Assuming a bored pile diameter of 1500mm with a depth of 50m, an estimated 90 cubic meter of excavated soil will be displaced from the bored location. This translates to about 20 nos. of lorries to be used for transporting out these materials. The following figures illustrate the typical land disturbing activity involving borehole drilling. Unless otherwise specified, the depicted photos below are selected and collated from DOE’s database.

**Table 3.7: Example of Borehole Drilling**



Another land disturbing activity which is related to excavating is “in-stream” works, whereby the land disturbing activity is undertaken within or very close to the river main channel or flow. This type of excavating works ought to be given particular attention in view of its works location and the immediate impacts of eroded materials and sediment being carried away or deposited into the water body. The following figures illustrate the typical land disturbing activity involving in-stream works and unless otherwise specified, the depicted photos below are selected and collated from DOE’s database.

**Table 3.8: Example of In-stream Works**



**3.7.3 Planning Considerations**

When planning for any excavation works from the perspective of erosion and sediment control, it is important to remember that such land disturbing activity will always likely to result in one or more of the following observations:

- The process of excavating will dislodge the once stable ground soil and render the soil materials to be in a “loosed” form which can be easily eroded or carried away by surface runoff;

- The excavation works will create cavities or large holes in the ground whereby after rainy events, accumulated water will need to be dewatered or pumped offsite to allow works to continue. Often this water is contaminated with suspended sediment so it is essential that its disposal should not contribute to water pollution;
- During the boring activity, soil stabilisation agent such as bentonite as well as a large amount of water is likely to be used, which will generate wastewaters during the excavation process. These solid waste and wastewaters will need special attention for their collection, temporary storage and treatment before disposal or discharge off site.

In view of the above, appropriate BMPs are needed to address the above inevitable erosion and sediment issues.

#### 3.7.4 Applicable Minimum Standards Requirements

The pertinent basic principles to be taken into account when executing this land disturbing activity include the following :

- a) *Integrate project design with site constraints.*
- b) *Minimize the extent and duration of disturbance.*
- c) *Control runoff flows onto, through and from the site in stable drainage structures.*
- d) *Install perimeter controls.*
- e) *Stabilize disturbed areas promptly in a timely manner.*
- f) *Protect steep slopes.*
- g) *Use sediment controls to prevent off-site damage.*
- h) *Protect inlets, storm drain outfalls, and culverts.*
- i) *Provide access and general construction controls.*
- j) *Inspect and maintain best management practices and control measures.*

In addition, the minimum standards requirements that may be relevant to this land disturbing activity include the following:

- a. ***Schedule of Phasing, Staging and Sequencing***, whereby as a minimum, the project schedule shall be prepared prior to commencement of site works to include the following key activities: survey of work zones and areas for P2M2s implementation; identification of site and work zone boundaries, including interfaces with surrounding projects or facilities and clearance

extent; identification and implementation of BMPs and implementation schedule; and undertaking of excavating works, and identification of relevant BMPs that are needed to be upgraded or replaced due to changing site conditions;

- b. Scheduled Site Meeting* prior to start of major excavation works to be attended by all parties to discuss in detail all of the relevant scopes of work that have relevance to pollution prevention and mitigating measures.
- c. Construction Markers* to physically mark on site to show the limit of the: excavation works from any drainage way/waterway/watercourse within project site; areas not to be worked or disturbed, and buffer area or/and existing vegetation meant for temporary or permanent preservation and for protection.
- d. Stream/drainage way/waterway/watercourse buffers* to be provided by maintaining a 20 meter buffer between the excavating activities and any watercourses; or by providing a vegetated buffer that is less than 20 meters between excavating activities and any watercourse in combination with additional erosion and sediment controls; or install suitable erosion and sediment controls in combination with all possible perimeter controls.
- e. Perimeter Control* shall be first constructed and made operational before the excavating activities are executed to control discharges from the site.
- f. Sediment Basin/Trap* shall be first constructed and made operational before excavating activities are executed.
- g. Runoff Management* such as key runoff control measures shall be first constructed and made operational before the excavating activities are executed. The runoff control measures shall include but is not limited to temporary earth drain, diversion channel and conveyance system that control flows and discharges from and within the site and to be combined with installation of interval check dams along the channel to reduce the runoff velocity.
- h. Temporary or permanent watercourse diversion* provided for existing watercourses that might be physically affected by the excavating activities and shall be protected either by using rock lined channel bed with protected side slope using Turf Reinforcement Mat (TRM) or plastic sheeting, or by

installing plastic sheeting canvas along the channel with extend across the side slope in combination with constructed check dams or sump slot checks.

- i.* For **temporary or permanent watercourse crossing** such as culvert or bridge, the surface of the filling material (if earth is used) on the inlet and outlet end of the culvert or abutment of the both sides of the bridge shall be covered with appropriate materials such as rocks, Rolled Erosion Control Products (RECPs) and plastic sheeting or turf. In addition, the approach distance of 10 metres or any suitable distance from both sides of the watercourse crossing shall be installed with sediment fence or equivalent along the sides, together with gravels or stone pad and water bar to prevent sediment traction onto the crossing that may potentially enter the stream.
- j.* **Temporary or permanent roadways** shall be provided with runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion for conveying runoff to stabilized area or into sediment treatment P2M2s prior to discharge.
- k.* **Temporary Stabilization** shall be applied to exposed areas within fourteen (14) days after final formation level is reached on any portion of the site. Otherwise, temporary soil stabilization shall be applied within seven (7) days to exposed areas that may not be at final grade but will remain unattended for longer than fourteen (14) days. Temporary stabilization is typically achieved by subjecting the exposed soils or disturbed areas with a temporary vegetative and/or non-vegetative protective cover to prevent erosion and sediment loss, and may include temporary seeding, geotextiles, mulches, and other techniques to reduce or eliminate erosion until further construction activities take place to re-disturb this area.
- l.* **Stockpile Soil Management** by restricting stockpiles area to be located away at a minimum distance of 20 metres from any watercourse. Additionally, the stockpiled soil shall be protected from contact with runoff water (including run-on) using a temporary perimeter control such as berms, dikes, fiber rolls, silt fences, sandbag and gravel bags.
- m.* **Spoil Management Area (Disposal Area)** by restricting any disposal area to be located away at a minimum distance of 20 metres from any watercourse. All disposal areas shall be protected from contact with runoff water (including run-on) using a temporary perimeter sediment barrier such as

berms, dikes, fiber rolls, silt fences, sandbags and gravel bags. All anticipated runoff flowing from any disposal area shall be drained into a sediment trap/basin prior to discharge.

- n. Dewatering practices* for accumulated runoff water from excavations, trenches, foundations, vaults, or other similar points of accumulation shall include treating effectively the dewatered runoff water using sediment basins / traps, dewatering tank treatment system, active treatment system, bag or sand filters prior to discharge.
- o. Active Treatment System (ATS)* shall be implemented whenever recommended by the consultant or instructed by the Director General of DOE, by treating the runoffs using a mechanical system with the application of coagulants and flocculants to promote the settling of suspended solids out of the aqueous phase. ATS system is most appropriate if the project site has been found to have violated the total suspended solids discharge standard stipulated in the EIA approval conditions (COAs) or analysis of soil investigation in the project site shows that the dispersible fine-grained clays contain more than 10% of dispersible material.
- p. Discharge* of all runoff water from any excavating activities shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

## 3.8 TRENCHING

### 3.8.1 Practice Description

This is another form of land disturbing activity, and strictly speaking can be generally grouped under the category of “excavating”, exhibiting similar works nature and impacts to erosion and sediment. One of the key differences of trenching and the other excavating works is that for the former, it may involve a more “linear-type” construction, meaning the trench may extend for significant distance, while the other excavating works have a more “stationary” footprint.

### 3.8.2 Examples of Trenching

Examples of trenching works are shown below.

**Table 3.9: Example of Trenching**



During the course of trenching activities (as well as other excavation works), there may be occasions where river channel crossings or diversions may be involved. Even though these watercourse works are not directly related to the trenching works, the methodology of the construction may arguably be similar from the perspective that the works are undertaken within a channel, i.e. constrained by two banks. Examples of stream or river diversion and/or crossing activities are shown below.

Table 3.10: Example of River Diversion or Crossing Activity



Another activity which is related to trenching and also the excavating land disturbing activities is the dewatering process. Due to the cavities or holes in the ground and the need to maintain a dry workable working area, dewatering is almost always required especially when working during the rainy season or within areas with high water tables. Wastewaters generated from this activity are usually highly contaminated with sediment and high turbidity which need to be properly treated prior to discharge off site to the nearest sensitive receivers such as rivers or streams. Photos illustrating the dewatering process are given below.

**Table 3.11: Example of Dewatering Activity**





**3.8.3 Planning Considerations**

Under the above categories of land disturbing activities, other than the erosion and sediment issues, control of the associated wastewaters is also a concern. The consideration for handling the solid part of the issue has been discussed previously in the precedent section. Often the wastewater is contaminated with suspended sediment so it is essential that its disposal should not contribute to water pollution. To remove water from the work area, the pump intake should be kept as close to the surface of pool as possible. Floating intakes should be used when the depth of water is sufficient. Care must be taken to avoid pumping from the bottom of ponds, and constant supervision is required during pumping operations to ensure this does not happen. Treatment is required before discharging sediment-laden runoff to a natural waterway or stormwater system.

### 3.8.4 Applicable Minimum Standards Requirements

The minimum standards requirements that are applicable for the above various activities include the following:

- a. Schedule of Phasing, Staging and Sequencing*, to lay out the project schedule for the key activities including survey of work zones and areas for P2M2s implementation, identification of site and work zone boundaries, including interfaces with surrounding projects or facilities and clearance extent; implementation of BMPs and schedule; and undertaking of trenching, diversion or crossings works;
- b. Scheduled Site Meeting* prior to start of each major activity;
- c. Construction Markers* to physically mark on site to show the limit of the works areas and sensitive receivers;
- d. Stream/drainage way/waterway/watercourse buffers and perimeter control* from works areas;
- e. Sediment Basin/Trap* shall be first constructed and made operational before excavating activities are executed.
- f. Runoff Management* such as key runoff control measures shall be first constructed and made operational before the excavating activities are executed. The runoff control measures shall control flows and discharges from and within the site and to be combined with installation of interval check dams along the channel to reduce the runoff velocity.
- g. Temporary or permanent watercourse diversion* shall be protected either by using rock lined channel bed with protected side slope using Turf Reinforcement Mat (TRM) or plastic sheeting, or by installing plastic sheeting canvas along the channel with extend across the side slope in combination with constructed check dams or sump slot checks.
- h. For temporary or permanent watercourse crossing* such as culvert or bridge, the surface of the filling material (if earth is used) on the inlet and outlet end of the culvert or abutment of the both sides of the bridge shall be covered with appropriate materials such as rocks, Rolled Erosion Control Products

(RECPs) and plastic sheeting or turf. In addition, the approach distance of 10 metres or any suitable distance from both sides of the watercourse crossing shall be installed with sediment fence or equivalent along the sides, together with gravels or stone pad and water bar to prevent sediment traction onto the crossing that may potentially enter the stream.

- i. Temporary or permanent roadways* shall be provided with runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion for conveying runoff to stabilized area or into sediment treatment P2M2s prior to discharge.
- j. Temporary Stabilization* shall be applied to exposed areas within fourteen (14) days after final formation level is reached on any portion of the site. Otherwise, temporary soil stabilization shall be applied within seven (7) days to exposed areas that may not be at final grade but will remain unattended for longer than fourteen (14) days. Temporary stabilization is typically achieved by subjecting the exposed soils or disturbed areas with a temporary vegetative and/or non-vegetative protective cover to prevent erosion and sediment loss, and may include temporary seeding, geotextiles, mulches, and other techniques to reduce or eliminate erosion until further construction activities take place to re-disturb this area.
- k. Stockpile Soil Management* by restricting stockpiles area to be located away at a minimum distance of 20 metres from any watercourse. Additionally, the stockpiled soil shall be protected from contact with runoff water (including run-on) using a temporary perimeter control such as berms, dikes, fiber rolls, silt fences, sandbag and gravel bags.
- l. Spoil Management Area (Disposal Area)* by restricting any disposal area to be located away at a minimum distance of 20 metres from any watercourse. All disposal areas shall be protected from contact with runoff water (including run-on) using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbags and gravel bags. All anticipated runoff flowing from any disposal area shall be drained into a sediment trap/basin prior to discharge.
- m. Dewatering practices* for accumulated runoff water from excavations, trenches, foundations, vaults, or other similar points of accumulation shall include treating effectively the dewatered runoff water using sediment basins

/ traps, dewatering tank treatment system, active treatment system, bag or sand filters prior to discharge.

- n. **Active Treatment System (ATS)** shall be implemented when the dispersible fine-grained clays contain more than 10% of dispersible material.
- o. **Discharge** of all runoff water from any excavating activities shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

### 3.9 FILLING & EMBANKMENT

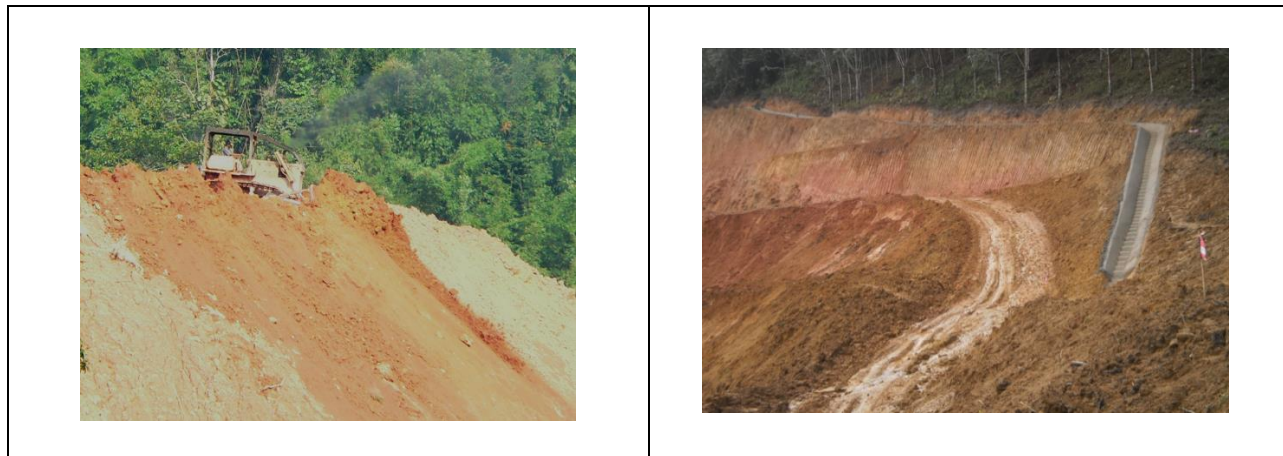
#### 3.9.1 Practice Description

An embankment refers to “a volume of earthen material that is placed and compacted for the purpose of raising the grade of a roadway (or railway) above the level of the existing surrounding ground surface. A fill refers to a volume of earthen material that is placed and compacted for the purpose of filling in a hole or depression. Embankments or fills are constructed of materials that usually consist of soil, but may also include aggregate, rock, or crushed paving material”.

#### 3.9.2 Examples of Filling & Embankment

Example illustrations of filling & embankment are provided below.

**Table 3.12: Examples of Filling/Embankment**





### 3.9.3 Planning Considerations

Although filling or embankment can be regarded as the opposite of excavating or trenching, both categories of land activities will involve earth moving, whether on flat grounds or slopes, via the use of heavy equipment and machineries. The activities will involve the handling of loose earth materials, which if not given enough attention, will contribute to erosion and sediment issues on site. Consequently, the considerations given to excavation and trenching works will also apply to this land activity of filling / embankment.

### 3.9.4 Applicable Minimum Standards Requirements

Similarly, the minimum requirements prescribed for the previous excavating are also applicable for the current land activity of filling or embankment, including the following: *Schedule of Phasing, Staging and Sequencing; Scheduled Site Meeting; Construction Markers; Stream/drainage way/waterway/watercourse buffers; Perimeter Controls; Sediment Basin/Trap; Runoff Management; Temporary Stabilization; Stockpile Soil Management; Spoil Management Area (Disposal Area); and Discharge.*

### 3.10 LOGGING

#### 3.10.1 Practice Description

Logging or “deforestation” involves the cutting down of mature trees in a forest and in Malaysia, it is done for a variety of reasons, including: dam construction; housing development; Oil palm plantations; roads and timber plantations.

#### 3.10.2 Examples of Logging

Selected representative photos of logging in Malaysia are shown below.

**Table 3.13: Examples of Logging**



### 3.10.3 Planning Considerations

In a way, logging as a land disturbing activity is quite similar to land site clearing discussed in the early section of this chapter. The key difference between the two is that for land site clearing, the key purpose of the activity is to prepare an existing land for constructing a project, whilst for logging, the main interest is to remove the trees for their economic values.

### 3.10.4 Applicable Minimum Standards Requirements

Although logging is not strictly a construction project, the impacts on erosion and sediment cannot be underestimated, given that the coverage of logging activities can sometimes be up to several hundred hectares at a single time. Noting from the above illustrations, the pertinent basic principles as mentioned in **Chapter 3** which are mostly focused on civil construction projects, are also applicable for the logging activity and need to be taken into account when implementing the pollution prevention and mitigation measures:

- a) *Preserve and stabilize drainage ways.*
- b) *Minimize the extent and duration of disturbance.*
- c) *Control runoff flows onto, through and from the site in stable drainage structures.*
- d) *Install perimeter controls.*
- e) *Stabilize disturbed areas promptly in a timely manner.*
- f) *Protect steep slopes.*
- g) *Use sediment controls to prevent off-site damage.*
- h) *Protect inlets, storm drain outfalls, and culverts.*
- i) *Provide access and general construction controls.*
- j) *Inspect and maintain best management practices and control measures.*

The minimum standards requirements that may be relevant to this land disturbing activity include the following:

- a. ***Schedule of Phasing, Staging and Sequencing***, prior to commencement of site works to identify project components and associated activities, to divide project into manageable phases and work zones, to survey work zones and P2M2s implementation areas, to identify site and work zone boundaries, to identify BMPs and implementation schedule, and to formulate a project

sequencing programme to fit in the elements of pollution prevention and mitigation measures for the development.

- b. Construction Markers* to physically mark the limit of logging clearance works from any drainage way/waterway/watercourse within project site.
- c. Stabilized Construction Entrance* by providing all entrance/exit roads to the logging site to be stabilized and paved for a suitable distance from where these access roads join the existing paved roads or public road.
- d. Stream/drainage way/waterway/watercourse buffers* to be provided by maintaining a 20 meter buffer between the logging clearance activities and any watercourses.
- e. Perimeter Control* shall be first constructed and made operational before the logging clearing activities are executed.
- f. Sediment Basin/Trap* shall be first constructed and made operational where appropriate before logging clearing activities are executed.
- g. Runoff Management* such as key runoff control measures shall be first constructed and made operational before clearing activities are executed.
- h. For temporary or permanent watercourse crossing* such as culvert or bridge, the surface of the filling material (if earth is used) on the inlet and outlet end of the culvert or abutment of the both sides of the bridge shall be covered with appropriate materials such as rocks, Rolled Erosion Control Products (RECPs) and plastic sheeting or turf. In addition, the approach distance of 10 metres or any suitable distance from both sides of the watercourse crossing shall be installed with sediment fence or equivalent along the sides, together with gravels or stone pad and water bar to prevent sediment traction onto the crossing that may potentially enter the stream.
- i. Temporary or permanent roadways* shall be provided with runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion for conveying runoff to stabilized area or into sediment treatment P2M2s prior to discharge.

- j. Temporary Stabilization* shall be applied to exposed areas by subjecting the exposed soils or disturbed areas with a temporary vegetative and/or non-vegetative protective cover to prevent erosion and sediment loss, and may include temporary seeding, geotextiles, mulches, and other techniques to reduce or eliminate erosion until further construction activities take place to re-disturb this area.
  
- k. Discharge* of all runoff water from any land-disturbing activities such as land site clearing shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

### 3.11 STORING OF MATERIALS

#### 3.11.1 Practice Description

Throughout the duration of the project site activities, there will be numerous occasions whereby construction materials will be stockpiled or stacked on site, including the likes of biomass (trees and vegetation), excavated earth materials, rocks, topsoil, construction materials such as sand, gravels, stones.

#### 3.11.2 Examples of Storing of Materials

The following figures illustrate some examples of material storage.

**Table 3.14: Example of Material Storage**





### 3.11.3 Planning Considerations

The stockpile location should be out of drainageways and traffic routes. Stockpiles should not be placed on steep slopes where undue erosion will take place. Measures should be taken to prevent erosion of the stockpiles, including mulching the stockpile when it is left inactive for 14 days or longer; planting temporary vegetation when the stockpile is to be inactive over 30 days; covering the stockpile with plastic whenever the piles are small or any soil loss would damage existing buildings or facilities; planting permanent vegetation when the stockpile use will be inactive over 12 months, and in cases where the stockpile is small and will be removed in fewer than 14 days, it may be more practical to use a sediment barrier than an erosion-control practice.

Additionally, locate stockpiles away from drainage lines to where they are protected from wind. Wherever possible, minimise the number and size of stockpiles and keep topsoil separate from underburden when stockpiling soil. Construct the stockpile with

no slope greater than 2:1 (horizontal to vertical), and a less steep slope may be required where the erosion risk is high. Lastly, hand water or install temporary sprinklers to suppress dust from unstabilized stockpiles and batters, and finish and contour any stockpiles located on a floodplain so as to minimise loss of material in a flood or rainfall event.

#### 3.11.4 Applicable Minimum Standards Requirements

Minimum standards requirements relevant to storing of materials include the following:

- a. Stockpile Soil Management* by restricting stockpiles area to be located away at a minimum distance of 20 metres from any watercourse. Additionally, the stockpiled soil shall be protected from contact with runoff water (including run-on) using a temporary perimeter control such as berms, dikes, fiber rolls, silt fences, sandbag and gravel bags.
- b. Spoil Management Area (Disposal Area)* by restricting any disposal area to be located away at a minimum distance of 20 metres from any watercourse. All disposal areas shall be protected from contact with runoff water (including run-on) using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbags and gravel bags. All anticipated runoff flowing from any disposal area shall be drained into a sediment trap/basin prior to discharge.
- c. Construction Markers* to physically mark buffer zones around the stockpile areas to avoid works being undertaken within these zones.
- d. Sediment Basin/Trap* shall be first constructed and made operational to receive and treat runoff from the stockpiles.
- e. Temporary or permanent roadways* shall be provided with runoff conveyance system around or leading to the stockpile areas.
- f. Discharge* of all runoff water from the stockpile areas shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

### 3.12 BLASTING

#### 3.12.1 Practice Description

Controlled blasting or “rock excavation” consists of the use of explosives to break rock for excavation. After excavating the rock cuts, the slopes shall be scaled and dressed to a safe, stable condition by removing all loose spalls and rocks not firmly keyed to the rock slope using mechanical scaling such as dozers, front end loader, etc. Loose spalls and rocks lying outside the slope stakes which constitute a hazard to the roadway shall be removed

#### 3.12.2 Examples of Blasting

Some examples of blasting activity are shown below.

**Table 3.15: Example of Blasting**



### 3.12.3 Planning Considerations

Besides dust and noise being the obvious environmental impacts from a blasting activity, the loosening of soft soil materials, stockpile of blast materials and surface runoff from the excavated faces are also key issues from the perspective of erosion and sediment. For safety reasons, a large no work zone will be required to sterilize the immediate surroundings of a blast zone. Designated areas for stockpiling the excavated materials are also required.

### 3.12.4 Applicable Minimum Standards Requirements

The minimum standards requirements that are applicable for the above blasting activity include the following:

- a. ***Schedule of Phasing, Staging and Sequencing***, to lay out the project schedule for the key activities including survey of work zones and areas for P2M2s implementation, identification of site and work zone boundaries, including interfaces with surrounding projects or facilities and clearance extent; implementation of BMPs and schedule; and undertaking blasting works;
- b. ***Scheduled Site Meeting*** prior to start of each major activity;
- c. ***Construction Markers*** to physically mark on site to show the limit of the works areas and sensitive receivers;
- d. ***Stream/drainage way/waterway/watercourse buffers and perimeter control*** from works areas;
- e. ***Runoff Management*** such as key runoff control measures shall be first constructed and made operational before the rock excavating activities are executed.
- f. ***Temporary or permanent roadways*** shall be provided with runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion for conveying runoff to stabilized area or into sediment treatment P2M2s prior to discharge.

- g. *Temporary Stabilization*** shall be applied to exposed earth areas within fourteen (14) days after final formation level is reached on any portion of the site. Otherwise, temporary soil stabilization shall be applied within seven (7) days to exposed areas that may not be at final grade but will remain unattended for longer than fourteen (14) days. Temporary stabilization is typically achieved by subjecting the exposed soils or disturbed areas with a temporary vegetative and/or non-vegetative protective cover to prevent erosion and sediment loss, and may include temporary seeding, geotextiles, mulches, and other techniques to reduce or eliminate erosion until further construction activities take place to re-disturb this area.
- h. *Stockpile Soil & Rock Management*** by restricting stockpiles area to be located away at a minimum distance of 20 metres from any watercourse. Additionally, the stockpiled soil/rock shall be protected from contact with runoff water (including run-on) using a temporary perimeter control such as berms, dikes, fiber rolls, silt fences, sandbag and gravel bags.
- i. *Spoil Management Area (Disposal Area)*** by restricting any disposal area to be located away at a minimum distance of 20 metres from any watercourse. All disposal areas shall be protected from contact with runoff water (including run-on) using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbags and gravel bags. All anticipated runoff flowing from any disposal area shall be drained into a sediment trap/basin prior to discharge.
- j. *Discharge*** of all runoff water from any excavating activities shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s).

## CHAPTER 4

### UNDERSTANDING PHASES IN A PROJECT

#### 4.1 INTRODUCTION

##### 4.1.1 Construction Planning

It is a widely accepted norm that “construction planning is a fundamental and challenging activity in the management and execution of construction projects”. It also follows that such planning “involves the choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks. A good construction plan is the basis for developing the budget and the schedule for work. Developing the construction plan is a critical task in the management of construction, even if the plan is not written or otherwise formally recorded. In addition to these technical aspects of construction planning, it may also be necessary to make organizational decisions about the relationships between project participants and even which organizations to include in a project.”

The above notion is also true when planning a strategy to address and control potential erosion and sediment that may result from project site activities. In developing such a strategy, the “ingredients” as mentioned above for construction project management also hold true, as elaborated below.

In Chapter 4, we looked at the various land disturbing activities that are typically encountered during the construction of a civil or building project. It was also noted that these activities are likely to occur at the early stage of the project during the preliminary and advanced works, but could also occur during the main construction works. In this regard and with reference to addressing potential erosion and sediment issues, it is critical to understand phases in a project so as to identify where and when land disturbing activities may take place at the work site, with the ultimate objective to determine the suitable choice(s) of BMPs (i.e, technologies to control erosion and sediment issues) to be implemented to reduce the risk of erosion and sedimentation. With this understanding, the LD-P2M2 practitioners will be able to surgically pinpoint the types of BMP that should be implemented at the appropriate locations as well as at the suitable time.

In concurrent to the identifying the project phases, one should be also able to decipher the key components of the project, so as to establish the associated project activities or work tasks, especially those related to land disturbing activities. Also, important in the above process includes the understanding of

the possible construction sequences and subsequently, with all the information collated, appropriate environmental method statements can be prepared. For the Project Proponent, such a strategy provides his planners with key information to undertake an estimation of the required resources and durations for the respective individual tasks, and the identification of any interactions among the different work tasks. For the Contractor, this strategy would contain to some extent certain technical aspects which could be integrated into his construction planning, so as to enable the Contractor to plan his overall works programme to cater for the control of erosion and sediment, as well as to make the appropriate organizational decisions about the relationships between project parties within his own teams in the project.

## 4.2 CONSEQUENCES FROM POOR PLANNING AND INADEQUATE PHASING

### 4.2.1 Example 1

Before proceeding to discuss the topics of *phases*, *project components*, etc. as mentioned above in detail, some selected examples are presented below to illustrate the impacts when site activities were undertaken without apparent adequate planning or well-thought out phasing (in reference to controlling erosion and sedimentation) taken into account in the site activities. From these examples, it was evident that uncontrolled erosion and sediment issues had occurred at these locations, and it is also not difficult to visualize the possible impacts of these issues for the receptors located downstream of the sites.

In Example 1 (**Figure 4.1** to **Figure 4.3**), the subject site represents an agricultural project surrounded by forested area. Based on the aerial photo (**Figure 4.1**), it is observed that large scale clearing has taken place at this particular site, but without apparent evidence of adequate or proper BMPs installed. It is also important to note that the site is not flat but with an undulating topography. It is predicted that during any heavy rain event at this site, surface runoff would occur naturally, seeking to find the lowest points on this platform. Although this photo was taken at a relatively high altitude, rills and gullies could still be seen to have formed on the slope sides of the platform (see center of photo).

In the subsequent **Figure 4.2** and **Figure 4.3**, the direct impacts from this particular land clearing activities without apparent phasing implementation are evident. From **Figure 4.2**, it is observed that surface runoff had transported the eroded materials from the exposed ground surfaces of the site and discharged the loose sediment into the adjacent watercourse. Note the significant water pollution (highly turbid water quality) that has occurred in the river. Notably such impact could have been avoided had there been a proper planning and management of site through implementation of phasing and work sequencing

throughout the land clearing activities, which is the main objective of this Chapter.

The impact to the flora ecology in the vicinity of the same site is shown in **Figure 4.3**. Here, it is observed that a large amount of earth materials has either been pushed over onto the slopes intentionally or has dislodged naturally and slipped on the slope side by the force of gravity. This was likely due to the unprotected bare ground surface as well as due to basically no buffer zone provided between the cleared land and the hill side. The slipped material is expected to cause damages to the vegetation located in its path.



**Figure 4.1: Large Scale Earthworks with No Proper BMPs Installed**

In summary, the consequences from insufficient construction planning and/or inadequate implementation of phasing into this site are evident from the photographic evidence, with the following issues as previously highlighted in **Chapter 1.2** being identified:

- Issue of work programme;
- Construction activity;
- Construction schedule;
- Construction methodology;
- Issue of planning;
- Issue of work stages;
- Issue of project phasing;
- Issue of work sequence;
- Issue of upholding the Code of Practice in Earthwork;
- Issue of erosion and sediment control measures not supervised properly; and
- Issue of BMPs not in place.

The above is also in line with several of the commonly found non-compliances of erosion and sediment control as identified in DOE's "*Manual Panduan Pemeriksaan BMPs (Best Management Practices) Untuk Kawalan Hakisan and Sedimen*", namely the following:

- Too much soil exposed at one time.
- Missing and/or misunderstanding of erosion and sediment control.
- Inadequate BMP maintenance.
- No BMPs to minimize vehicle tracking onto the road.



**Figure 4.2: Effects of Erosion and Sedimentation on River Downstream**



**Figure 4.3: Damages to Vegetation from Soil Erosion**

**4.2.2 Example 2**

**Figure 4.4** and **Figure 4.5** give another good example of a site (nature of project unknown) with which limited phasing has been implemented during the clearing works. In this example, as in Example 1, a large tract of land evidently has been cleared at an area which is surrounded by existing forested area.

Based on the aerial photographs, it is shown that a large extent of ground surface has been exposed of its cover crops (presumably from land clearing activities), with lack of the suitable BMPs installed. Based on a visual examination of the site conditions, it is believed that this exposed condition has been left unattended for a relatively long period of time, or at least long enough to result in major scouring of the ground surface as the evidence show. In **Figure 4.5**, rills and deep gullies are shown to have occurred at the majority of the site area covered by this photo. If we consider the adjacent sensitive receivers surrounding this site area, namely the forested area, the impact of surface runoff carrying loose soil materials and sediment during event of heavy rain can be considered to be relatively significant, as no perimeter controls or buffer zones are apparent at the site. Other sensitive receivers (not seen in this photo) such as streams or rivers which may likely be found at the lower elevation will also be adversely impacted from these potentially polluted runoff discharges.



**Figure 4.4: Vast Land Clearing with Lack of Phasing Planning**



**Figure 4.5: Massive Scouring of Ground Surface due to Erosion of Unprotected Surfaces**

As in Example 1, the issues with this second example appear to include the following, which resulted in the consequences as shown in **Figure 4.4** and **Figure 4.5**:

- Issue of work programme;
- Construction activity;
- Construction schedule;
- Construction methodology;
- Issue of planning;
- Issue of work stages;
- Issue of project phasing;
- Issue of work sequence;
- Issue of upholding the Code of Practice in Earthwork;
- Issue of erosion and sediment control measures not supervised properly; and
- Issue of BMPs not in place.

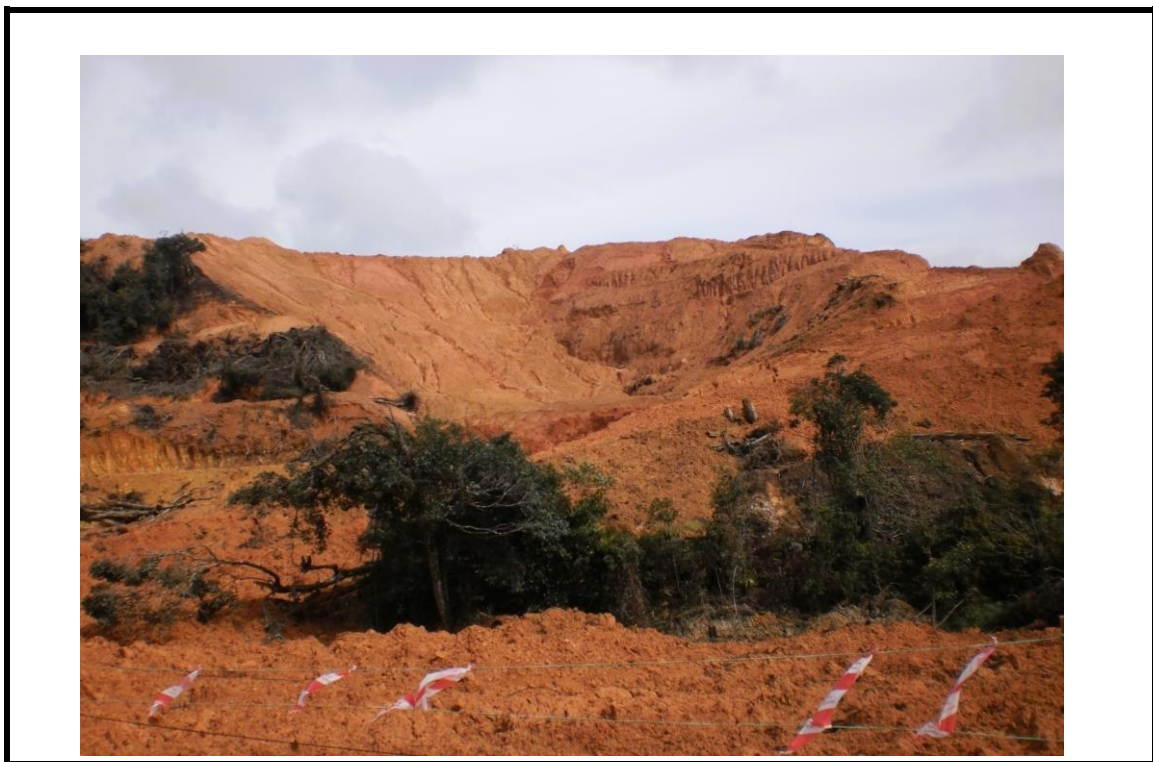
### 4.2.3 Example 3

The following **Figure 4.6** provides a further example to indicate the potential adverse impacts brought about by, amongst other factors, inadequate planning on site activities phasing. In this example, the impacts of erosion such as rills and gullies are observed to have formed on this exposed slope, mostly likely due to erosion caused by rain and surface runoff. Note also the haphazard method of site work at this site whereby clusters of vegetation were left untouched but the ground area around them has been stripped clear of its natural vegetation. It is predicted that if the exposed surface is left untreated for a further period of time,

continual erosion and surface runoff would eventually cause these vegetation to be uprooted, and possibly causing further damages to the downstream side of the slope.

The potential issues associated with Example 3 appear to be literally similar to the previous two examples, which include the following:

- Issue of work programme;
- Construction activity;
- Construction schedule;
- Construction methodology;
- Issue of planning;
- Issue of work stages;
- Issue of project phasing;
- Issue of work sequence;
- Issue of upholding the Code of Practice in Earthwork;
- Issue of erosion and sediment control measures not supervised properly; and
- Issue of BMPs not in place.



**Figure 4.6: Impacts from Poor Planning in Phasing of Site Works**

#### 4.2.4 Example 4

This example (**Figure 4.7**) illustrates what happens when an active work area is not provided with proper identification of land disturbing activities and the associated phasing, and is subject to the element of the weather. As a consequence, erosion and surface runoff occurred inevitably during a rain event, and note the extent of sediment being transported via the surface runoff into the adjacent drainage, and presumably, eventually to a nearby watercourse.

The issues associated with Example 4 appear to include the following:

- Construction activity;
- Construction methodology;
- Issue of erosion and sediment control measures not supervised properly; and
- Issue of BMPs not in place.



**Figure 4.7: Erosion and Surface Runoff from a Poorly Managed Work Site**

#### 4.2.5 Example 5

Example 5 attempts to illustrate an example which involves a linear-type land clearance work. A linear-type project basically involves a construction works limit which extends linearly (as opposed to a site which is confined to a “stationary” works area), such as construction of roads, drainage or transmission lines. For this example, the project involves the construction of a new electricity

transmission line on a mountain ridge. In **Figure 4.8**, as a result of inadequate project phasing, the land disturbing activity, namely, site clearance, has created a large extent of exposed and unprotected ground surfaces at the high ground. Leaving exposed ground surface in such condition is conducive for the process of erosion to occur during rain events. Compounded by the lack of the minimum erosion and sediment controls such as perimeter controls, buffer zones, silt fences, drainage, silt traps or basins, etc., it is not surprising for the erosion impacts to deteriorate and possibly causing the landslide as shown in **Figure 4.9**.



**Figure 4.8: No Indication of Works Phasing Implemented**



**Figure 4.9: Erosion and Landslides Resulted from Lack of Activities Phasing**

The environmentally damaging consequences resulting from the type of construction work as illustrated by Example 5, to a large extent, may be attributed to the following issues:

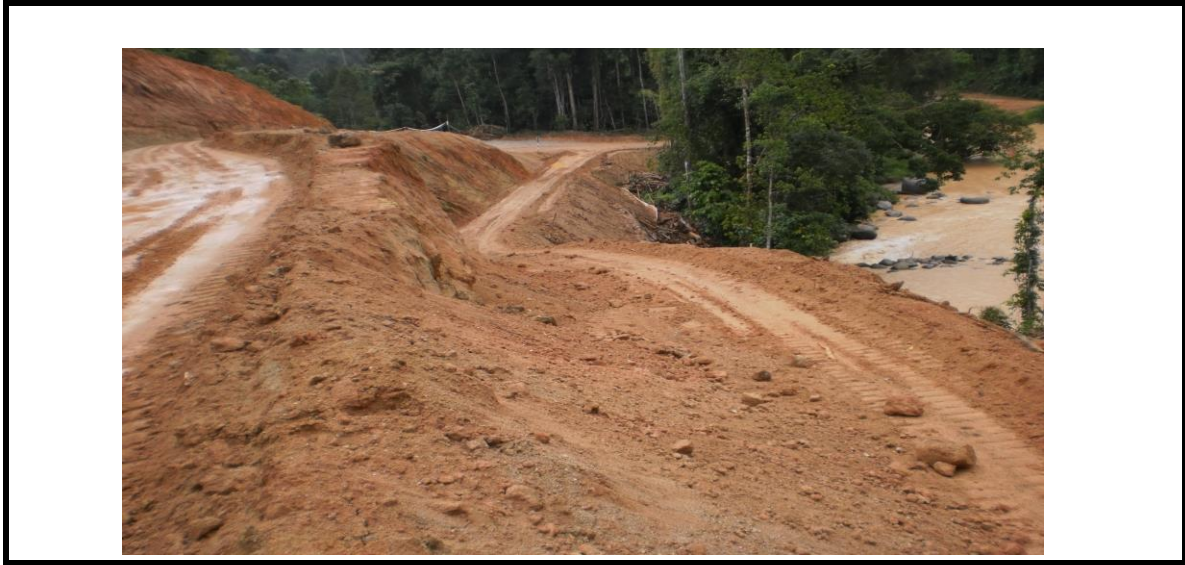
- Construction activity;
- Construction schedule;
- Issue of planning;
- Issue of work stages;
- Issue of project phasing;
- Issue of work sequence;
- Issue of upholding the Code of Practice in Earthwork;
- Issue of erosion and sediment control measures not supervised properly; and
- Issue of BMPs not in place.

#### 4.2.6 Example 6

From the perspective of erosion and sedimentation, identifying phases in a project becomes more critical, particularly for works undertaken immediately adjacent to a watercourse such as rivers and streams. In **Figure 4.10** below, a large area of an existing vegetated land next to a main river was cleared to form an access road, but evidently, there was a lack of planning and phasing in the work activities to address erosion and sedimentation issues. In the event of rain at this location, erosion will inevitably occur and sediment subsequently washed into the adjacent river via surface runoff.

The potential issues associated with this last example include the following:

- Issue of work programme;
- Construction activity;
- Construction schedule;
- Construction methodology;
- Issue of planning;
- Issue of work stages;
- Issue of project phasing;
- Issue of work sequence;
- Issue of upholding the Code of Practice in Earthwork;
- Issue of erosion and sediment control measures not supervised properly; and
- Issue of BMPs not in place.



**Figure 4.10: Erosion and Surface Runoff from a Poorly Managed Work Site**

#### **4.2.7 Discussion**

All of the above examples and photos illustrate only a sample of work sites found to be facing erosion and sediment issues due to their site activities, but in reality, these occurrences are believed to be relatively typical throughout the civil projects in Malaysia. Based on the possible issues or causes that have resulted in the observed situations as seen in the above photographic evidence, it is strongly believed that had proper planning and phasing of the site activities been implemented prior to the land disturbing activities, most of the adverse erosion and sediment impacts could have been avoided. For instance, in nearly all of the work sites shown above, phasing of the activities would need to be integrated into the planning of the works in order to control the erosion and surface runoff issues. One of the factors that need to be considered during the phasing of the site works would be the ‘division’ of the works area footprint into smaller and manageable work parcels. Once a smaller footprint is defined, then the application of minimum requirements for the Land Disturbance Pollution Prevention and Mitigation Measures would follow for this parcel in relation to the work scheduling and sequencing to control erosion and sediment discharge. The remaining of this Chapter will be dedicated to discussing the process of identifying phases and other associated aspects in this regard.

## 4.3 PHASES IN A PROJECT

### 4.3.1 Meaning of “Phase”

The term “*phase*” is generally defined as “*a particular stage in a process or in the gradual development of something*”, and also as “*any distinct or characteristic period or stage in a sequence of events or chain of development.*”<sup>1</sup> The word “phase” is sometimes used interchangeably with “*stage*”, which is defined in the dictionary as “*a distinct step or period of development, growth, or progress.*” For the purpose of this Guidelines, no differentiation will be made between these two words, and they will be deemed to have the same meaning in the context of LD-P2M2 application.

### 4.3.2 Project Cycle

Before discussing further on the application of “phasing” in the context of controlling erosion and sediment in a project, let’s have a quick review on the cycle of a typical civil engineering project in Malaysia, up to the end of the construction activities. This is to give the reader a better understanding of the potential timing within a project’s life whereby the theory of LD-P2M2 can be applied before the actual physical works commence at site, so as to enable the maximum benefits to be attained in arresting potential issues of erosion and sediment before they occur. For the purposes of this discussion, let’s assume an example for a typical and relatively straightforward project which requires an EIA to be conducted, for which its project flow can generally be illustrated in **Figure 4.11**. It should however, be noted that this flow shown is only a generic illustration, as different projects may have specific characteristics or requirements that deviate from the process flow as shown below. A brief explanation on each of the steps in the flow in **Figure 4.11** is provided below.

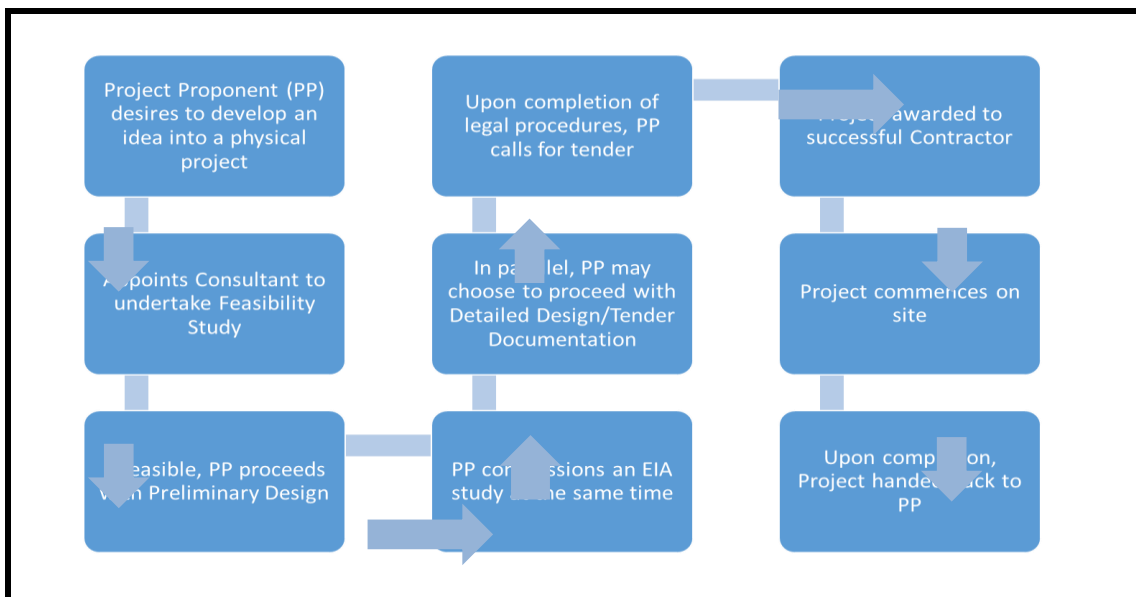
The cycle of any project always commences from the same starting point, i.e., the Project Proponent’s need or desire for a “product”. “Project Proponent” in this context can be a private entity or government institutions or semi-government bodies. In the case of a civil engineering project, this “product” can be in many forms, such as an entirely new development project (either residential, commercial or industrial), utility facilities (such as sewage treatment plants, water treatment plants, power stations, major drainage or sewerage schemes, etc.), agricultural projects (such as oil palm plantation, etc.), new infrastructural networks (such as highways, bridges, canals, airports, ports, etc.), and so on. The reasons for the above needs can vary between a wide spectrum of needs, ranging from a purely economic reason (in the case of privately initiated projects) to that of national interests (such as infrastructural and utilities projects). Regardless of the status of the project initiator, i.e., Project Proponent

---

<sup>1</sup> Collins English Dictionary

and the reasons for the need of the project, most, if not all, of these projects will have to go through this simplified flow as shown in **Figure 4.11**.

Once the Project Proponent (PP) decides to pursue further or proceed with his desire to materialise his ideas or needs, the next step would typically be the appointment of a consultant to investigate the feasibility of the project. This would likely involve the evaluation of the project feasibility from the perspectives of technical, economical, social, environmental and safety, and normally requires the consultant to review and assess the various options or alternatives to implement the PP’s ideas by comparing each of these options or alternatives against a set of agreed parameters for comparison. Depending on the complexity of the proposed project, the duration of a feasibility study can range anywhere from as little as six (6) months (or less) for a relatively straight forward project, to even to eighteen (18) months (or more) for mega or major projects. Ultimately, the objective of this step in the project’s flow will be to ascertain the feasibility of the proposed project based on the given assessment criteria (i.e., technical, economical, social, environmental, safety, etc.). If it were found that the project is not feasible due to whatsoever reasons, the PP may wish to reconsider and adjust the original scope of the project, or to totally abandon the whole idea of pursuing further with his idea (if the feasibility study discovered insurmountable issues that cannot be resolved). If the PP chooses the former, then a separate feasibility may be undertaken to confirm the feasibility of the revised plan. Conversely, if the feasibility study recommends that it is viable for the project to proceed, then the project will move into the next step, that is, typically the Preliminary Design stage.



**Figure 4.11: Typical Flow of a Project**

Once the feasibility of the PP's idea is ascertained, the PP may normally engage an engineering consultant (which could be the same consultant who have previously undertaken the Feasibility Study) to provide the preliminary designs of the proposed project. Typically, the basic engineering information on the project is obtained and compiled to enable the formulation of a preliminary visualisation of what the project might look like upon construction. To this end, the preliminary designs may entail the compilation of initial soil and site investigation data, project boundary and Right of Way (ROW), pre- and post-development formation levels, footprint of the final works (buildings, roads, drainage, etc), layouts of associated utility services (such as sewerage, drainage, water supply, electricity, gas, telecommunication, etc), and usually the build-up drawings of the final works. The main objective of this step in the project can be perceived to enable the PP to achieve the following goals:

- Further confirmation of the Feasibility Study findings by developing the constructability of the project;
- Early identification and resolving of any physical constraints in the field in terms of land use, project interfaces, constructability of the project, and operation & maintenance of the completed project, which may lead to refinement of the final designs;
- Early identification of potential site impacts on geotechnical, hydrology, environmental, traffic, utility, etc., so as to formulate practical solutions and mitigation measures to be integrated into the detailed designs and construction of the project;
- Initial estimates for the completion of the project, i.e., from the fulfilment of all the legal requirements through to the handover of the constructed final works by the contractor to the PP;
- Initial budget estimates for the implementation of the project; and
- Identification of further information that needs to be obtained or investigated in detail in order to complete the detailed designs of the project.

Again, depending on the complexity of the project, the duration for completing the preliminary designs can range anywhere between another nine (9) to eighteen (18) months. It should be noted that that these durations are provided herein solely for the reader's information only, so as to get some sense on the effort needed for such an activity. The duration cited in this section are estimates only based experience from other projects and should not be used for any other purposes outside of this *Guidelines*. Ultimately, the objective of step 3 in the project will be to produce a set of initial designs for the PP, with enough information so as to fulfil the above goals, but yet to be finalised with adequate detailed information for tender documentation and construction purposes.

With the preliminary designs completed to the satisfaction of the PP, step 4 will likely involve the commencement of the EIA study, to evaluate the

environmental impacts of the project to its surroundings during the construction and operation stages, as well as to propose mitigation measures to control these impacts to the acceptable levels. Sometimes, the PP may also initiate step 5, which is the preparation of the detailed designs and tender documents as shown in **Figure 4.11**, in parallel with the EIA study; most often than not, this is likely for the purpose of expediting the overall process whereby it is hoped that construction works may start at the earliest date. Although such merit may appear to be beneficial for project implementation, the downside of initiating these two activities concurrently is that at times, findings from the EIA study may need to be integrated into the detailed designs or tender documentation. With both activities running at the same time, there is a possibility that pertinent information from the EIA study might not be incorporated into the designs in a timely manner, and thus resulting in possible abortive work, or more seriously, exclusion from the tender documentation. Notwithstanding the above however, the PP (and his designers) should diligently include the pertinent findings from the EIA study into the detailed designs at the appropriate stage in the project and preferably prior to the award of the contract.

The duration for the EIA study can range between six (6) months to twelve (12) months. Ultimately, the objective of step 4 is to produce an approved EIA report, with or without associated conditions of approval by the DOE.

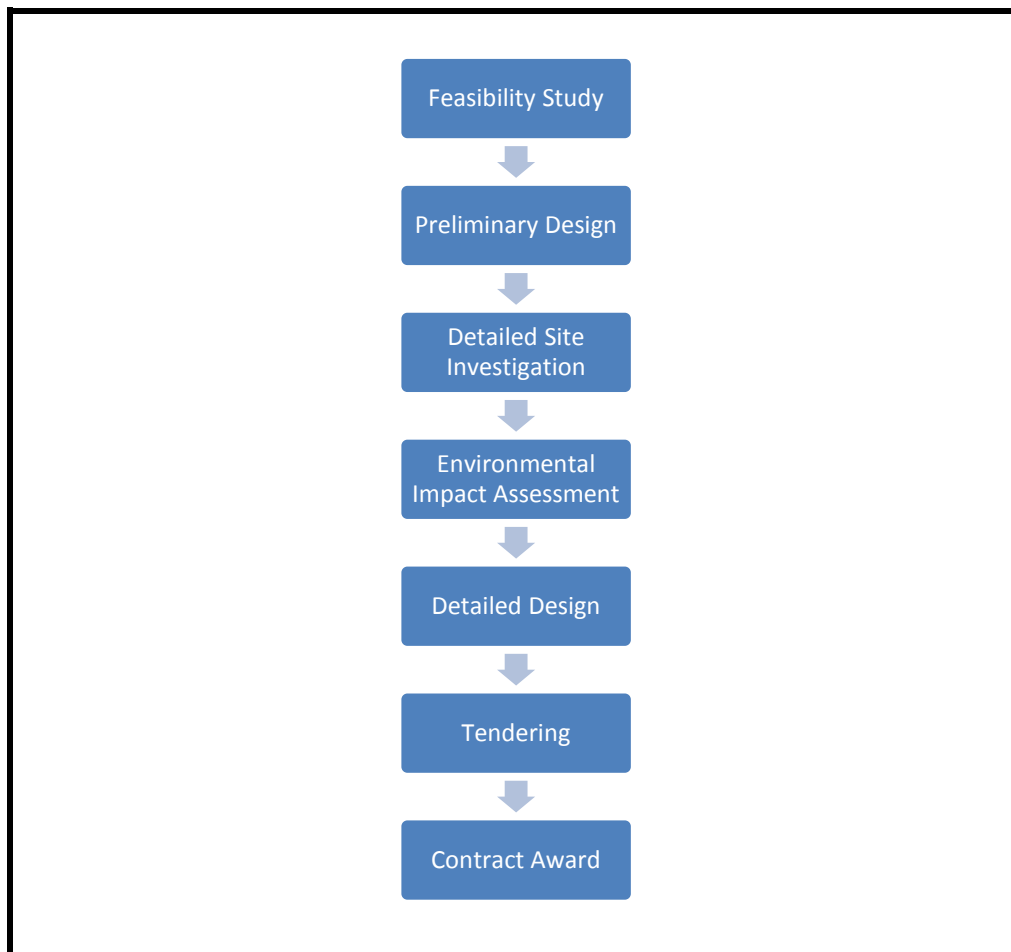
Assuming the PP chooses to conduct the detailed designs and tender documentation upon completion of the EIA or at least, towards the end of the EIA study, this step then becomes step 5 in the project. Under this step, the PP's engineering team will undertake to complete the final designs of the project based on a comprehensive suite of data and information, with most of these data and information transferred from the previous steps of the cycle whilst the remaining compiled during this step. Here, the team will assemble all the available design data into design reports, engineering drawings and specifications, to a level that is understandable by an experience builder or contractor to execute the works on site. It should be noted that except for very special cases, most of the time these drawings will show only the details of the final works that are required to be delivered to the PP; in other word, the designers will almost never specify the methodology of how these final works are to be constructed by the contractor. It is not the intention of this *Guidelines* to discuss further on the contractual legalities underlying this topic, but the important point for the reader to bear in mind is that, it is really the responsibility of the contractor to come up with his methodologies on how to deliver the final product as specified in the drawings and specifications, based on the requirements of the project (including civil, geotechnical, structural, infrastructural, environmental, electrical and mechanical, etc.) that are included in the tender documents. Having said the above, it is imperative then that these requirements should be clearly spelled out and allowed for in the tender documentation so that the contractor can properly price his works. The duration

for the preparation of the detailed designs and tender documentation may take another nine (9) months to eighteen (18) months, depending on the complexity of the project.

Upon completion of the detailed designs and the associated tender documents, the Project Proponent may need to assure himself that all the necessary legal procedures have been undertaken and accomplished, so as to make sure that the project can be implemented smoothly once the successful contractor has been selected. Some of these procedures may be those required on the federal or state level. Once all the necessary procedures are completed, the PP can then proceed with the tender exercise, i.e., to invite qualified tenderers to submit their proposals (technical and financial) to execute the project. Upon receipt of the tenders, the PP and his team will then assess and evaluate the submission based on a set of agreed assessment criteria, with the ultimate aim to select one contractor who is deemed to be technically and financially sound to carry out the construction works. The outcome of this step is then to select the successful tenderer and subsequently, to award the contract for the project to this contractor.

Once the contract has been awarded, the Contractor then commences his site activities and implements the works activities in accordance to the requirements of the Contract Document, which collectively includes the Drawings, Specifications and all other documents that are deemed to be part of the Contract Document, for example, the approved EIA report and EMP, amongst others. In other word, the contractor is obliged to operate and manage the construction site to comply with not only the Contract Document which he entered into an agreement with the PP, but also with the recommendations as prescribed in the EIA report which was previously approved at the earlier stage of the project's cycle. It is important for the reader to remember this point because as we will see later, this obligation plays a key role for the applying LD-P2M2 into the construction stage. At the completion of all the works covered in the contract document, the Contractor eventually hands over the completed project to the Project Proponent for the operation and maintenance stage.

As discussed above, there are various major steps that are needed to be accomplished before a project can commence its physical works at site, including the feasibility studies and investigation, designs, Environmental Impact Assessment, and tendering & assessment, or graphically shown in **Figure 4.12**:



**Figure 4.12: Typical Pre-Site Activities**

Within the simple 9-step process shown in **Figure 4.11**, a commonly misconstrued perception on handling erosion and sedimentation issues at a project site is that this would be taken care of at Step 8, namely, after the project's commencement at site, whereby the Contractor is solely tasked to control such issues during his works. When such "mistake" is made and set in motion, it is not surprising then to receive feedbacks from relevant project stakeholders in the following form (as discussed in **Chapter 1** earlier) on the reasons why erosion and sedimentation occur at their jobsites:

- *Erosion and sediment control implementation considered to be an additional cost to the project which has not been accounted for or anticipated earlier, due to lack of budget during the planning and design phase;*
- *Absence of development phasing in which only a portion of the construction site is cleared and graded at any one time;*
- *Site clearing and earthmoving normally carried out in large area at one time, instead of in staggered and phased development, as it will yield higher return on the reason of economic of scale;*

- *Rates allowed for temporary BMPs normally on the low side and often considered as items with negative profit, and thus, given low priority in construction planning;*
- *Contractor's erosion and sediment control programme may address only the initial and final phase of construction but not the interim construction phases with adequate temporary BMPs.*

To overcome the above scenarios (which are not uncommon in most projects unfortunately), the timing to kick off the process for handling erosion and sedimentation issues becomes critical. This is where the application of LD-P2M2 theory can assist. For the entire concept of LD-P2M2 to be effective, it is imperative for the preparer of the LD-P2M2 Document to understand that the process for handling erosion and sedimentation issues on a project site actually begins even much earlier before the physical activities start.

For instance, the LD-P2M2 Document is required to be prepared and submitted as part of the EIA report<sup>2</sup>; this then becomes the first opportunity for the Project Proponent and his EIA Consultants to assess the *where* and *when* potential erosion and sedimentation may occur for the particular project, and consequently, to review the extent and appropriate BMPs that should be implemented during the land disturbance activities of the project. Subsequent to the approval of the EIA report and correspondingly the LD-P2M2 Document, the pollution prevention and mitigation measures recommendation contained therein can be carried forward to the stages of detailed design and tender document preparation for inclusion.

With the above attention and consideration given to handling erosion and sedimentation issues by the Project Proponent and his Consultants, requirements for the minimum actions to be implemented on site to control erosion and sedimentation by the Contractor will become transparent, and even contractually and legally binding, since the approved EIA report and all its content therein normally form part of the Contract Document.

For relatively large projects, it is not uncommon for the Project Proponent to manage his project by dividing the development into several phases. It is noted that such type of *development phases* is different from and not similar to the concept of project phases that this Guidelines is advocating. Further clarification on these two concepts is provided in the subsequent Section 5.3.3. After the contract has been awarded, it is normal for the Contractor to break down the project (or the Works to be performed to deliver the project) into distinct categories, such as *pre-construction*, *construction*, *commissioning*, *handover*. *Work breakdown structures* will then be prepared under each of these categories, so as to enable the Contractor to effectively manage his resources (materials, equipment, labour) within the prescribed programme and budget of his contract.

---

<sup>2</sup> Per DOE's latest "EIA Guidelines in Malaysia, 2016"

For the LD-P2M2 to become effective, it is imperative that the preparer or user of the LD-P2M2 Document has some basic knowledge in identifying the key elements in reference to the above-mentioned *work breakdown structures*, particularly in the context of controlling erosion and sedimentation that may arise from the site activities. Description on these terminologies is given below.

#### 4.3.3 Distinction between “Development Phases” and “Project Phases”

At times, it is beneficial for a project to be subdivided into several development phases, especially for mega infrastructural or residential development. One of the main advantages of such type of development phasing is that it allows the Project Proponent to dedicate his resources to completing one “phase” of his development, which upon completion, can render this completed phase to be operated for generating income or services. To this end, such a “phasing” on its own can be regarded as a whole project by itself, which at the end of the construction period, all the integral components of this “phase” are essentially functional and the whole “phase” enters into the next stage of the project, which is operation and maintenance. At this point in time, implementation of the construction works can commence for the subsequent phase of the overall development and the same scenario will repeat itself if the development involves more than two phases.

Conversely, the “project phasing” being referred to in this *Guidelines* is distinctly different from the “development phase” as mentioned above. In this *Guidelines*, we are talking about breaking down a “whole” project into smaller divisions of work, regardless of whether this “whole” project is part of a “development phase” described above, or is indeed the entire project by itself. In other words, the concept of phasing from the perspective of controlling erosion and sediment in this sense is more like a “phase within a phase”, if indeed the project constitutes two or more development phases. The “phasing” for the purposes of controlling erosion and sediment is more of an internal subdivision of the project into smaller packages so as to manage the work sequences within these packages to minimise the erosion and sediment events. As such, from here onwards, “project phasing” in the remaining chapters of this document is taken to mean the subdivision of a project internally, to facilitate the implementation of erosion and sediment controls or BMPs in a sequential or systematic manner.

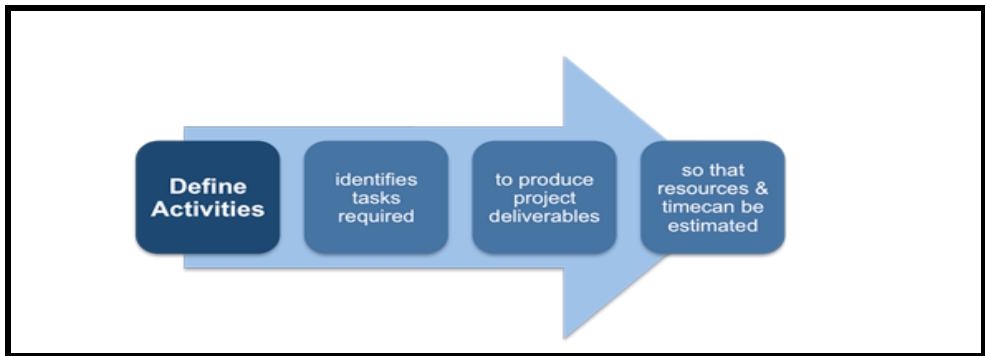
#### 4.3.4 Distinction between “Pre-Construction” and “Construction”

In Section 5.3.2.14, it was mentioned that the Contractor may break down the project (or the Works to be performed to deliver the project) into distinct categories, such as *pre-construction*, *construction*, and so on. Perhaps some clarification should be made here to distinguish these two terminologies, in the context of this *Guidelines*.

From the perspective of controlling erosion and sediment, the terminology “Construction” can be standardised in this *Guidelines* to mean “all those activities involved in the creation or building of the *permanent works* of the project”. “Permanent works” in turn herein refer to the final products or final deliverables that are the intended outcome from the contract that the PP signed with the Contractor, such as a new airport, a new residential development, a new highway, a new sewage treatment plant, etc. In this regard, “Pre-Construction” activities can be normalised in this *Guidelines* to mean all those preliminary or early site activities to prepare the platforms for the above construction works. Whilst the “Construction” involves the creation of the *permanent works* of the project, which may include activities directly related to the formulation of the final works such as *excavation for foundation, forming of foundation including formworks steelworks and concreting, structural formation, roof works, electrical & mechanical works, architectural works*, “Pre-Construction” conversely would involve activities such as *forest clearing or site clearance, temporary construction access roads and drainage, earthwork to raise or lower platforms, site grading, slope formation, setting up storage yards, disposal sites, workshops, staff offices & quarters*, to name a few. From the above examples, it could be perceived that the pre-construction activities would involve a larger extent of land disturbing activities, which is true for a majority of civil engineering projects, and to a lesser extent land disturbing activities are also found during the construction activities.

**4.3.5 What is Work Breakdown Structure (WBS)**

In simple terms, work breakdown structure (WBS) can be defined as a "hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables”.<sup>3</sup> Graphically, the purpose of defining project activities can then be shown as follows:



**Figure 4.13: Purpose of Defining Activities in Project Management** <sup>4</sup>

<sup>3</sup> Project Management Body of Knowledge (PMBOK 5)

<sup>4</sup> Source: <http://www.free-management-ebooks.com>

It is further described that *Defining Activities* “uses decomposition to take the work packages identified in the WBS, which are nouns, and to identify the activities (which are verbs) required in order to complete them. The work packages are product or deliverable based to deliver the scope of the project. In order to produce the activity list it is necessary to examine each work package and break it down into individual work schedule activities.” The *activity list* is a “*list of all the activities that must be performed within the project and each one should be linked back to just one work package (although each work package may have several activities within it).*” In project management, the “work package” included as part of the WBS is intended to be achieved when the work can be accurately estimated (both cost and duration) and can be managed by one individual. The literature goes on to suggest that “although the work package can be managed by one person, the actual work within the work package may be completed by several people. Each activity must be complete and accurate, because it will be used to develop the project schedule. An activity is typically described using a noun and verbs such as ‘Specify Task Requirements’”.

To illustrate the above, an example is given whereby one individual could manage a particular work package called ‘Select and Appoint Contractor’. However, this work package could be decomposed into the following activities each of which could be undertaken by a different person:

1. Specify Task Requirements
2. Identify Potential Contractors
3. Send Invitation to Tender
4. Review Tenders
5. Interview Contractors
6. Choose Contractor
7. Check References
8. Agree Contract Terms
9. Appoint Contractor

As seen above, when the work packages are decomposed into activities in this way the result is to create an activity list, which can then be used to develop the project schedule. As mentioned earlier, the work packages are product or deliverable based to deliver the scope of the project, whereas activities’ focus on the work that needs to be carried out in order to execute such work packages. An activity has an expected duration and consumes resources in terms of manpower and/or budget. If duration cannot be meaningfully assigned to it then it should be considered a milestone. The technique of decomposition, as applied to defining activities, involves subdividing the project work packages into smaller, more manageable components called activities. Activities represent the effort needed to complete a work package.

With the clarification of the several key terminologies above, let's continue with the following sections on how one should identify *project phases*, *project components*, *project activities*, and *work sequences* from the angle of minimising erosion and sediment in a project.

#### 4.4 IDENTIFYING PHASES IN A PROJECT

##### 4.4.1 Meaning of “Phases” in the Context of this Guidelines

The meanings of “*phase*” are given above in Section 5.3, as well as for the project phases from the perspective of controlling erosion and sedimentation issues at site. For the purposes of this *Guidelines*, we shall further extend the meaning of “*phasing*” to involve the *planning and development of a schedule of construction activities, and to match these activities with recommendation of the appropriate P2M2's or BMPs* at that particular stage of the project. The main purpose of introducing *phasing* in such a manner is to ensure that the amount and duration of soil exposed (from the land disturbing activities) to erosion is reduced as much as practicable at any one time by implementing and maintaining the suitable BMPs in coordination with the sequence of construction activities.

Consequently, when the word *phasing* is discussed in this *Guidelines*, it is not just to look at only a particular or distinct stage in a sequence of events or chain of development, but to also discuss the consideration of suitable pollution prevention and mitigation measures to be recommended for controlling erosion and sedimentation during this phase of work. To undertake the above, one would also need to have the basic knowledge in identifying the *work breakdown structures* and the associated *project components*, *project activities*, *work scheduling*, *environmental method statements*, and *BMPs*. This Chapter will cover in detail all of the above terminologies in the later sections, except for the last where it will be covered in **Chapter 6**.

In view of the context as discussed above, it should be evident that the intent for the use of the concept of *phasing* in this *Guidelines* is focused on those site works which will involve land disturbing activities. The key to developing an effective “*phasing plan*” should be that it is not undertaken prior to the mobilisation of the Contractor's team to the project site, but rather at much earlier stages of the project (as discussed in Section 5.3 previously). This plan should also emphasize the concept in which any disturbed areas in one phase should be stabilized before disturbing the subsequent phases.

There is no hard or fast rule to establish the size and extent of a *phase* for any particular project. In the process of identifying possible phases in a project, several factors will need to be considered.

#### 4.4.2 Factors of Consideration in Phasing

**Size of site:** No matter what the project's footprint or size is, *phasing* can in principle be applied for the purposes of controlling erosion and sedimentation from the impending land disturbing activities. In other word, *phasing* is applicable to a project with a footprint of 10 hectares, as well as to another project which covers only 1000 m<sup>2</sup>, just as long both projects involve land disturbing activities. The key difference in the *phasing* between these two projects will depend on the other relevant factors as discussed below. In most cases, the number of phases will increase to correspond to the complexity of the project, with size being one of these contributing factors. Nevertheless, the actual phasing will depend also on the types of land disturbing activities that are involved, topography of the site, existing conditions of the site, and so on.

**Existing land use:** The existing condition of the site where works will be undertaken will also determine how *phasing* would be planned out. A project site which is covered by virgin forest inevitably will need to be treated differently than a site which is already disturbed or is currently relatively established (for example, with available access roads or drainage, etc). For those sites which are relatively *undisturbed* and land disturbance activities will be involved in the site works, *phasing* of such sites will need to pay particular attention to the construction sequence of works and the provision of suitable BMPs in order to reduce the amount and duration of exposed disturbed surfaces.

**Types of land disturbance activities:** The extent of *phasing* for a site will depend heavily on the type of land disturbance activities that might occur in the construction sequence. A project site with a footprint of 1 ha requiring a concrete platform to be constructed on the entire site which is currently occupied by dense forest, when compared to another project site with the same footprint but only requiring a three meter wide road to be constructed with some spot excavation for structure foundations spaced every 20 m, will have a significantly different extent of phasing. For the former, the site activities are predicted to incur large scale land clearance and vegetation removal (over the entire 1 ha of land), cut and fill for land formation, excavation works for access roads, drainage & platform foundation, materials transport, amongst others. The latter project, on the other hand, may require some land clearance and vegetation removal but on a much smaller scale, i.e., along a strip of land, say 10 m wide, as well as some excavation for the road foundation and structure foundation. It is obvious from the above description the platform project will incur more land disturbing activities and hence a larger area of ground surface being exposed to the elements which could result in erosion, as compared to the second project. Under such circumstances, *phasing* of the first project will likely involve more and smaller parcels of work areas (to control erosion), and the second project, whilst still requiring some *phasing* to be provided, can afford to have fewer but larger extent of parcel of work areas.

**Topography:** This factor will influence the *phasing* of a site from the perspective of controlling surface runoff. By taking into account of the ground topography during identification of the site *phasing*, one can not only “contain” the surface runoff for that particular parcel of work area, but also introduce some engineering economics by optimizing the natural flow paths within a site.

**Weather:** Weather plays a critical role in *phasing* in conjunction with the work sequence. When identifying the *phasing* for a particular site, one needs to know the type of site activities that are needed as well as the season of the year during which these activities are taking place. Where possible, land disturbance and construction activities in and around waterways should be scheduled during the dry weather, to minimise opened ground surface exposed to the elements of rain.

**Type of soil:** The ease for the soil materials to be dislodged from the land disturbing activities as well as the difficulty in treating the captured eroded materials also play a part in establishing the suitable *phasing* for particular site. Ground conditions comprising easily loosened soil materials and difficult to treat (for instance, fine silt) should be subjected to a more manageable (i.e., smaller) parcels of phased work areas.

**Environmental Sensitive areas:** The presence of environmentally and ecologically sensitive receivers within a project site will also affect the extent of *phasing*. This is to avoid haphazard clearing or pollution of or causing adverse impacts to such sensitive receivers including fauna and flora, high quality rivers, human settlements, etc.

**Practicality of BMP installation:** How fast can the BMP(s) be installed on site depends on the type of BMPs (silt fence or sedimentation pond), whether access is available, how much resources will be provided to install BMPs, type of terrain BMPs to be sited on, weather conditions, etc. A site which faces challenges when answering the above queries should be *phased* carefully, i.e., with smaller work areas and coordinated closely with the construction sequence, to reduce the amount and duration of soil exposed from land disturbing activities.

**Rate of production:** Rate of production refers to the how rapid the site activities could be carried out. Evidently then this depends on the number of resources (equipment, machinery, labour) deployed by the Contractor, as well as on the type of terrain (flat or hilly grounds) and weather. Another factor to be considered concurrently is the rate the BMPs can be installed; if it is anticipated that the rate of site activities were able to proceed at a much greater rate than the BMPs could be installed, there is then a need to assess the *phasing* such that to avoid a scenario whereby large areas of exposed ground are left unattended to.

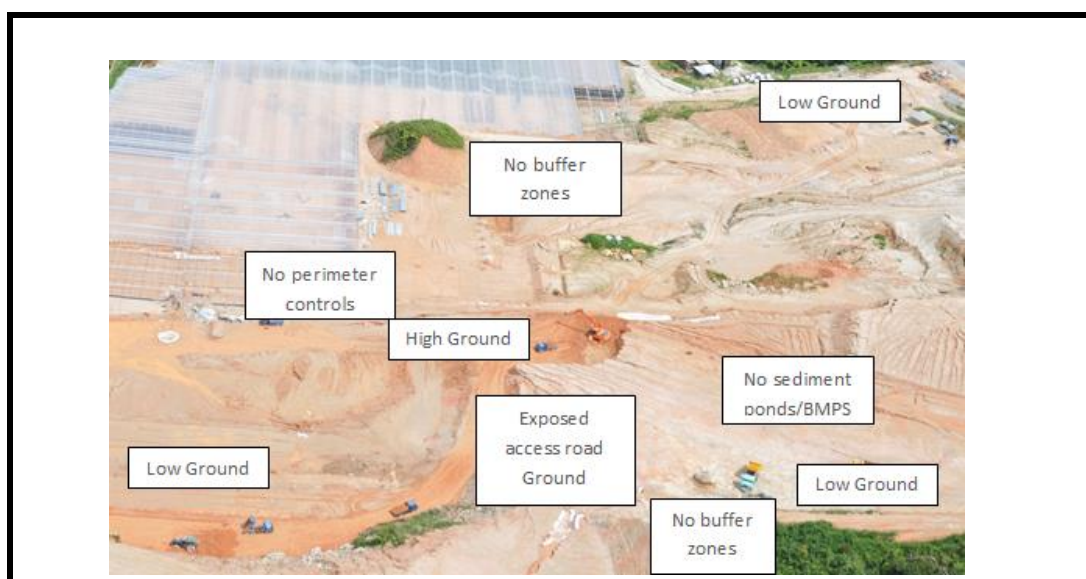
Based on the above discussion, it should be clear why it was stated earlier there is no fast and hard rule to establish the size and extent of a *phase* for a particular project, because every project is distinctly different. There is no right or wrong answer to whether a *phasing* has been done correctly or not, but for each planned *phasing*, adequate justification should be provided behind the basis for the planning. It *should* always be remembered that the ultimate objective of introducing *phasing* to a project site is to ensure the amount and duration of soil exposed (from the land disturbing activities) to erosion is reduced as much as practicable at any one time by implementing and maintaining the suitable BMPs in coordination with the sequence of construction activities.

#### 4.4.3 Examples of Phasing

Without going into the specific details as recommended in Section 5.4.2 above, let's take a look at some examples of possible phasing that could be considered using the site scenarios presented earlier in this Chapter.

To recap, **Figure 4.1** is reproduced below. Key issues relating to erosion and sedimentation that can be captured from this photo include the following:

- A large area of land subject to site clearance at one go;
- The ground surface at the bottom portion of the photo appears to be at a lowest elevation;
- Another low point of the site may be at the area located at the right top corner of the photo;
- No buffer zone appeared to have been provided;
- Access road not topped with materials to prevent erosion;
- Sediment ponds or other forms of BMPs are not evident.



**Previous Figure 4.1: Large Scale Earthworks with No Proper BMPs Installed**

Based on only the above observations (and not having enough data to take into account the other factors as discussed in Section 5.4.2), one could even plan a preliminary *phasing* programme which might have lessened the impacts of erosion from this site. **Figure 4.14** below presents a simple graphical illustration one of the possible ways to phase the activities on this site. It should be stressed again that there is no right or wrong way to plan a *phasing*, as long as adequate justification is provided for the basis of the planning. Ultimately, the final objective is to ensure the amount and duration of soil exposed is reduced as much as practicable. In this regard, the notes associated with the proposed phasing in **Figure 4.14** are as follows:

- Assuming this photo has covered all of the site to be worked on, the approximate area shown to be currently exposed is about 1.5 ha.
- Assuming the lowest elevation is at the bottom of the photo, and the top of the ridge is at around middle of the photo, “Phase 1” should start from the lowest portion of the site, as indicated. Concurrently, clearing can also start at the presumed low point at the top right corner of the photo.



**Figure 4.14: Possible Phasing**

- The width of the lower Phase 1 region is approximately half the distance between the low point and the ridge top, to allow adequate BMPs to be installed at the lower half of the sloping surface or toe of the slope before exposing the slope side at the higher elevation. The length of this phase extends from the left most of the site towards the right until the edge of the flat surface. If adequate resources are available, two “Phase 1” areas have been proposed to allow simultaneous works to proceed on this site.
- Phase 2 is then planned to take place adjacent to Phase 1, and by definition, to commence only after completion of the Phase 1 works. For this site, the rationale for Phase 2 is that this area is also generally at the lower ground

level, and hence, imperative for the BMPs to be installed before works proceed to the higher ground. The benefit of such planning is that when land disturbing activities begin at the higher ground, the exposed surfaces at the lower ground would have been provided with temporary stabilization as well as the appropriate BMPs installed such as perimeter controls, buffer zones, sediment basins, etc. Thereafter when the works at the higher ground commences, sediment discharges and/or runoff from this latter phase would be “captured” by the existing BMPs at the lower ground, hence minimising the deposition of these runoff materials to the downstream sensitive receptors such as rivers and watercourses. At the completion of Phase 2, the following phases would follow suit.

- Had this been a proper *phasing* exercise, the next steps would be identifying the project components within this parcel of work area, and establishing the construction sequence with the intention of identifying BMP recommendation to be provided herein. For example, looking at the site conditions, some of the possible BMPs that may be relevant within this area include the following:
  - Provision of physical markers such as fences, signs, tapes, flags or other similar marking device on site to show the limit of land disturbing activities from any drainage way, waterway or watercourse within project site, and areas not to be worked or disturbed;
  - Establishment of buffer area or/and existing vegetation meant for temporary or permanent preservation and for protection;
  - Provision at all entrance/exit roads to the site with proper stabilization such that these roads are paved for a suitable distance from where these access roads join the existing paved roads or public road, including stabilized construction entrance P2M2 and/or tires washing facility to be constructed;
  - Provision of a 20 meter natural buffer between on-site land disturbance and any watercourse (intermittent or permanent) unless otherwise specified by the relevant authority, or provision of a vegetated buffer that is less than 20 metres between on-site land disturbance and any watercourse (intermittent or permanent) in combination with additional erosion and sediment controls. If not feasible to provide a natural or vegetated buffer of any size between on-site land disturbance and any watercourse (intermittent or permanent), install suitable erosion and sediment controls in combination with all possible perimeter controls;
  - Before land-disturbing activities are executed, perimeter control shall be first constructed and made operational, including but not limited to filter

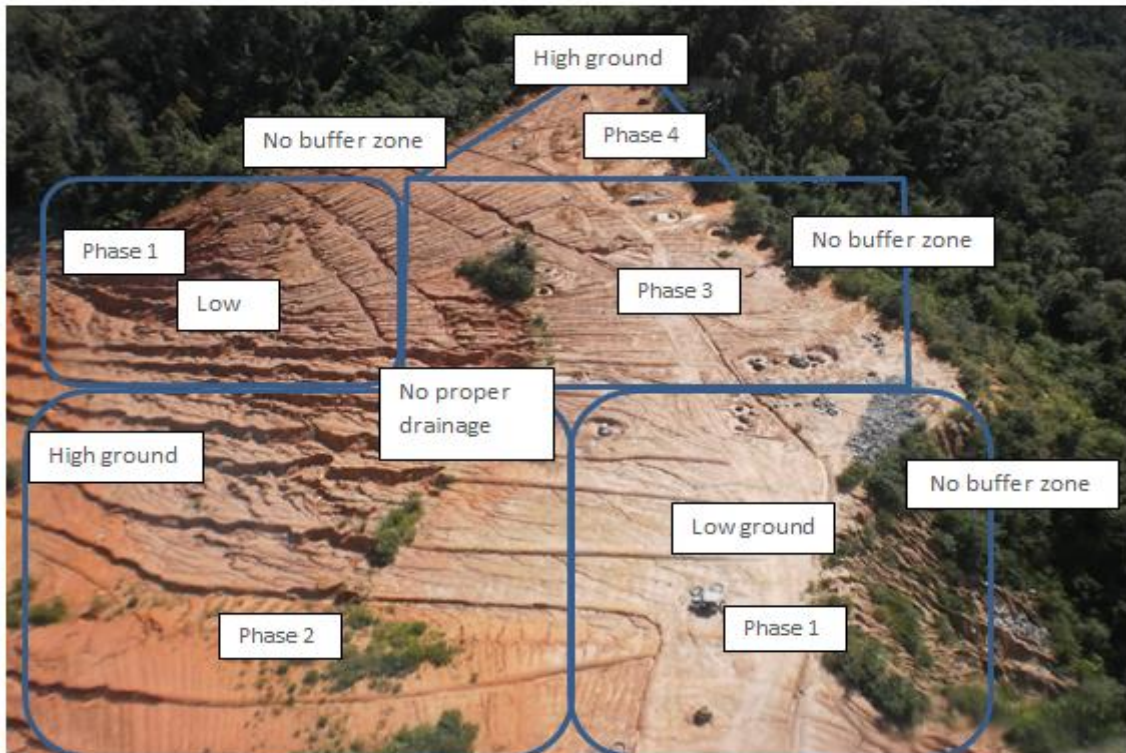
or perimeter berms, silt fences, sediment traps, sediment basins, construction entrance, temporary diversion dikes or earth bunds and diversion drains that control discharges from the site. Site clearing and grading should be kept to a minimum until the perimeter controls are in place;

- Before land-disturbing activities are executed, principal sediment basin/trap shall be first constructed and made operational. Any constructed sediment basin/trap shall install vertical silt marker for the purpose of measuring the depth of accumulated sediment to facilitate maintenance program;
- Before land-disturbing activities are executed, key runoff control measures shall be first constructed and made operational. The runoff control measures shall include but is not limited to temporary earth drain, diversion channel and conveyance system that control flows and discharges from and within the site and to be combined with installation of interval check dams along the channel to reduce the runoff velocity;
- Slope drains, flexible pipe slope drains or downpipe, rock lined drainage chutes or flume, cascade drain shall be applied to convey upslope runoff down slope without affecting the slope surface;
- In-slope or out-slope diversion runoff control P2M2s shall be applied in combination with water bars to divert runoff towards stabilized area or sediment treatment P2M2 prior to discharge.
- Any incomplete permanent drainage lines constructed along sloping area shall not be left unattended without first applying rocks dissipater at the end points or at the toe end of the incomplete adjoining conveyance structure. The anticipated runoff discharge from this point should be diverted using temporary earth drain combined with check dam towards stabilized area or into sediment treatment P2M2s. It is highly recommended that pipe slope drains are used to convey runoff directly into sediment containment system.
- Provision of runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion to convey runoff to stabilized area or into sediment treatment P2M2s prior to discharge.
- Provision of temporary soil stabilization to exposed areas within fourteen (14) days after final formation level is reached on any portion of the site. Temporary stabilization means a condition where exposed soils or disturbed areas are provided a temporary vegetative and/or non-

vegetative protective cover to prevent erosion and sediment loss. Temporary stabilization may include temporary seeding, geotextiles, mulches, and other techniques to reduce or eliminate erosion until further construction activities take place to re-disturb this area. Temporary soil stabilization shall be applied within seven (7) days to exposed areas that may not be at final grade but will remain unattended for longer than fourteen (14) days;

- Provision of suitable stockpiles and disposal areas which shall be away (at a minimum distance of 20 meters) from any watercourse. The stockpiled soil shall be protected from contact with runoff water (including run-on) using a temporary perimeter control such as berms, dikes, fiber rolls, silt fences, sandbag and gravel bags. All anticipated runoff flowing from any disposal area shall be drained into a sediment trap/basin prior to discharge;
  - Accumulated runoff water from excavations, trenches, foundations, vaults, or other similar points of accumulation shall be treated effectively using appropriate controls such as but are not limited to sediment basins / traps, dewatering tank treatment system, active treatment system, bag or sand filters prior to discharge. Whenever recommended by the consultant, Active Treatment System (ATS) shall be implemented.
  - All discharge runoff water from any land-disturbing activities shall be made through a sediment control P2M2 such as sediment basin or trap or any other erosion and sediment controls which is regarded as the designated final discharge(s). All disturbed areas shall drain to sediment control measures at all times during land-disturbing activities and during site development until stabilized, after which, the sediment controls shall be removed. Any trapped sediment and the disturbed soil areas resulting from the removal of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation. The discharge point of the treated runoff shall be released by using a dissipater or other means of outlet protection.
- Each phase of construction should have a specific construction sequence which identifies the order in which the site is developed, brought to finished grade and stabilized. Disturbed areas in one phase should be stabilized before disturbing subsequent phases.

More illustration on possible phasing to the earlier **Figure 4.4** and **Figure 4.8** is presented next page.



**Figure 4.15: Possible Phasing**

As shown in **Figure 4.15** (previous **Figure 4.4**), the key issues relating to erosion and sedimentation at this site include the following:

- A large area of land subject to site clearance at one go;
- No buffer zone appeared to have been provided;
- Access road not topped with materials to prevent erosion;
- Proper drainage not evident; and
- Sediment ponds or other forms of BMPs are not evident.

Again, Phase 1 is first designated for those area at the lower ground, to ensure the suitable BMPs are installed foremost for this site prior to other works. In view of the landscape and topography of this particular site, some of the relevant BMPs that would be suitable to reduce the potential impacts of erosion, surface runoff, sedimentation and vegetation damages include the following:

- Physical markers to show the limit of land disturbing activities;
- Buffer areas for vegetation preservation;
- Entrance/exit roads with proper stabilization;
- Natural buffer of 20 meter between on-site land disturbance and any watercourse, or suitable erosion and sediment controls in combination with all possible perimeter controls;

- Perimeter controls including filter or perimeter berms, silt fences, sediment traps, sediment basins, construction entrance, temporary diversion dikes or earth bunds and diversion drains;
- Principal sediment basin/trap;
- Runoff control measures including temporary earth drain, diversion channel and conveyance system;
- Slope drains, flexible pipe slope drains or downpipe, rock lined drainage chutes or flume, cascade drain;
- In-slope or out-slope diversion runoff control P2M2s;
- Runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion:
- Temporary soil stabilization including temporary seeding, geotextiles, mulches, and other techniques;
- Suitable stockpiles and disposal areas.

Similar to the previous example, two Phase 1 areas have been planned into the construction sequence of this work site, as both being considered to be the lowest points on this site. Phase 2 then follows suit after the completion of Phase 1, and this can be seen in **Figure 4.15** to be the area to the left of the Phase 1 area, which is deemed to be at a higher elevation than Phase 1. Once Phase 2 is completed, Phase 3 can then proceed followed by Phase 4.

The previous **Figure 4.8** indicated a linear-type land clearance work along a mountain ridge. Some of the key issues relating to erosion and sedimentation at this site are shown in **Figure 4.16**:

- Site clearance undertaken at one go;
- No buffer zone appeared to have been provided;
- Access road not topped with materials to prevent erosion;
- Proper drainage not evident; and
- BMPs are not evident.



**Figure 4.16: Possible Phasing**

Again, the relevant BMPs that would have been considered for this site location include the following:

- Physical markers to show the limit of land disturbing activities;
- Buffer areas for vegetation preservation;
- Entrance/exit roads with proper stabilization;
- Perimeter controls including filter or perimeter berms, silt fences, sediment traps, sediment basins, construction entrance, temporary diversion dikes or earth bunds and diversion drains;
- Principal sediment basin/trap;
- Runoff control measures including temporary earth drain, diversion channel and conveyance system;
- Slope drains, flexible pipe slope drains or downpipe, rock lined drainage chutes or flume, cascade drain;
- Runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion;
- Temporary soil stabilization including temporary seeding, geotextiles, mulches, and other techniques; and
- Suitable stockpiles and disposal areas.

The selected examples above should give the readers a little more idea now of what implementing *phasing* into a project entails. Some of the overarching guidelines which were listed in Section 5.4.2 were taken into consideration in the phasing planning for the examples, as discussed below.

**Existing land use:** In the examples shown, it is believed that the pre-development conditions of the site were largely relatively undisturbed. As such, it would be fair to assume that pre-construction activities would have constituted land disturbance activities which would expose the previously vegetated or forested land (which indeed did happen!). Due to the undisturbed conditions of

the site, *phasing* of such sites will need to pay particular attention to the construction sequence of works and the provision of suitable BMPs in order to reduce the amount and duration of exposed disturbed surfaces. The anticipated activities falling under the project phases would include: *establishment of perimeter control and buffer zones, tree felling, vegetation clearing, stockpile or transport of biomass, site grading, construction of access road and drainage, and installation of silt fences, silt traps, sedimentation ponds & cover crops*. In formulation the extent of the phase areas, one would need to take into account that some of the above activities will need be undertaken *sequentially* or *concurrently*, and this factor (together with the other considerations) would have an effect of the phase sizing.

One of the considerations which plays a role in deciding the extent of a phase is the requirement that “any ground surfaces or slopes exposed by the land disturbance activities must be temporarily protected with suitable material to prevent erosion within 7 days of the exposure”. To comply with this requirement, it makes sense then for the phasing to be sensibly sized such that no exposed surfaces are left unattended for more than 7 days or that suitable BMPs are able to be installed at a “rate” faster to the surface exposure activities.

***Types of land disturbance activities:*** The extent of *phasing* for a site will depend heavily on the type of land disturbance activities that might occur in the construction sequence. In the previous examples, and assuming the pre-development sites to comprise *relatively* undisturbed forested or vegetated areas, land disturbance activities are anticipated: *tree felling, crops or vegetation clearing, stockpile and/or transport of biomass, earthwork to raise platforms, site grading, and excavation for construction of access road and drainage*.

As seen above, the initial site activities in the three examples most likely involved site clearing – first for the formation of access roads, and then later for the platform formation; stockpiling of biomass prior to disposal off site; access road and drainage formation, and site grading. These initial activities basically dictate the extent of the phasing requirements, underlined by the need to “maintain the amount and duration of soil exposed (from the land disturbing activities) to erosion is reduced as much as practicable at any one time by implementing the suitable BMPs in coordination with the sequence of construction activities”, as well as the “7 day requirement to temporarily protect or cover exposed surfaces with suitable materials”. In fact, this criterion can be viewed hand-in-hand with the previous factor regarding land use.

***Topography:*** This factor is evident in the first two examples, where the initial phases (i.e., Phase 1) of the works are focused at the low grounds. Primarily, the rationale for commencing Phase 1 at the low points will allow for the necessary BMPs such as silt traps or sediment ponds to be constructed first so as to be available to capture potential surface runoffs flowing from the higher grounds.

**Weather:** This factor was not reflected in the previous examples as the project programmes were not available for assessment. The principle for *the* phasing in relation to this factor would have simply been the avoidance of land disturbance activities during the rainy and wet season.

**Type of soil:** Again, this information was not available for review, but essentially, areas with soil type which exhibit high erodibility (e.g., fine silt, sandy) should be subjected to a more manageable (i.e., smaller) parcels of phased work areas so as to provide a tighter control on the extent of erosion and sediment, as compared to a site consisting of soil type of lesser erodibility (e.g., rock or clay).

**Environmental Sensitive areas:** The presence of environmentally and ecologically sensitive receivers within the project sites is quite clear in the previous examples, namely relatively densely forested and vegetated areas bordering the sites, as well as presence of watercourses. Although the presence of these sensitive areas does not directly affect the sizing of the phasing, but the need to provide BMPs such as buffer zones and perimeter controls does however indirectly contribute to the planning of the phasing.

**Practicality of BMP installation:** This factor, as well as the following one, again cannot be assessed in the previous examples in view of lack of such information. Consideration on the extent of BMP required, how quickly the BMP(s) can be installed, accessibility, available resources, site conditions, and so on must be taken into account. A site which faces challenges when answering the above queries should be *phased* carefully, i.e., with smaller work areas and coordinated closely with the construction sequence, to reduce the amount and duration of soil exposed from land disturbing activities.

**Rate of production:** Depending on the available resources (labour, machineries, construction materials, etc), the rate of production may vary *considerably* between projects. If it is anticipated that the rate of site production activities will be greater than the BMPs installation, then there is a need to carefully assess the *phasing* to avoid a scenario whereby large areas of exposed ground are left unattended.

#### 4.4.4 Summary

In summary, the key points to take note during the identifying of project phases are as follows:

- “Project phasing” in the context of this *Guidelines* is different from the project’s overall “development phase”. Here, we are talking about breaking down a “whole” project into smaller divisions of work from the perspective of

controlling erosion and sediment, and is more like a “phase within a phase”. The “phasing” for the purposes of controlling erosion and sediment is more an internal subdivision of the project into smaller packages so as to manage the work sequences within these packages to minimise the erosion and sediment events, by facilitating the implementation of erosion and sediment controls or BMPs in a sequential or systematic manner.

- The main purpose of introducing *phasing* is to ensure that the amount and duration of soil exposed (from the land disturbing activities) to erosion is reduced as much as practicable at any one time by implementing and maintaining the suitable BMPs in coordination with the sequence of construction activities.
- The key to developing an effective “*phasing plan*” should be that it is not undertaken prior to the mobilisation of the Contractor’s team to the project site, but rather at much earlier stages of the project.
- There is no hard or fast rule to establish the size and extent of a *phase* for any particular project. However, the rationale for planning the phasing of a site can be underlined by the following two criteria:
  - To maintain the amount and duration of soil exposed (from the land disturbing activities) to erosion is reduced as much as practicable at any one time by implementing the suitable BMPs in coordination with the sequence of construction activities; and
  - To temporarily protect or cover any ground surfaces or slopes exposed by land disturbance activities with suitable material to prevent erosion within 7 days of the exposure.
- Other related key considerations for planning the extent of phases include the following:
  - Existing land use
  - Types of land disturbance activities
  - Topography
  - Weather
  - Type of soil
  - Environmental Sensitive areas
  - Practicality of BMP installation
  - Rate of production

More examples of project phasing will be illustrated in the latter sections of this Chapter. In the following sections, we will discuss next on some of the other techniques that are needed to commensurate the skills for identifying *phasing*.

## 4.5 WORK BREAKDOWN STRUCTURE (WBS)

### 4.5.1 Meaning of WBS

The meaning of WBS is generally discussed in Section 5.4.3. In summary and to recap, a WBS is normally used to define individual work packages in order to deliver the scope of the project, by first identifying the required work package and the breaking down each package into individual work schedule activities comprising a “*list of all the activities that must be performed within the project and each one should be linked back to just one work package (although each work package may have several activities within it).*” In project management, the “work package” included as part of the WBS is intended to be achieved when the work can be accurately estimated (both cost and duration), and that each activity must be complete and accurate, because it will be used to develop the project schedule.

### 4.5.2 Application to this Guidelines

The above definition for identifying project activities from the view of project management can also be applied for the purposes of addressing erosion and sedimentation. Following on from the discussion in Section 5.4 on *project phasing*, the concept of work breakdown structures and their associated elements can be deployed to recognize the respective works particularly those related to land disturbing activities. For illustration, the WBS for the purposes of this *Guidelines* can be illustrated below in **Figure 4.17**.

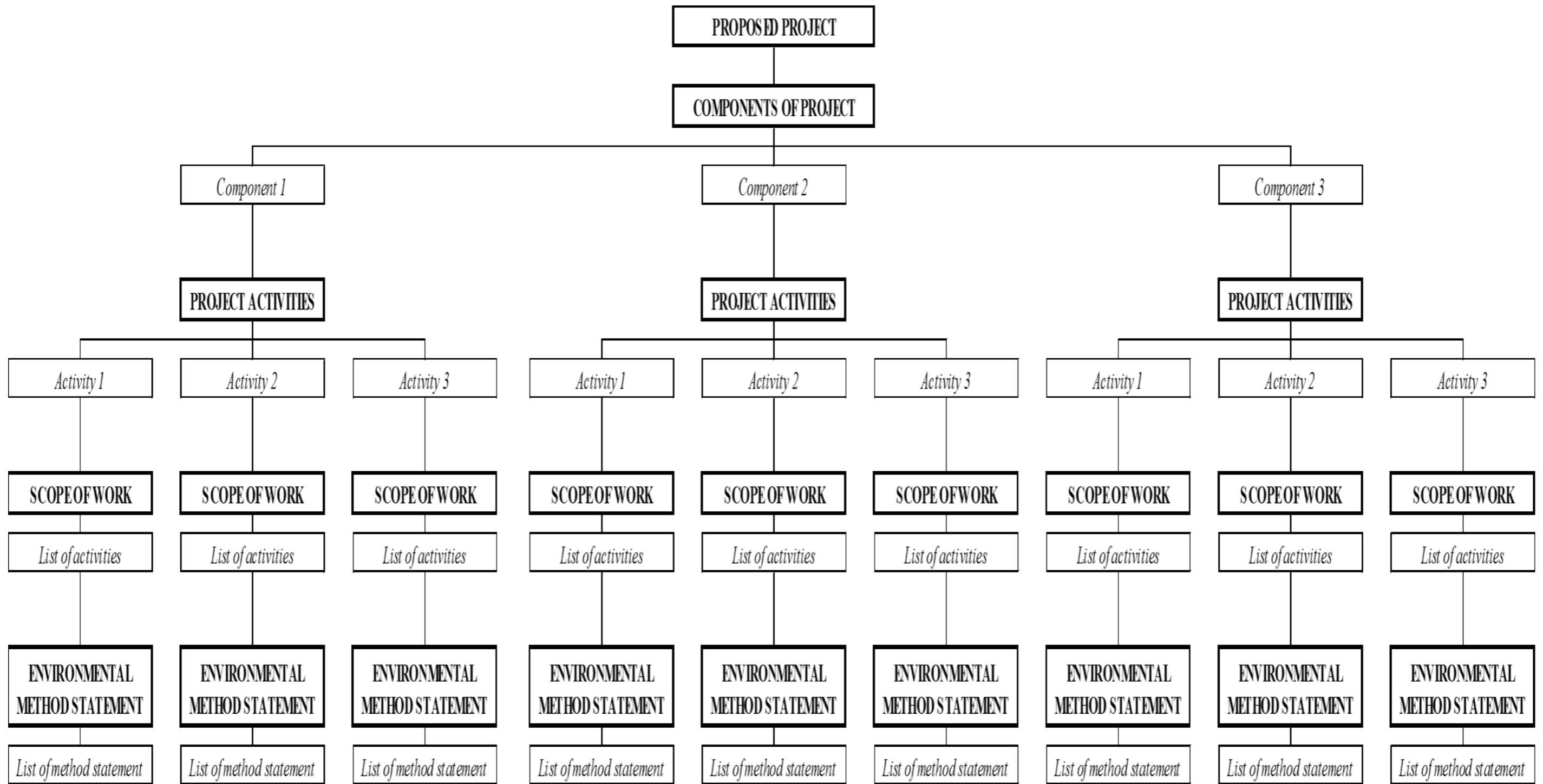


Figure 4.17: WBS for Addressing Erosion and Sedimentation

In essence, **Figure 4.17** can be regarded as a *work breakdown structure* because in line with the previous definition, it attempts to define the individual project components and their associated work packages and project activities. Under each of the listed project activities, the project team would then list out the scope of work involved, and subsequently, assigning appropriate environmental method statements for project implementation. Although this WBS is not strictly intended to define and resources and duration to achieve the final deliverable under the scope of the project, it however drives towards attaining the relevant parts of the final deliverable but with emphasis on controlling erosion and sediment issues during the project. This WBS can then be complemented or integrated with the overall WBS of the Contractor in delivering the final scope of the project.

To this end, the meaning and examples of elements of the WBS in the context of erosion and sediment control, namely, *project component*, *project activities*, *scope of work* and *environmental method statements* are demonstrated further in the following sections.

## 4.6 IDENTIFYING PROJECT COMPONENTS

### 4.6.1 Conventional Way of Identifying Project Components

More often than not, a project entails hundreds, if not thousands, of pieces information to enable the Contractor to build or assemble the final product of this project in a systematic manner to reach to the end point. In this regard, a part of his *construction planning* involves breaking down his project to various distinct components to clearly delineate the ‘deliverables’ or ‘responsibilities’ to be accomplished in a progressive manner (since no project is completed in a single day!). Conventionally, the breakdown of these components of a project is done by grouping all the relevant tasks and deliverable under the respective engineering disciplines, to give a holistic picture of the overall resource requirements in terms of specialist needs, labour, material & equipment, time and financial.

For illustration, let’s take a look on how a civil engineering project might be broken down into its project components from the perspective of the Contractor, because as shown later, there are some distinct differences in terms of identifying components for the purposes of “constructing the project” and for the purposes of “controlling erosion and sedimentation”.

Firstly, let’s assume a fictional project as shown in the simple sketch in **Figure 4.18**. Essentially, this project will involve constructing a new Sewage Treatment Works (STW) which is to be located in the vicinity of a forest reserve.

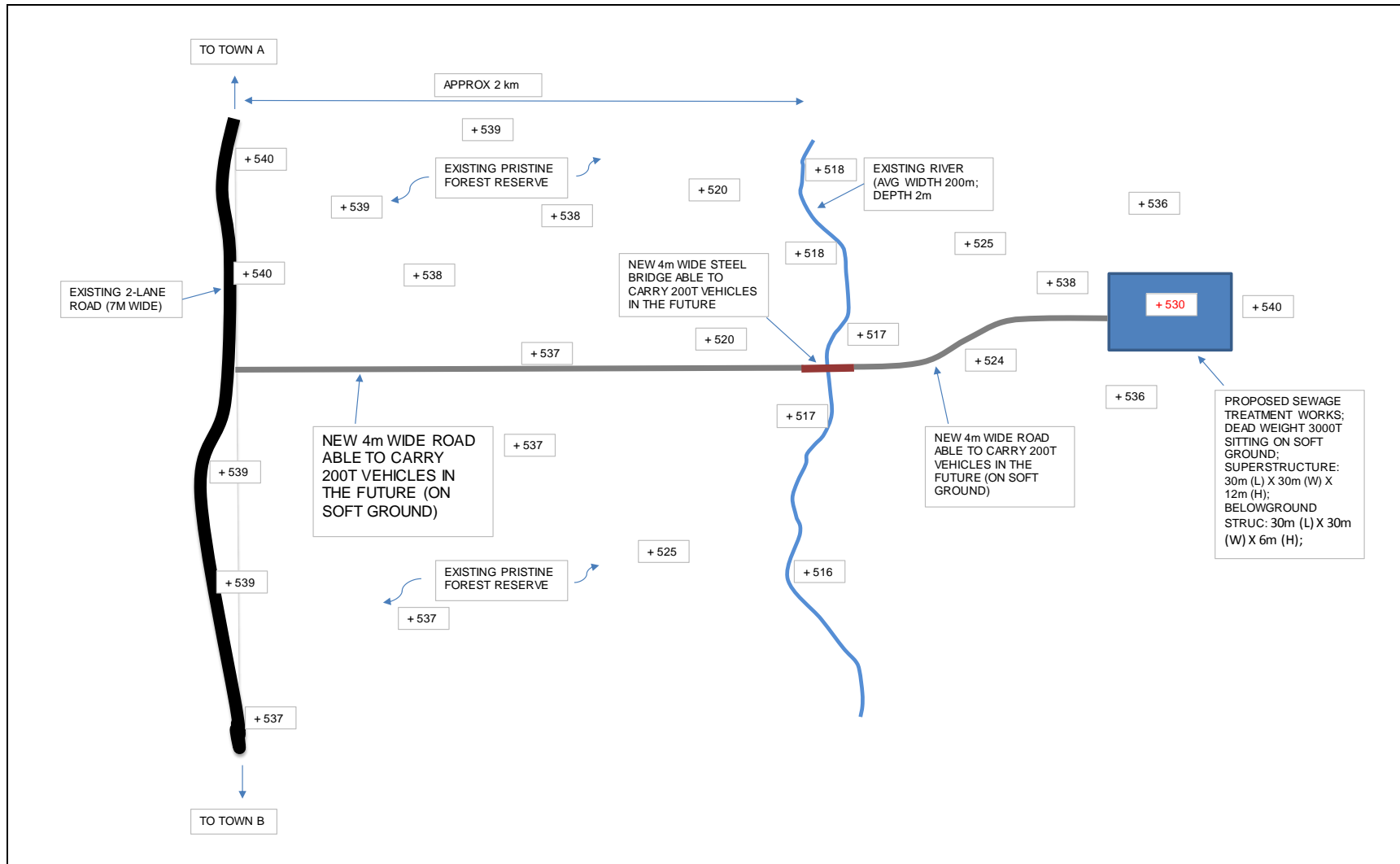


Figure 4.18: Example of a Civil Engineering Project

Some of the key features of this project site are observed as follows:

- The proposed STW is to be located about 3 km to the east of an existing 2-lane road, where an existing pristine forest reserve sits directly in-between the road and the STW;
- A new 4 m wide road needs to be constructed to provide future access from the existing 2-lane road to the STW site. Presumably the temporary construction road will also follow the alignment of this permanent road;
- All of the permanent works including roads and STW will be sitting on soft grounds, meaning some form of foundation is needed to support these structures;
- The low ground of this site is generally along the alignment of the river, with a new river crossing structure (bridge) to be constructed to connect the new road;
- Forest clearing will be required to construct the access road, as well as for the platform for the STW;
- The proposed STW will involve substructure and superstructure construction.

Typically, the Contractor will begin to break down the project based on disciplines into the following major sectors: *Infrastructure; Geotechnical; Civil; Structure; Electrical; Mechanical; and Architectural*. Under of each of these disciplinary sectors is then listed all those possible components of works related to the STW project, which may potentially include the following:

- Infrastructure
  - *Access to STW*
- Geotechnical
  - *Foundation works for the Roads*
  - *Foundation works for the STW Building*
- Civil & Structure
  - *STW substructure*
  - *STW superstructure*
  - *Substation*
  - *Chemical warehouse*
  - *Staff quarters*

- Electrical & Mechanical
  - *Electrical works*
  - *Mechanical works*
  - *Instrumentation works*
  
- Architectural
  - *Finishing works for STW*
  
- Civil
  - *STW exterior works*
  - *Guard house*
  - *Landscape works*
  - *Fencing*

The above breakdown is illustrated in **Figure 4.19**. Subsequently, each of these project components can be broken down into smaller packages, where for this example, are called Project Activities. For instance, for the Component “Access to STW”, it comprises five major project activities, namely, *access road, site formation, foundation, bridge columns and elevated structure*, and so on.

Although the example breakdown shown in **Figure 4.19** provides a good starting point for the Contractor to plan his resource requirements, it however does little to bring out the elements relating to erosion and sedimentation controls needed for the project. The main reason is such a WBS is product or deliverable oriented, whereby the focus or purpose of the breakdown is more geared towards getting to the endpoint, i.e., delivery of the final products.

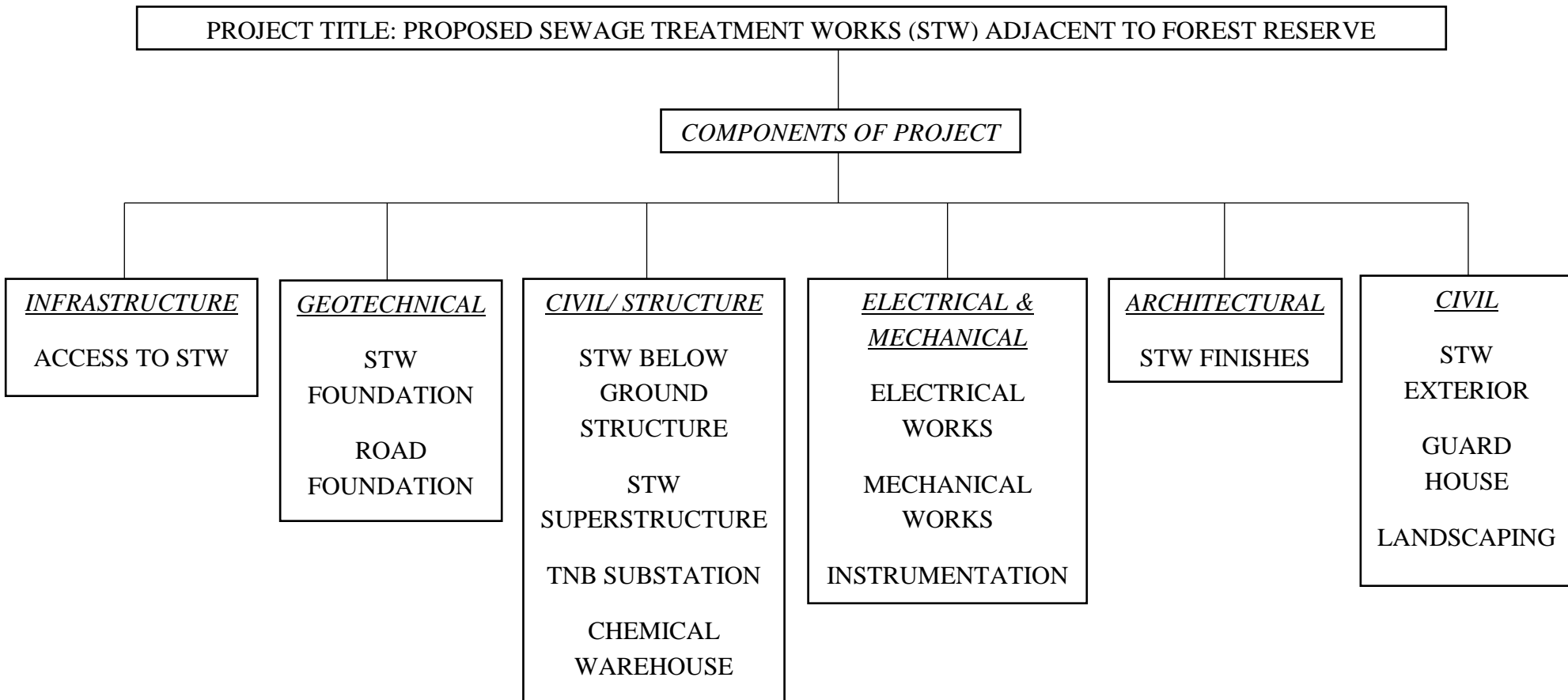
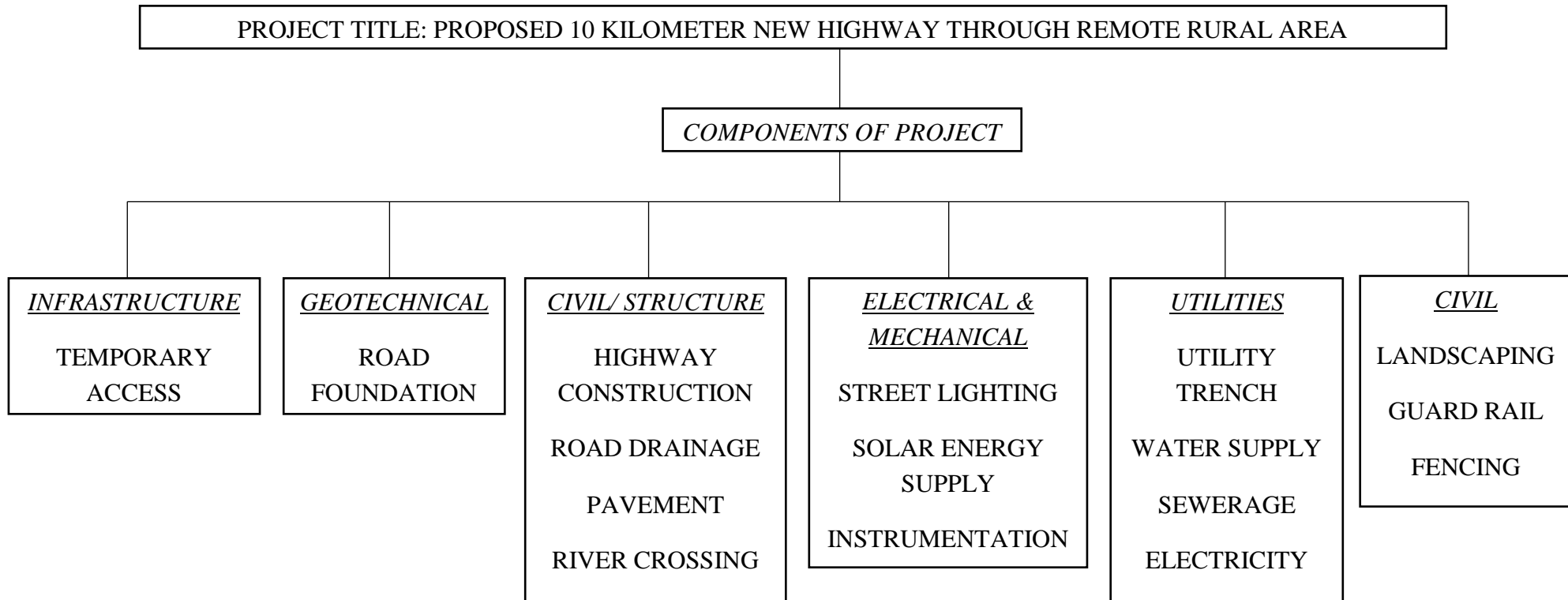


Figure 4.19: Possible Component Breakdown of STW Project (based on disciplines)

Let's look at another example on how conventionally the project components might be identified. This example illustrates a proposed new highway construction through a remote and rural area in Pahang. It is envisaged that for this 10 km long highway project, the project team will likely subdivide the project into its respective disciplines as follows:

- *Infrastructure Works*, which would provide the temporary access into the highway works areas. Based on the project title, it is also anticipated that the provision of these access roads would entail some degree of vegetation and forest clearing, land formation, slope cutting and filling, watercourse diversion and crossing, to name a few;
- *Geotechnical Works*, which would entail foundation works for the new highway. In the absence of more details on the form of foundation to be provided, it is reasonable to assume that for any kind of foundation that is to be deployed, some form of excavation will be needed for the works, with associated temporary stockpile of earthwork materials on site;
- *Civil & Structural Works* to cater for the likes of the new highway construction, along with the associated road drainages, pavement, river crossings, and other road fixture and installations. The civil/structure team will also be responsible for establishing the site offices and staff quarters for the project;
- *Electrical & Mechanical Works* will cover all the ancillary E&M installation, testing and commissioning including street lighting, solar energy and power supply, and other instrumentation equipment;
- *Utility Works*, which covers the provision of common trenching for the installation of various utility services including water supply, sewer lines, electricity and telecommunication cables; and lastly,
- *General Civil Works* for the finishing works for the completed highway including landscaping, and road safety features such as guard rails and fencing.

**Figure 4.20** illustrates the possible breakdown of the highway project as described.



**Figure 4.20: Components of A Highway Project**

Again, the above WBS is geared towards deliverable-oriented, and thus does little to bring out the elements relating to erosion and sedimentation controls needed for the project.

#### 4.6.2 Application to this Guidelines

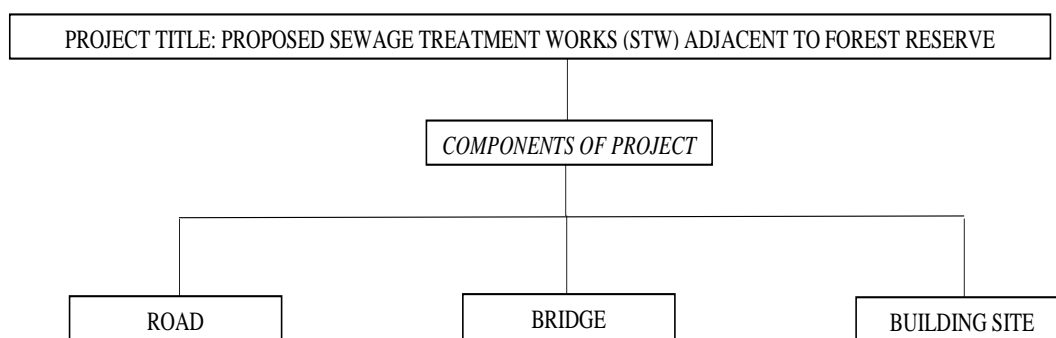
The concept of identifying project components as illustrated in the above examples is also applicable when developing a strategy for erosion and sedimentation, in that it is important to recognize how a project can be broken down to the relevant project components so as to establish the project activities particularly to those relating to land disturbing activities. By doing so, suitable environmental method statements can subsequently be developed for the individual project components in a logical and systematic manner, and more importantly, in a progressive way such that the amount and duration of soil exposed (from the land disturbing activities) to erosion is reduced as much as practicable at any one time by implementing and maintaining the suitable BMPs in coordination with the sequence of construction activities. Therefore the guidelines for application of this concept in the context of the Guidelines underlie the following:

- To breakdown the overall project into a simpler form which comprises the major and significant final deliverables of the project. Although it is not a straightforward exercise to discern what components constitute major and significant, the general guideline would be to preferably break down an overall project into no more of five or six components, depending on the complexity of the project.
- It may be argued that a limited number of components may not represent convincingly the overall project, but it should be kept in mind that the purpose of the components identification in the context of this *Guidelines* is to be able to group those major deliverables whereby land disturbing activities would be expected. As such, those deliverables that would involve any activity that changes the physical conditions of land form, vegetation and hydrology, creates bare soil, or otherwise may cause erosion or sedimentation such as, site clearing, removal of vegetation, stripping, grading, grubbing, excavating, filling, logging and storing of materials, etc. would be given more attention when creating these groups of project components.
- Less attention is needed to be given to those other deliverables whereby land disturbing activities are not expected, and where possible, preferably to be group into two (or less) common components for completeness.

The following sections will illustrate how project components can be identified to focus on erosion and sediment.

### 4.6.3 Example 1 – Proposed Sewage Treatment Works Project

For the purposes of addressing erosion and sediment issues in this *Guidelines*, a logical and simpler approach is used to arrange the parceling of the project components, keeping in constant awareness the ultimate objective of LD-P2M2. Let's first start with the previous STW example, previously provided with a possible conventional breakdown to include *Infrastructure, Geotechnical, Civil, Structure, Electrical, Mechanical and Architectural*, and depicted in **Figure 4.19**. However, from the perspective of identifying those deliverables and focusing those with possible land disturbing consequences, an alternative breakdown of the above example project could take the following form, as illustrated in **Figure 4.21**.



**Figure 4.21: A Simpler Alternative to Component Breakdown of STW Project**

In this simpler breakdown, the project components are now restricted to three major physical assets of the project, namely the road, bridge and the STW building package. In this approach, no distinction is made on the types of disciplines of work such as civil, structure, geotechnical, and so on, but rather, the focus is on the major types of physical structures that will be constructed for the project. Identifying the project components in this way will enable easier follow-on breakdown of project activities for each component so that all the related land disturbing activities (discussed in **Chapter 3**) can be readily identified and further *environmental method statements* be formulated to address potential erosion and sedimentation issues associated with such activities.

Notably, this project is considered a relatively mega project, expected to involve various specialist disciplines, to require a few years to complete, to cost tens of

millions to construct, and to involve hundreds of workers to complete the project. Despite such complexity, from the desire of needing to control erosion and sediment, and in the context of this *Guidelines*, we have simply broken the whole project into only three (3) components, namely: *Road, Bridge and STW or Building Site*. Although it may be argued that three components by themselves are not likely to be able to completely represent the entire project, again, it should be kept in mind that the purpose of this breakdown is not to facilitate the construction of the project but rather to single out those major components that would involve land disturbance activities giving rise to potential erosion and sediment issues on site.

From the simple layout sketch in **Figure 4.18**, and if we disregard the numerous details that might be associated with the delivery of this project, effectively the whole project can be simply “represented” by the 3 components: the road, bridge and STW building site. This is in line with the purpose for the project breakdown so as to focus on those deliverables that will involve land disturbance activities. For instance, for the above example of project component restructuring, the following associated land disturbing and other associated activities are envisaged to complement the construction of these components:

- Roads: *Land clearing, removal of existing vegetation, stockpiling of biomass, earthworks consisting of cutting and filling for slope and land formation, exposing ground surfaces for road formation, stockpiling of earthwork materials, excavation for road foundation, roadworks, utility trenches, pavements, laying of road structures;*
- Bridge: *Forest clearing, stockpile of biomass, river diversion, river bank protection, excavation for crossings foundation, stockpiling of excavated materials and construction materials, culvert placement, bridge elevated structural works;*
- STW Building Site: *Land clearing, removal of existing vegetation, stockpiling of biomass, earthworks consisting of cutting and filling for slope and land formation, excavation for structure foundation and basement works, stockpiling of excavated materials and construction materials, sub-structural and super-structural works, electrical & mechanical works.*

#### **4.6.4 Example 2 – Proposed Highway Project**

Breaking down a new highway project using a possible conventional method was also shown in the previous section above. Alternatively, a simpler approach to identify project components for the purposes of addressing erosion and

sedimentation for such a project (as indicated by **Figure 4.22**) is presented in **Figure 4.23**.

In a conventional way, this example project could be broken down to include: *Infrastructure Works* (such as temporary access roads, land formation, slope cutting and filling, watercourse diversion and crossing, etc.); *Geotechnical Works* (foundation works for the new highway); *Civil & Structural Works* (associated road drainages, pavement, river crossings, and other road fixture and installations); *Electrical & Mechanical Works* (all ancillary E&M installation, testing and commissioning including street lighting, solar energy and power supply, and other instrumentation); *Utility Works* (water supply, sewer lines, electricity and telecommunication cables); and lastly *General Civil Works* (finishing works, landscaping, road safety features etc.). Again, the breakdown in such a manner does not allow for the land disturbance activities to be systematically identified, since its original intent is predominantly deliverable-oriented.

Alternatively, for a more beneficial analysis of this project in the context of addressing erosion and sediment issues, a simpler breakdown strategy can be adopted, as shown in **Figure 4.23** below. In this modified project component breakdown, again, no distinction is made on the types of disciplines of work such as civil, structure, geotechnical, and so on, but rather, the focus is on the major types of physical works that will potentially contribute to erosion and sedimentation issues.

As shown in **Figure 4.23**, the key project components now are limited to: *temporary roads; permanent roads; drainage systems, and river crossings*. In the next Section, we will see how restructuring the project in such manner can easily facilitate the identification of the common project activities associated with these individual components to allow formulation of further *environmental method statements* be formulated to address potential erosion and sedimentation issues associated with such activities. As such, it is worth noting that a general rule of thumb to identifying project components for the purposes of addressing erosion and sedimentation is ***to first recognise the potential activities that are associated with these respective components that may comprise land disturbing activities that need to be adequately controlled and protected against the elements of erosion and sedimentation from occurring.***

For instance, for the above example of project component restructuring, the following associated land disturbing activities are envisaged to complement the construction of these components:

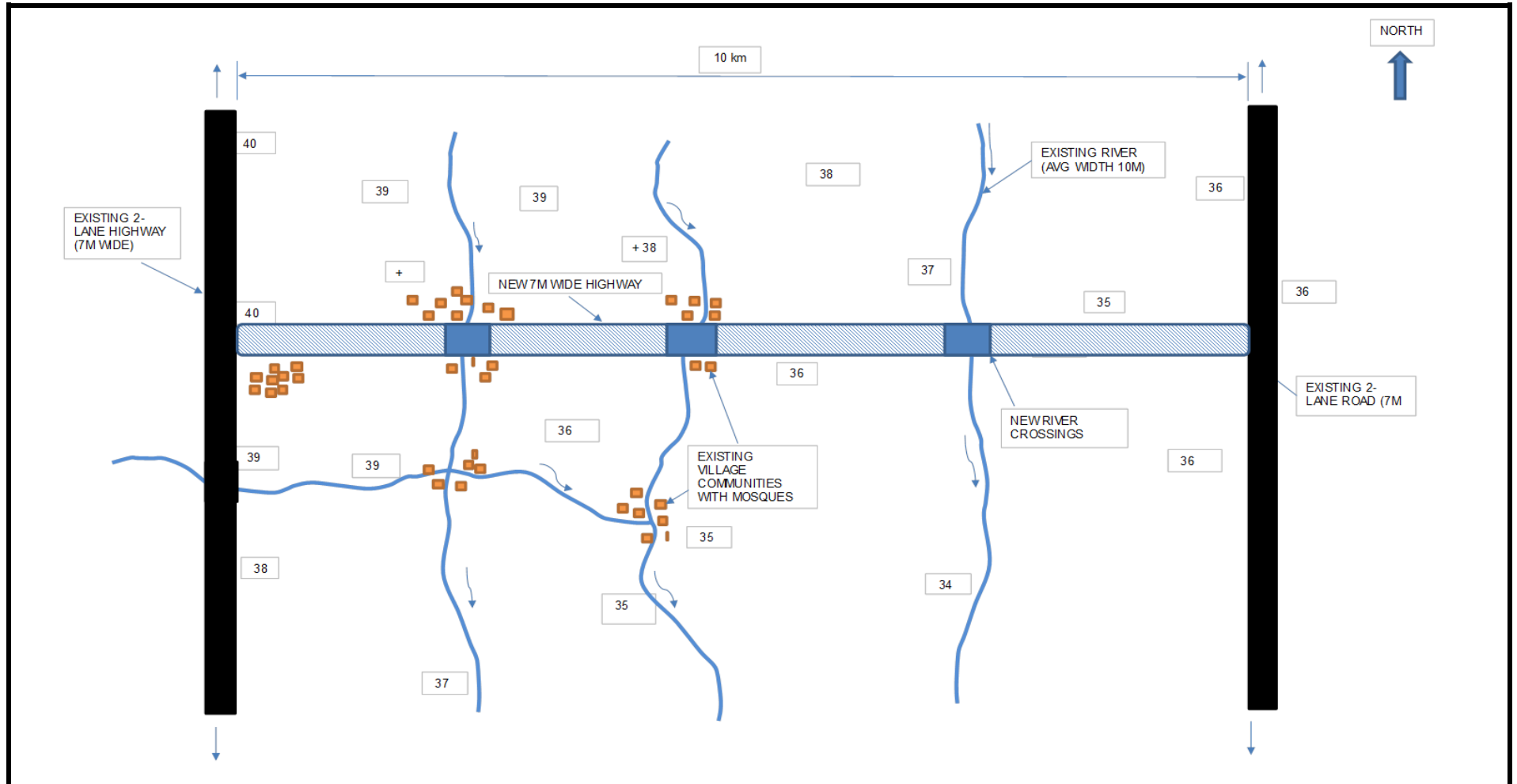
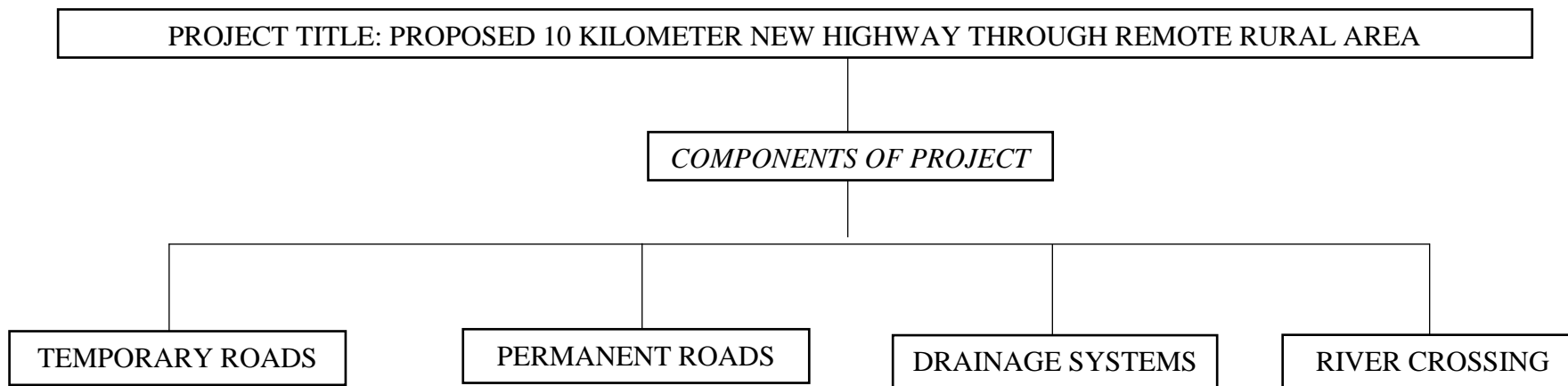


Figure 4.22: Layout of a New 10 km Highway Project



**Figure 4.23: A Simpler Alternative to Component Breakdown of A Highway Project**

- Temporary Roads: *forest clearing, stockpiling of biomass, earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials, exposing ground surfaces for temporary access road formation;*
- Permanent Roads: *forest clearing, stockpile of biomass, earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials, excavation for highway foundations, roadworks, utility trenches, pavements, laying of road structures;*
- Drainage Systems: *earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials, excavation for drainage;*
- River Crossings: *forest clearing, stockpile of biomass, river diversion, river bank protection, excavation for crossings foundation, stockpiling of excavated materials and construction materials, culvert placement.*

With the above identification, one can then have a better understanding of where and when erosion might occur due to the exposure of ground surfaces as a result of these land disturbing actions, and thereafter, pollution prevention and mitigation measures (P2M2) can be recommended accordingly.

#### 4.6.5 Example 3 – Proposed Housing Development Project

In the next example in **Figure 4.24**, we will take a look at a housing development proposed to be constructed within a forest reserve. For this development, it is envisaged that various types residential units will be provided (apartments, bungalows, duplex), complete with its own utility facilities such as electrical substation, water supply pipelines, sewage treatment unit, clubhouse, and refuse collection point. For this development project, the project team will likely to subdivide the project into its respective disciplines as follows, as indicated in **Figure 4.25**:

- *Earthworks*, which would be needed to provide for a massive land formation, primarily to form a working platform for the construction of the project. Due to the location of the project within a forest reserve, the process of land formation would inevitably entail a high degree of forest clearing, slope cutting and filling, temporary stockpile of biomass and earthworks, and possibly watercourse diversion and crossings;
- *Geotechnical Works*, which would entail foundation works for the buildings and possibly roads as well due to the forest setting. Extensive excavation

will be anticipated for these structures, with the associated requirement for temporary stockpile of earthwork materials on site;

- *Civil Works* to cater for the various engineering features of the project including access roads and pavement, drainage works, pump house, open space, landscape works, and a boundary wall. All of the above would involve land disturbing activities such as site clearing, excavation, slope works, and stockpile of construction & earthwork materials as well as chemicals and scheduled wastes;
- *Electrical & Mechanical Works* will cover all the ancillary E&M installation, testing and commissioning including street lighting, power supply to the project for the apartments as well as the STW and clubhouse, and other instrumentation equipment;
- *Utility Works*, which covers the provision of common trenching for the installation of various utility services including water supply, sewer lines, gas pipes, electricity and telecommunication cables; and lastly,
- *Structure Works* for the construction of the building works, electricity substation, the dedicated sewage treatment works for the development, and clubhouse.

For the purposes of identifying erosion and sedimentation associated with this project, and using the general rule of thumb as mentioned earlier for identifying project components, we need to first recognise the potential activities that are associated with these respective components that may comprise land disturbing activities that are needed to be adequately controlled and protected against the elements of erosion and sedimentation from occurring. Following this, a simpler format for breaking down this housing development project can then be formulated as shown in **Figure 4.26** below. Accordingly, the key project components for this example are now confined to: *forest clearance; roads; drainage systems; apartment buildings; and pump house & STW*. Such a breakdown then enables the identification of the associated land disturbing activities that may occur:

- *Forest Clearance: land clearing, removal of existing vegetation, stockpiling of biomass, earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials;*
- *Roads: land clearing, , exposing ground surfaces for road formation, stockpile of biomass, stockpiling of earthwork materials, excavation for*

*road foundation, roadworks, utility trenches, pavements, laying of road structures;*

- Drainage Systems: *earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials, excavation for drainage;*
- Apartment buildings: *excavation for structure foundation, stockpiling of excavated materials and construction materials;*
- Pump house & STW: *excavation for structure foundation, stockpiling of excavated materials and construction materials, culvert placement.*

Again, the breakdown of the project components as described above and shown in **Figure 4.26** attempts to direct the attention to understanding where and when erosion might occur due to the exposure of ground surfaces as a result of the land disturbing actions, and thereafter, pollution prevention and mitigation measures (P2M2) can be recommended accordingly.

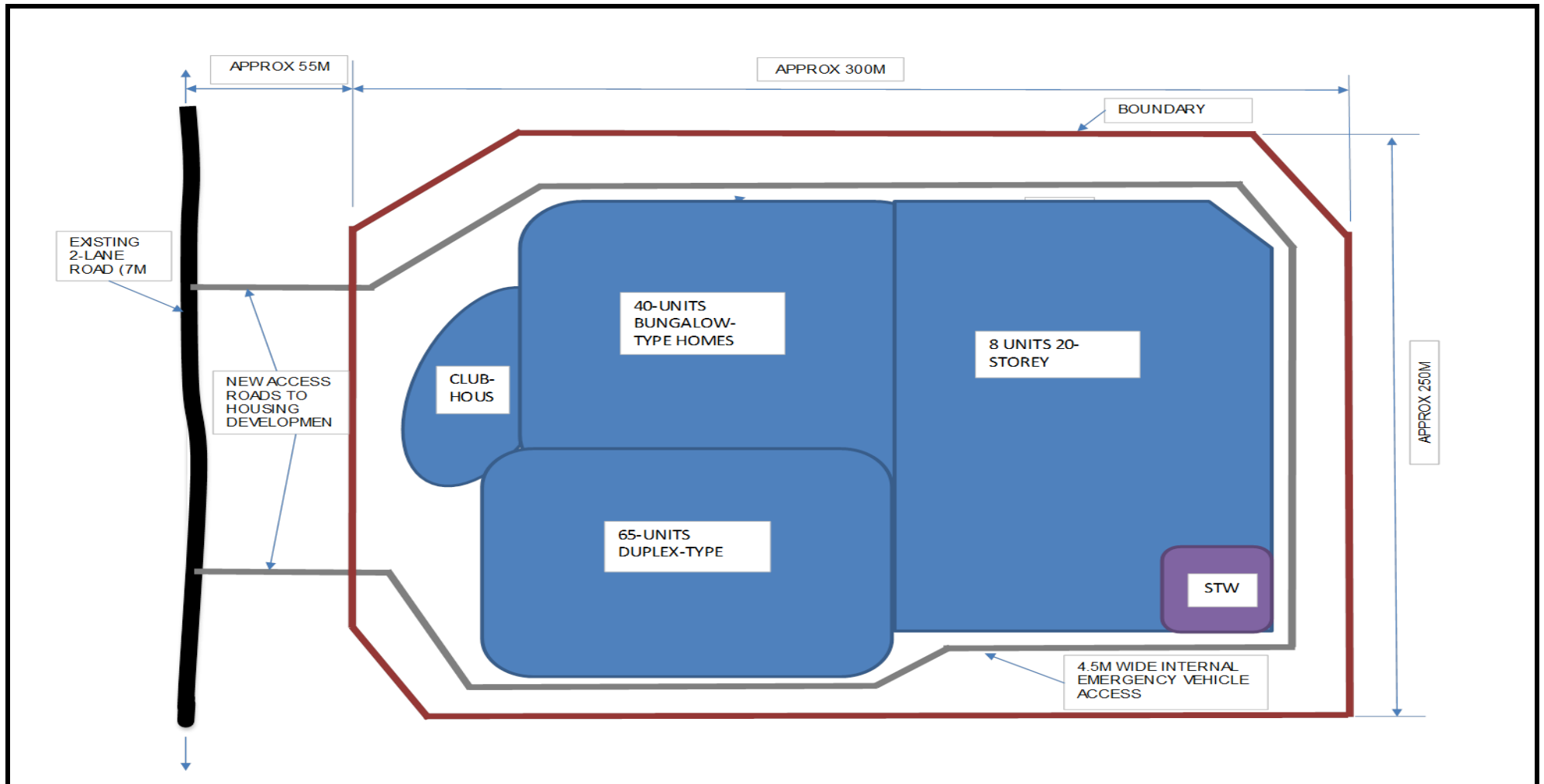
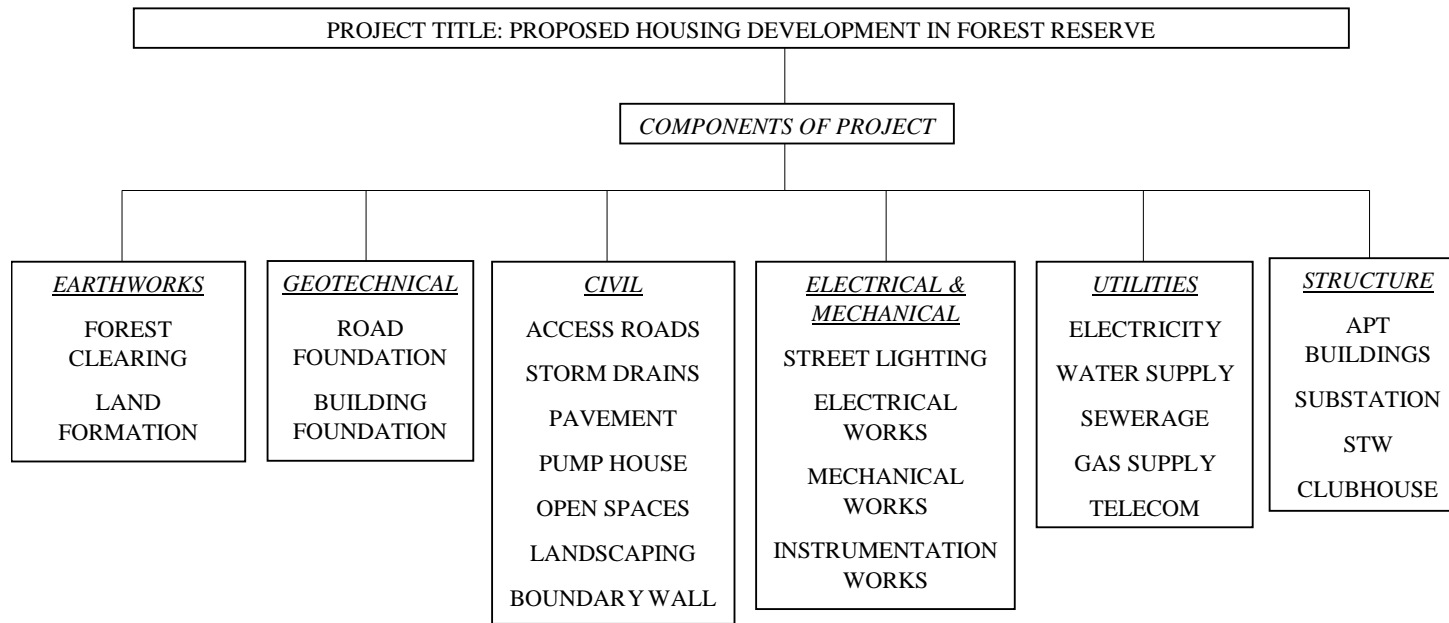
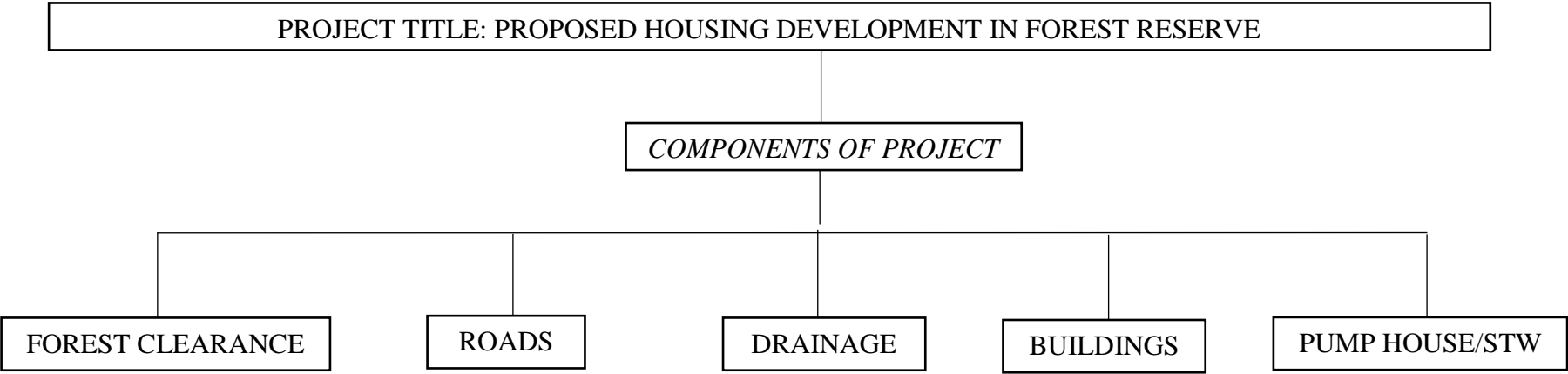


Figure 4.24: Layout of A Housing Development Project



**Figure 4.25: Components of A Housing Development Project**



**Figure 4.26: Alternative Component Breakdown of A Housing Development Project**

#### 4.6.6 Example 4 – Proposed Main Drainage Project

For the next example, the objective of the project is to construct a 3 km long drainage channel to convey stormwater in an urban setting to a final waterbody downstream, diagrammatically illustrated in **Figure 4.27**. It is envisaged that for water-related project, the project team will likely subdivide the project into its respective disciplines as follows:

- *Earthworks*, which would include some land clearing activities and followed by creating a trench for the laying of the large drainage structures. The land clearing activities is anticipated to involve some degree of tree felling and removal of existing vegetation. However, the more extensive land disturbance activity from this discipline of work would be the excavation of a wide trench to provide for working space as well as a platform for construction of the drainage structure which will consist of cast in-situ box culverts;
- *Geotechnical Works*, which would entail foundation works which are required for slope stabilization to cater for the deep trench, and also for the proposed drainage pump house and substation;
- *Civil Works* to cater for the civil construction of access roads and drainage, connectors of the existing drainage network to the new main drainage channel, associated manholes and gullies as well as for the finishing works including landscaping, railing and boundary wall upon completion of the drainage structures;
- *Electrical & Mechanical Works* will cover all the ancillary E&M installation, testing and commissioning for the storm water pump house, street lighting, power supply, and other related instrumentation equipment;
- *Structural Works*, which covers construction of a pump house and substation.

An illustration of the project breakdown by discipline is indicated in **Figure 4.28**, which like in the previous examples, doesn't provide much insight into how erosion and sedimentation would be addressed during the implementation of this project. Conversely, to tackle erosion and sedimentation, a more straightforward project structure can be adopted by focusing on the major types of physical works that are anticipated and which will potentially cover major land disturbing activities during project implementation.

As shown in **Figure 4.29**, the key project components now are proposed to be: *trenching; roads; drainage; and pump house*. Such restructuring allows the

formulation of further *environmental method statements* by first identifying the associated land disturbing activities which are potentially involved with the respective components:

- Trenching works: *land clearing, excavation works, cut and fill for slope formation, stockpiling of earthwork materials, dewatering of trench;*
- Roads: *land clearing, earthworks for land formation, stockpiling of earthwork materials, roadworks including road drainage;*
- Drainage: *earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials, excavation for drainage;*
- Pump house: *excavation for structure foundation, stockpiling of excavated materials and construction materials, culvert laying.*

With the above identification, one can then have a better understanding of where and when erosion might occur due to the exposure of ground surfaces as a result of the land disturbing actions, and thereafter, pollution prevention and mitigation measures (P2M2) can be recommended accordingly.

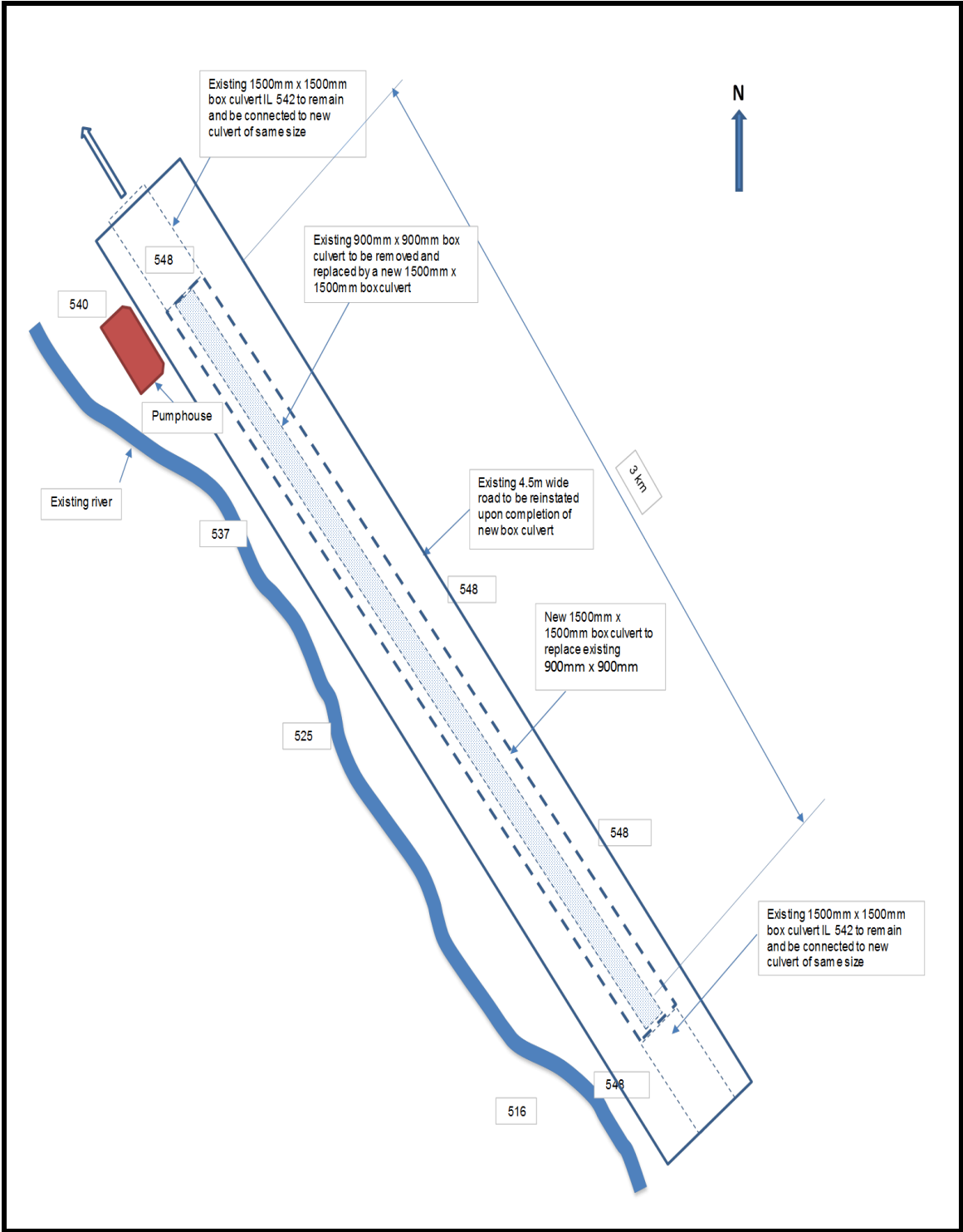
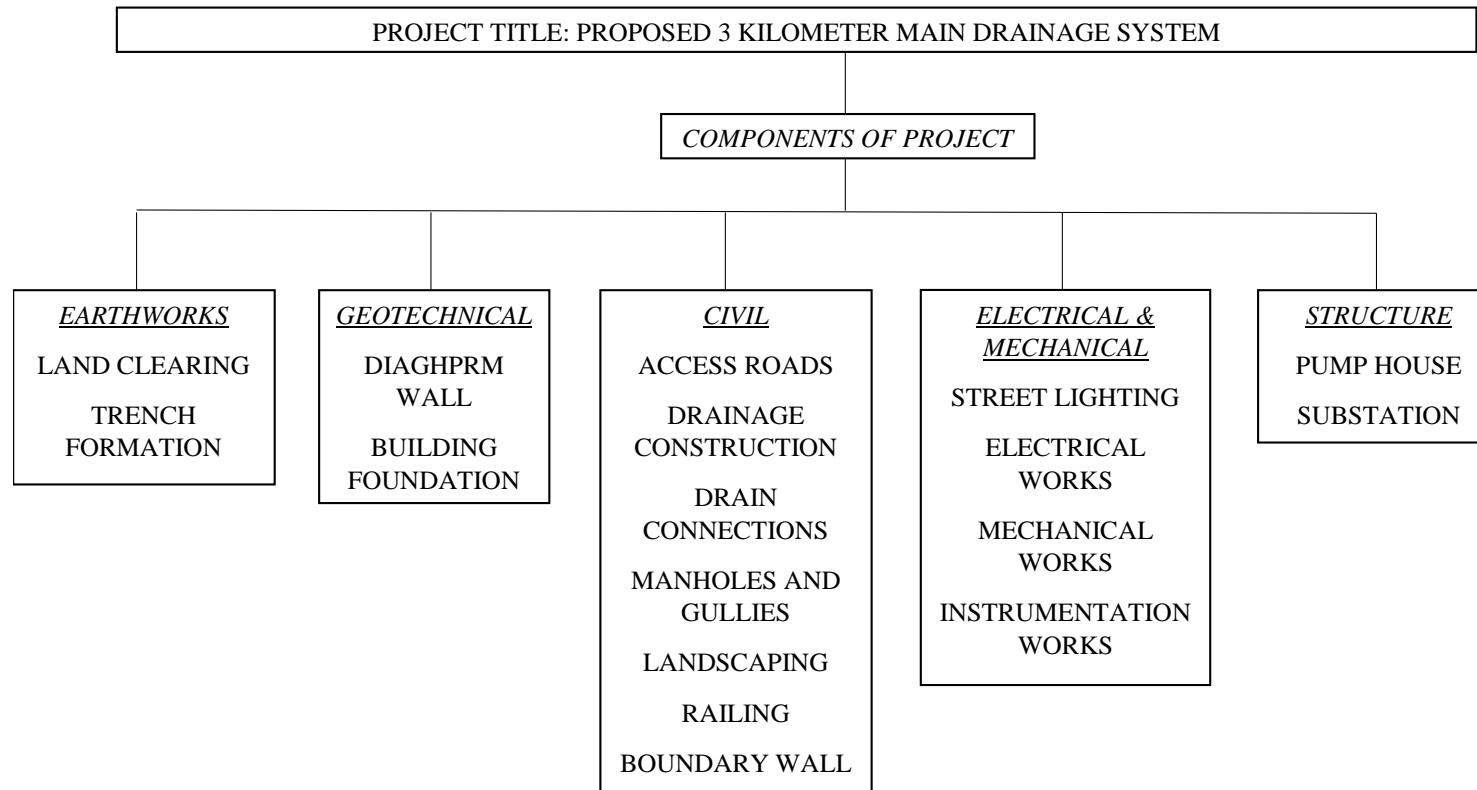
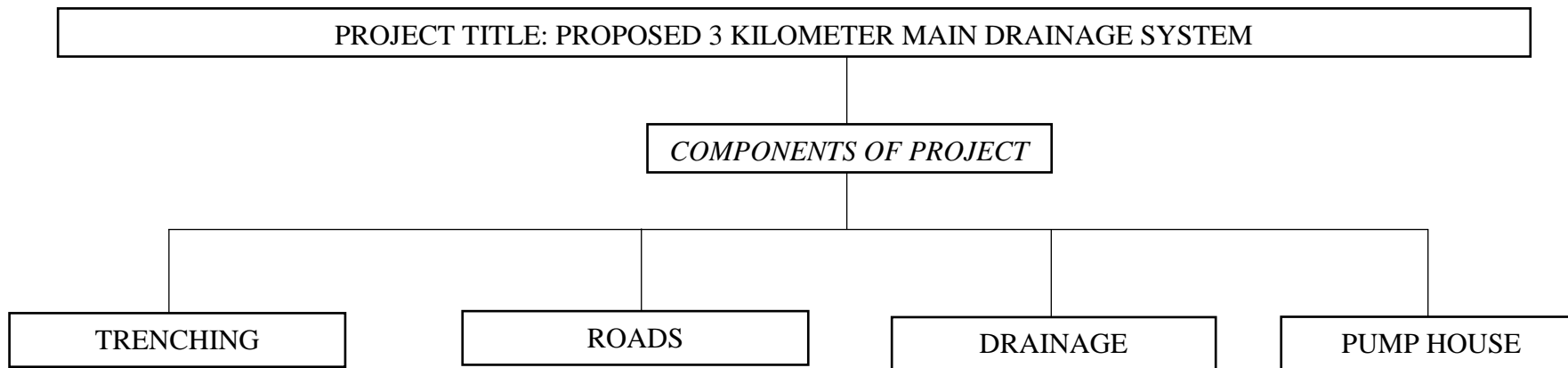


Figure 4.27: Components of Main Drainage Project



**Figure 4.28: Conventional Breakdown of A Main Drainage Project**



**Figure 4.29: Alternative Component Breakdown of A Main Drainage Project**

#### 4.6.7 Example 5 – Proposed River Check Dam Project

The next example is a project to construct a river check dam. Due to the nature of the project, only three main disciplines are envisaged to dominate the implementation of this project, namely, civil, geotechnical and structural (**Figure 4.30**). However, to facilitate the control of erosion and sedimentation, **Figure 4.31** illustrates a more practical breakdown of project components into *river works* and *dam structures*.

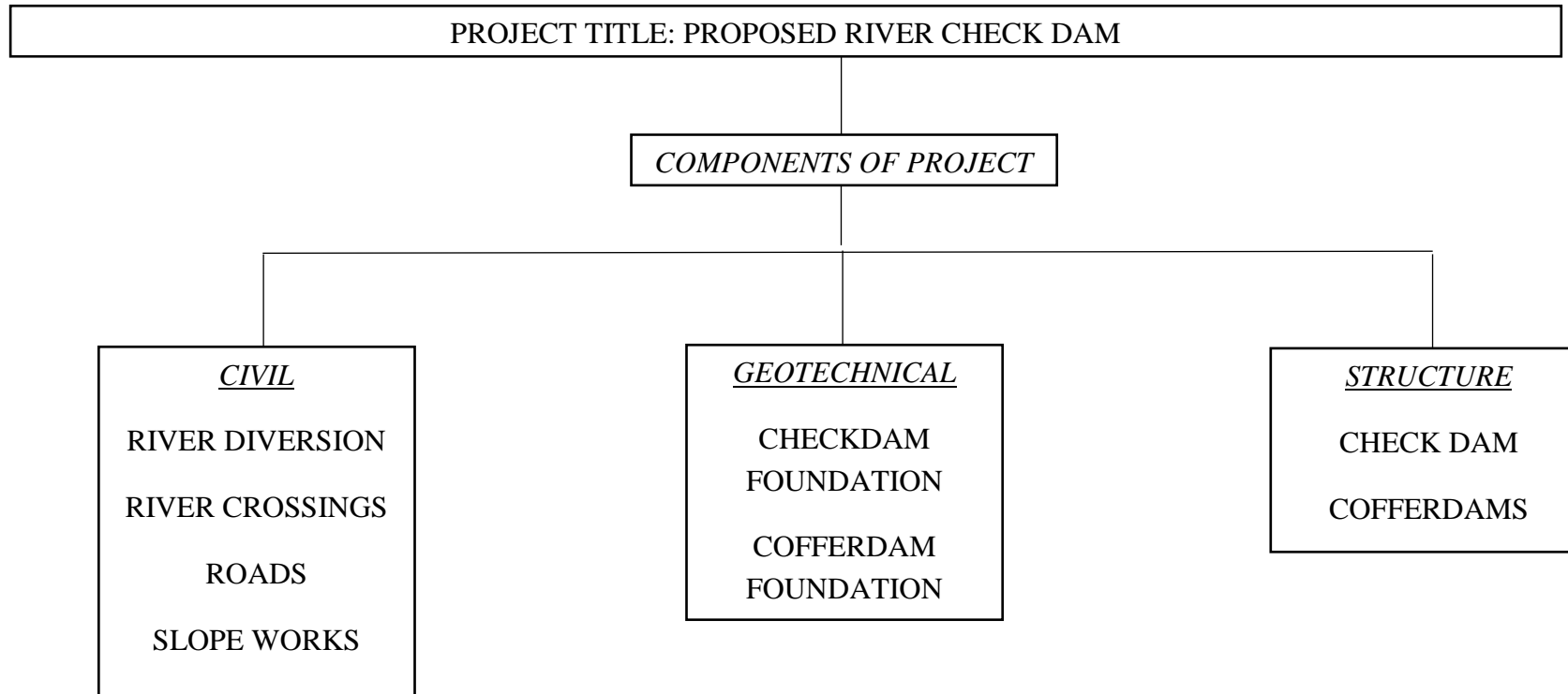
Typically for such type of project, the possible primary sequence of works comprises the following:

- Formation of a new temporary channel to divert existing river flow from the proposed check dam site location;
- Formation of upstream and downstream cofferdam or barriers to keep check dam works site in a dry working condition;
- Divert main river flow to temporary channel;
- Excavate within main river (now in a dry condition) to formation level;
- Construct check dam;
- Remove cofferdams / barriers to redivert river flow into original alignment; and
- Rehabilitate defunct diversion channel

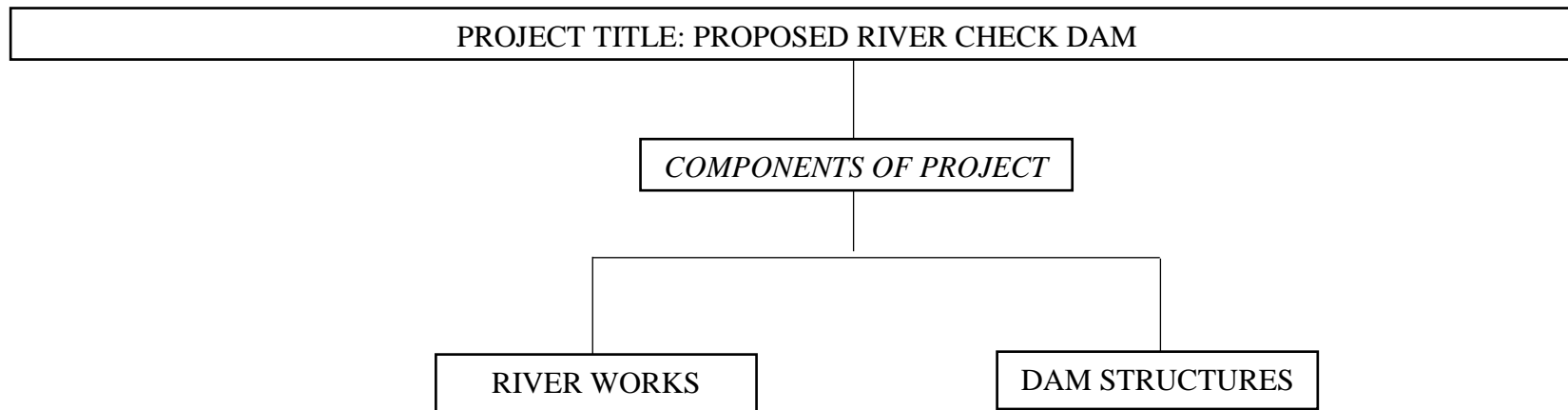
In view of the above illustration of the possible construction sequence, it should be clear now why the project component breakdown to arrest erosion and sedimentation before they occur is confined to only two main items: river works and dam structures. The associated land disturbing activities that need to be adequately controlled and protected against the elements of erosion and sedimentation can be identified as follows:

- River works: *land clearing, excavation of diversion channel, protecting channel bed, slopes and bank, stockpiling of earthwork materials, culvert laying;*
- Dam structures: *excavation of river bed, excavation for dam foundations, stockpile of earthwork material, concreting works.*

Identifying project components in such manner for this river structure evidently provides some benefits in understanding the possible location and timing for the occurrence of erosion during project implementation.



**Figure 4.30: Components of A River Check Dam Project**



**Figure 4.31: Alternative Component Breakdown of A River Check Dam Project**

#### 4.6.8 Example 6 – Proposed Forest Development Project

The principles of identifying project components can also be extended to non-engineering project, such as a forest redevelopment project. In this example, let's take a look at a proposed forest redevelopment project to facilitate a new oil palm plantation. As shown in **Figure 4.32**, the typical components for such type of project could be broken down to include earthworks, civil works and horticultural works, as elaborated below:

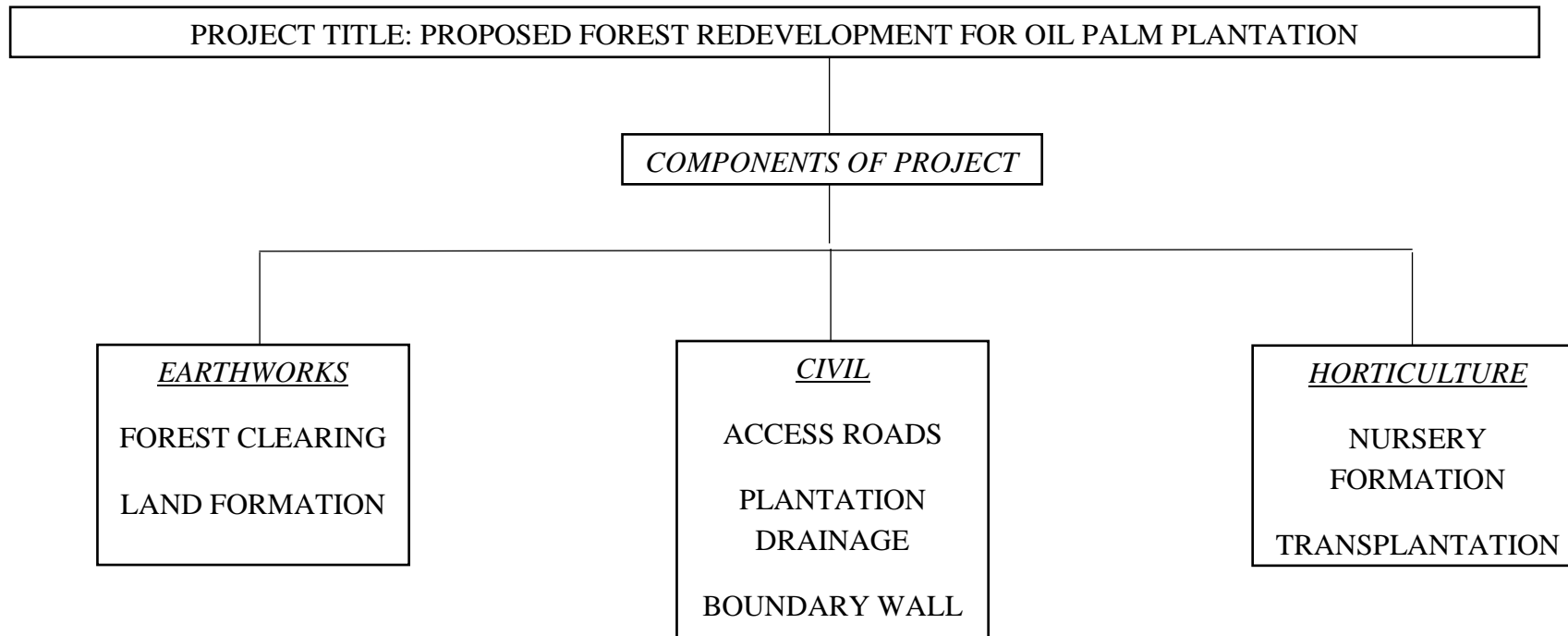
- *Earthworks*, which would provide for the clearing of the existing project site of the existing forest or other non-related vegetation and for the forming of a suitable platform for the plantation of the new crop;
- *Civil Works*, which would cater for the likes of the access road construction, along with the associated road drainages, pavement, river crossings, utility services and site boundary wall;
- *Horticultural works* which would involve the setting up of a nursery for the new crops and the subsequent transplantation of these new plantation.

To cater for the potential erosion and sedimentation risks from this development, we can identify project components in the following way, along with their associated land disturbing activities, as shown in **Figure 4.33**:

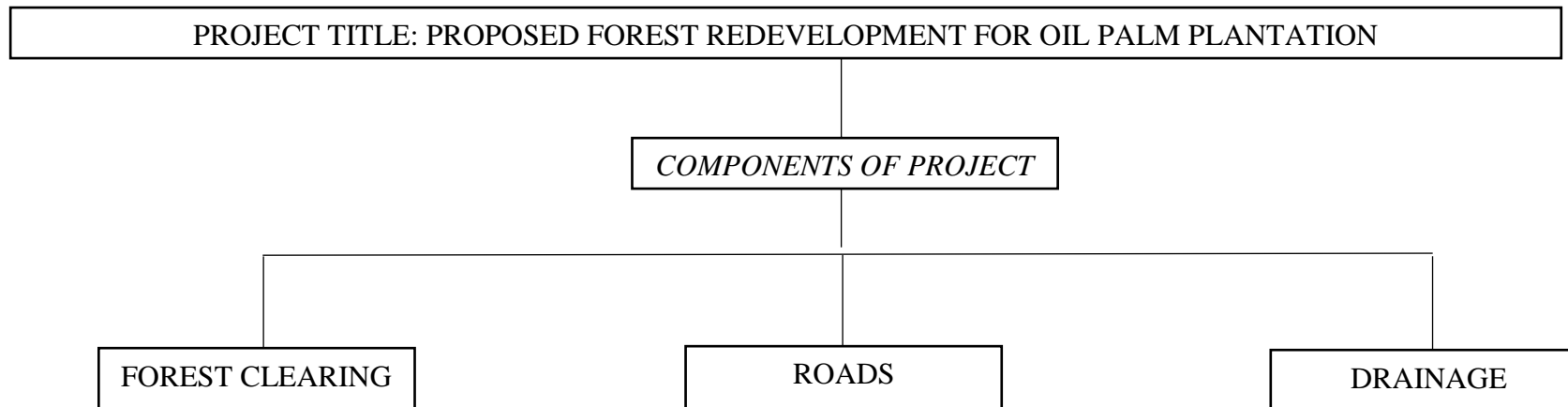
- *Forest Clearing: forest clearing, stockpiling of biomass, earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials;*
- *Roads: exposing ground surfaces for temporary and permanent access road formation, stockpiling of earthwork materials, excavation for road foundations, roadworks, utility trenches, pavements, laying of road structures, river diversion, river bank protection, excavation for crossings foundation, culvert placement;*
- *Drainage Systems: earthworks consisting of cutting and filling for slope and land formation, stockpiling of earthwork materials, excavation for drainage.*

Such manner in identifying the project components in **Figure 4.33** enables the project team to apply the general rule of thumb for recognising the potential activities that are associated with these respective components that

may comprise land disturbing activities that need to be adequately controlled and protected against the elements of erosion and sedimentation from occurring, and subsequently, for the formulation of further *environmental method statements* to address these issues on site.



**Figure 4.32: Components of A Forest Redevelopment Project**



**Figure 4.33: Alternative Component Breakdown of A Forest Redevelopment Project**

#### 4.6.9 Summary

The concept of *work breakdown structure (WBS)* in civil and construction engineering can also be apply to strategize the control of erosion and sediment issues at a project site, by defining the individual project components and their associated work packages, project activities, scope of work and environmental method statements for project implementation.

The WBS in the context of this Guidelines is not strictly intended to define and resources and duration to achieve the final deliverables under the scope of the project, but rather to emphasize or highlight those final products of the project that would contribute to erosion and sediment issues during project implementation. This WBS can then be complemented or integrated with the “overall WBS” of the Contractor for the project.

Conventionally, the breakdown of project components by Contractors is done by grouping all the relevant tasks and deliverables under respective engineering disciplines, to give a holistic picture of the overall resource requirements in terms of specialist needs, labour, material & equipment, time and financial. Typically, this involves breaking down the project based on the following major sectors: *Infrastructure; Geotechnical; Civil; Structure; Electrical; Mechanical; and Architectural*. Although the above method represents a good starting point for the Contractor to plan his resource requirements, it however does little to bring out the elements relating to erosion and sedimentation controls needed for the project, because such a WBS is product or deliverable oriented, whereby the focus or purpose of the breakdown is more geared towards getting to the endpoint, i.e., delivery of the final products.

Identifying project components from the perspective of controlling erosion and sediment in the context of this Guidelines is more about breaking down the project so as to establish the project activities particularly to those relating to land disturbing activities. By doing so, suitable environmental method statements can subsequently be developed in a manner that the amount and duration of soil exposed to erosion is reduced as much as practicable by implementing and maintaining the suitable BMPs in coordination with the sequence of construction activities.

General guideline for identifying project components is to breakdown the overall project into a simpler form which comprises the major and significant final deliverables of the project. Although not a straightforward exercise, it is recommended to break down an overall project into no more than five or six components, depending on the complexity of the project. Although this few

number of components may be argued that they do not represent convincingly the overall project, it should be kept in mind however that, the purpose of such component identification is to be able to group those major deliverables whereby land disturbing activities would be expected.

To this end, those deliverables that would involve any activity that changes the physical conditions of land form, vegetation and hydrology, creates bare soil, or otherwise may cause erosion or sedimentation such as, site clearing, removal of vegetation, stripping, grading, grubbing, excavating, filling, logging and storing of materials, etc. would be given more attention when creating these groups of project components.

Less attention is needed to be given to those other deliverables whereby land disturbing activities are not expected, and where possible, preferably to be grouped into two (or less) common components for completeness.

## **4.7 IDENTIFYING PROJECT ACTIVITIES**

### **4.7.1 Application to this Guidelines**

In the above sections, we have discussed the need to break down a project into manageable phases as well as to restructure a project by identifying relevant project components, for the benefit of controlling erosion and sedimentation that may arise during the implementation of a project.

In this section, we will look at the subsequent step to be taken once we have identified those project components of a project that we believe which will involve land disturbing activities that may contribute to accelerated erosion and sedimentation issues on site. It should be stressed at this point that the key objective of these identification (whether of phasing, project components or project activities) is not to dictate or define the methodology on how the Contractor should carry out his works, but more so for assisting his project team to be aware of those activities that would typically alter a stable site condition into one where the rate of erosion and sedimentation becomes accelerated (as compared to the natural process), to the extent that such alterations of the natural conditions are likely to pollute the downstream sensitive receivers such as rivers or water intakes.

Having said the above, the LD-P2M2 practitioners should always keep in mind that there is always more than one way in dealing with the identification of the

project activities (as well as the project components in the previous section), and that all projects are different from one another. Therefore, a particular approach for activity identification that is suitable for one project may not be applicable for another project which is situated at a different location or of a different nature. The most important point to remember is that in whatever form a project is restructured, whether it is based on project components and/or project activities, the key justification that ought to accompany such approach is that land disturbing activities that need to be adequately controlled and protected against the elements of erosion and sedimentation from occurring should be readily be identified.

Subsequent to the breaking down a project into meaningful components, whether in terms of the respective disciplines required to execute the project or in terms of project components that allow land disturbance activities to be readily identified for the purposes of controlling erosion and sedimentation, the next step would involve the identification of e associated *project activities*.

The definition of “project activities” from the context of general project management is given earlier in Section 5.3, but in short, to define project activities is basically an act “*to identify the specific tasks needed to be done in order to produce the project's deliverables.*” Such identification should be done in sufficient detail to estimate what resources and time will be required to complete them, by applying a “hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables”<sup>5</sup>. The technique of decomposition, as applied to defining activities, involves subdividing the project work packages into smaller, more manageable components called activities which represent the effort needed to complete a work package.

The above definition for identifying project activities from the view of project management can also be applied for the purposes of addressing erosion and sedimentation. Following on from the above discussions on *work breakdown structures, identifying phasing and project components*, let’s now look at the approach to identify *project activities* and their associated *scope of work*.

The task of attempting to identify the project activities may be conceived by a LD-P2M2 practitioner to be a challenging one, especially if the practitioner has not received any formal educational training in civil engineering or has limited experience in civil engineering construction projects. However, it is fair to note that even without the above two “qualifications”, it is imperative that anyone who is involved in the field of erosion and sedimentation ought to have some

---

<sup>5</sup> Project Management Body of Knowledge (PMBOK 5)

basic understanding of the process within a construction project, to be able to reasonably predict the potential cause and source of these two phenomena so as to adequately mitigate against their occurrence.

The simple rule to remember is this: the key purpose of this *Guidelines* of going through with these identification exercises is that we are not trying to override the way on how the Contractor executes his project, but rather to highlight to the attention of the Project Proponent and his Contractor on the “where” and “when” and “how” erosion and sedimentation may occur from their particular project site, so that early attention could be given by these parties on the resources required and the measures to be implemented prior to the actual physical works. With that in mind, one should not be intimidated during the formulation of the WBS in the context of erosion and sedimentation, and should not be overly worried about not producing a comprehensive enough list of project activities or scope of work for the identified project components. The most important thing to note, however, is that the WBS and associated project activities have adequately covered the major land disturbance activities that would be involved for those particular project components, and this should be a relatively easier task to undertake. With these critical elements identified and documented, the Project Proponent and Contractor would have been then made aware of these potential issues, if they don’t already know, and could be prepared to take the appropriate actions to minimize the occurrence of these issues.

#### 4.7.2 Example 1 – Proposed Sewage Treatment Works Project

Following from the above discussion, let’s now take a look at how to expand the simple work breakdown structures for the few examples previously created in the preceding section. Firstly, let’s review the proposed sewage treatment plant project as shown in **Figure 4.18**.

In this earlier example, it was identified previously the project components could be broken down to three parts, in lieu of the typical breakdown based on disciplines, namely, *Road*, *Bridge* and *Building Site*. Following on from these components, we can then identify the possible project activities for each component as follows:

##### a) Component 1 – Road

**Project Activities:** Typically the construction of roads will involve site clearance, grading and laying of road works including its drainage. Preparing the road right-of-way or construction area will normally involve clearing and grubbing activities, and particularly so for this project which is within a forest area. During the clearing phase, trees are felled, while the grubbing activity

refers to the clearing and removal of stumps and organic debris. After the clearing works are completed, the following major activity will involve earthworks which will involve excavation of the existing land to a suitable level so that road construction may begin. The earthworks can take the form of either excavation in the form of cuts or the construction of embankments to carry an elevated highway; typically, both will be necessary and movement of earth from one part of the site to the next will be inevitable. Such cut and fill would be done with as little waste created or as little extra material required as disposal or collection due to the cost involved in material transportation. Also under this earthwork will be the provision of drainage and compaction of the road materials to the appropriate level.

Some of the typical earthmoving equipment that will be used for the above works include the following:

- *Bulldozer*, which is used primarily for pushing soil. Bulldozers are generally tracked and require large amounts of traction and are sometimes equipped with hydraulic attachments at the rear for breaking up soil and rock;
- *Drag Line*, which allows excavation below its own level and is essentially equipped with a bucket on the end of a jib for bulk excavation;
- *Dump Lorries*, which will be used for transferring material from one part of the site to another;
- *Shovels*, which are normally wheeled vehicles and are used to fill up the lorries;
- *Hydraulic Excavators*, which are typically used due to their small capacity and flexibility, for excavating below lorry level;
- *Grader*, which will be used to level out deposited fill, to be ready for compaction; and
- *Rollers*, which consist of different types such as vibratory, sheepfoot and grid, and they are used for compaction.

In summary, the project activities that are identified for the *Project Component Road* include the following: *site clearance*, *site grading*, and *drainage works*.

b) Component 2 - Bridge

**Project Activities:** To simplify the analysis for the bridge construction, particularly with a view to focus only on those activities that may give rise to erosion and sedimentation, one can basically narrow down the related key activities to involve site clearance for the construction of the bridge piers, although the extent of the clearing works would be more limited and confined to the footprint of the piers (as compared to the extent required for the initial site clearance for the road works. Upon completion of establishing the work zones for the piers, the next key activity will involve excavation for the pier foundation. This could involve borehole drilling for the foundation structure, which is then followed by the erecting of the pier and elevated structures. In summary, the project activities that are identified for the *Project Component Bridge* include simply the following: *site clearance, borehole drilling, and column and elevated structures.*

c) Component 3 - Building Site

**Project Activities:** Although the STW in itself may be deemed to be a major structure, the actual activities that contribute to erosion and sedimentation during the whole process of producing the STW are actually quite limited, if we compare them to those activities that are not related to erosion and sedimentation. In essence, the construction of the STW would involve major activities (but not limited to) such as site clearance for the structure platform, excavation for the structure foundation and then followed by mainly structural related works such as formworking, steelworks, and concreting. In summary, with a focus on issues relating only to erosion and sedimentation, the project activities that can be identified for the *Project Component Building Site* include simply the following: *site clearance, excavation, and concreting.*

An illustration of the above project activities identification is shown in **Figure 4.34** below. As per the above discussion, the respective project activities for each of the components identified earlier for this example project are shown. One important observation that should be obvious from this figure is that the focus of the work breakdown is directed to the major activities that are anticipated to generate potential erosion and sedimentation issues from the implementation of this project. For instance, regardless of the project components under review, the project activities should always include all those major site activities that are anticipated to be required to construct the individual components but more importantly, that might generate erosion and sedimentation if left uncontrolled. In this regard, some of the identified project activities may appear more than once; in the STW project example, these activities include generally *site clearance, site grading, excavation, borehole drilling and drainage works.*

Subsequent to the above identification of the project activities, the next task will be the further expansion of the WBS for the project, by identifying the corresponding list of activities or the *scope of work*. Again, the key to this identification is not to be bogged down by the engineering technicality or complexity on the actual work itself but rather to look at the process of work in a simple manner but adequate to describe the activities required. Let's take a look at how each of the project activities identified above is described with its dedicated scope of work, and again, keeping the attention on activities related to or contributing to erosion and sediment issues, and not to be distracted by the technical methodologies in the executing the works.

Component - Road; Activity - Site Clearance: Under the activity "Site Clearance", it is anticipated that the typical scope of work to be undertaken (from a simplified perspective) might include the following:

- a) *Undertake survey* - Undertaking a comprehensive site survey to identify topography of site and to physically locate the extent of works as interpreted from the construction drawings;
- b) *Mark site boundary* - Marking the site boundaries so as to delineate the project's right of way (ROW);
- c) *Identify interfaces* - Identifying any potential interfaces between the proposed works and any existing facilities in the surrounding vicinity of the project site, such as roads, rivers, vegetation, etc;
- d) *Identify clearance extent* - Identifying the extent of site clearance required as per the construction drawings and/or per construction methodology, for example to cater for working space, access, etc.; and
- e) *Clearing works* - Undertaking the clearing works which might include felling of existing trees and removal of large vegetation. For this project, this step would be the first of the many subsequent land disturbance activities that are anticipated for this project. During this scope of work, ground surfaces which were previously covered with plants and trees will now be cleared of their surface protection and the ground surfaces are anticipated to be exposed to the elements. If unprotected, the exposed surfaces are likely to be subject to erosion from the wind and rain, and sediment being carried off from the site to the nearby receptors such as existing road or rivers and streams. Additionally, a large volume of biomass and excavated soils is expected to be generated under this activity which will likely to be stockpiled temporarily on site before being disposed off to a dedicated disposal area.

Component - Road; Activity - Site Grading: Under this activity, which was preceded by the previous site clearance works, the scope of work that could be prescribed include the following:

- a) *Undertake survey* – At the completion of the site clearance activities, a survey of the site should be undertaken so as to identify the limits of the road corridor as well as its associated working spaces such as temporary stockpile areas, material storage yard, construction machinery accesses, etc. These information facilitates the marking of the extent of the road works on site as stipulated in the construction drawings;
- b) *Mark surface elevation* – For road works, this is a relatively important task, which involve marking physically on site the final surface levels of the finished road. Not undertaking this step may involve abortive work at the later stage, or if not rectified after the road construction, may result in defects in terms of incorrect surface runoff flows, ponding, etc.;
- c) *Mark work/buffer zones* – This involves physically marking on the ground the boundaries or work limits allowed for the roadworks, as well as marking the buffer limits or zones. The former marking is to ensure that the subsequent works for the road construction are generally maintained within the prescribed area, and to avoid encroachment into areas outside of the ROW, whilst the buffer zone identification on site is to protect the nearby sensitive receivers, including trees and forested area for this example. Marking of the buffer zone provides a visible reminder to the workers on site to avoid venturing into these areas or damaging the environment outside of their work areas;
- d) *Grading works* – Upon completion of the marking activities, grading of the site will then be undertaken to form the recently cleared land to the desired formation to facilitate the road construction. This activity is expected to generate further exposed ground surfaces (subsequent to the site clearance activity) due to the scrapping or cutting of the ground in the process of the grading works. Additionally, further volumes of biomass and excavated soil will be generated from this activity.

Component - Road; Activity - Drainage: This activity should come sequentially after the site grading works are completed, and generally be performed concurrently with the road construction. The likely scope of work for this project activity may include the following:

a. *Identify flowpath* - For road works, it common for the drainage flow to be compatible with the road elevation but sometimes not practical as the road elevation might take an “uphill’ and ‘downhill” grades. As such, it is important for the drainage team to clearly mark physically on the site the proposed final invert levels of the finished drainage works, which are typically laid adjacent to the road;

b. *Mark work/buffer zones* – This involves physically marking on the ground the boundaries or work limits prescribed for the drainage works, as well as marking the buffer limits or zones. Again the marking of work limits is to ensure that the drainage construction is confined to within the prescribed works area, and to avoid encroachment into areas outside of the ROW. Marking of the buffer zone facilitates the protection of the nearby sensitive receivers, by providing a constant and visible reminder to the workers on site to avoid carrying out their works outside of the stated limits;

c. *Mark storage zones* – This involves physically marking on the ground the dedicated areas reserved for stockpiling both excavated materials from the drainage works, as well as material storage areas for the construction materials and machineries;

d. *Excavate trench* - Upon the identification of the above, the next work activity will involve the excavation of the trench for the drainage placement. This activity is expected to generate construction waste materials from the excavation works, and once the trench is formed, possible dewatering works to maintain the trench in a dry condition to lay the drainage works.

e. *Drainage works* – This step under the project activity involves several elements including laying of the drainage parts, water tests, and backfilling of the trench. More often than not, the drainage works may take place in concurrent with the road construction activity (Note: a separate road construction activity has not been included here for simplicity but it is assumed that the road works are being carried out at the same time with the drainage works).

*Component - Bridge; Activity - Site Clearance:* The scopes of work for this activity are more or less similar to the same activity identified under the *Road Construction* in that the scope would also involve *undertaking survey, marking site boundary, identifying interfaces, identifying clearance extent and clearing works*. However, there is a distinct difference between the clearing works for the Road and for the Bridge construction due to the nature and location of these components, and hence in the types of the pollution

prevention and mitigation measures (P2M2) and/or BMPs to be deployed accordingly. Such distinction is generally described below.

a) *Undertake survey* – The site survey under this scope is to identify the locations of the permanent structures of the bridge, in relation to the river that the bridge will cross over. In terms of erosion and sediment, the most critical of these structures would be the foundations of the bridge, as well as the surrounding permanent works to protect the river banks and slopes;

b) *Mark site boundary* - Marking the site boundaries of the physical structures of the bridge such as its foundation in the form of piers or columns, or any embankments which is part of the bridge design, with the aim to make sure that the works team is aware of where the prescribed works area within which the structural construction is confined to, and to avoid encroachment into areas outside of the footprint of these structures;

c) *Identify interfaces* - Identifying any potential interfaces between the proposed bridge works and any existing facilities in the surrounding vicinity of the project site, particularly the river over which the bridge will cross;

d) *Identify clearance extent* - Identifying the extent of site clearance required as per the construction drawings and/or per construction methodology, for example to cater for working space, access, etc.; and

e) *Clearing works* - Undertaking the clearing works to facilitate the construction of the bridge piers, embankment and other permanent works at or near the river. This scope may include felling of existing trees and removal of large vegetation. For this component, this activity would be another land disturbance activity that may potentially result in erosion and sediment being discharged to the nearby river. During this scope of work, ground surfaces will now be cleared of their surface protection (cover crops) and be exposed to the elements of the weather.

Component - Bridge; Activity – Borehole Drilling: Under this activity and viewing the process of this foundation work from a simplified perspective without going into the technical details of the actual drilling works, the scope of work for this activity includes the following:

a) *Mark work zones* – Prior to commencement of any land disturbance activities for the bridge component, it is important to mark the required working zones and limits for the construction of, predominantly the foundation works. It should be noted that adequate working space for other

ancillary activities other than the physical borehole sizes should be allowed, such as space to accommodate the heavy machineries that will be deployed during the drilling, space to implement relevant pollution prevention mitigation measures such as noise or visual barriers; buffer zones, dewatering activities, silt traps, sediment ponds or settling basins, drainage, to name a few;

*b) Mark storage zones* – Appropriate storage yards or dedicated zones should be clearly marked at the site (at or in the vicinity of the drilling locations) for the temporary stockpiling of construction materials to be used for the borehole drilling, as well as for construction waste materials such as excavated soil and earth that are not immediately transported out of the work areas;

*c) Drilling works* - Undertaking the borehole drilling works, and as mentioned above, which would generate both construction solid waste and wastewaters;

*d) Export excavated soil* – Exporting the excavated soil or earth materials out of drilling site, as well as by-products from the treatment of the construction wastewaters.

*Component - Bridge; Activity – Elevated Structures:* The scope of work for this activity has been formulated to simply include the following works: *formwork; steelwork; concrete pour; and formwork removal*. As the scope of work has suggested, there are limited land disturbance activities that would be involved during the above works, except for the need to identify proper areas for stockpiling and storing the construction materials needed for the works and construction wastes generated from these scopes of work.

*Component – Building Site; Activity - Site Clearance:* This activity again would appear to be similar to the same type of activity for the previous two components (i.e., *Road* and *Bridge*). However, there is a slight difference for the Building Site in terms of the nature and location of this component, and hence in the types of the pollution prevention and mitigation measures (P2M2) and/or BMPs to be deployed accordingly. Such distinction is generally described below.

*a) Undertake survey* – The site survey under this scope would be to identify the location of the footprint for the STW building structure. In terms of erosion and sediment, the site clearing works would involve a larger footprint as compared to the previous two components, and consequently, the amount

of biomass and inert construction wastes such as excavated materials is expected to be of greater volume;

*b) Mark site boundary* - Marking the site boundaries of the physical structures of the STW building and associated structures such as its support facilities, with the aim to clearly demarcate limits of land disturbance and avoidance of encroachment into areas outside of the footprint of these structures;

*c) Identify interfaces* - Identifying any potential interfaces between the proposed STW structures and the adjacent vicinity of the project site, particularly the undisturbed forested area;

*d) Identify clearance extent* - Identifying the extent of site clearance required as per the construction drawings and/or per construction methodology, for example to cater for working space, access, etc.; and

*e) Clearing works* - Undertaking the clearing works to facilitate the construction of the STW and associated supporting facilities. This scope may include felling of existing trees and removal of large vegetation, which is a land disturbance activity.

*Component – Building Site; Activity - Excavation:* The nature of this activity is somewhat similar to the “Borehole Drilling” activity except that for the “Excavation” activity, bentonite will not be used. The scope of work for this activity includes the following:

*a) Mark work zones* – Prior to commencement of any land disturbance activities for the bridge component, it is important to mark the required working zones and limits for the construction of, predominantly the foundation works. It should be noted that adequate working space for other ancillary activities other than the physical borehole sizes should be allowed, such as space to accommodate the heavy machineries that will be deployed during the drilling, space to implement relevant pollution prevention mitigation measures such as noise or visual barriers; buffer zones, dewatering activities, silt traps, sediment ponds or settling basins, drainage, to name a few;

*b) Mark buffer zones* – This involves physically marking on the ground the boundaries of the buffer zones to protect the nearby sensitive receivers. The purpose of this scope is to provide a constant and visible reminder to the workers on site to avoid carrying out their works outside of the stated limits;

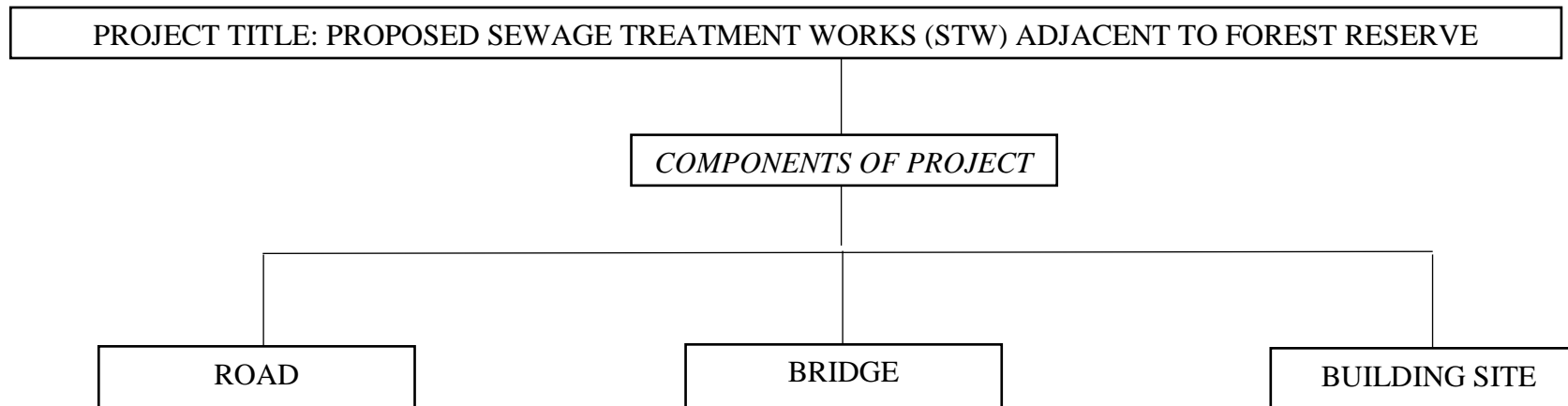
c) *Mark storage zones* – Appropriate storage yards or dedicated zones should be clearly marked at the site (at or in the vicinity of the excavation locations) for the temporary stockpiling of construction materials to be used for the excavation process, as well as for construction waste materials such as excavated soil and earth that are not immediately transported out of the work areas;

d) *Excavate foundation* - Undertaking the excavation works, and as mentioned above, which would generate both construction solid waste and wastewaters;

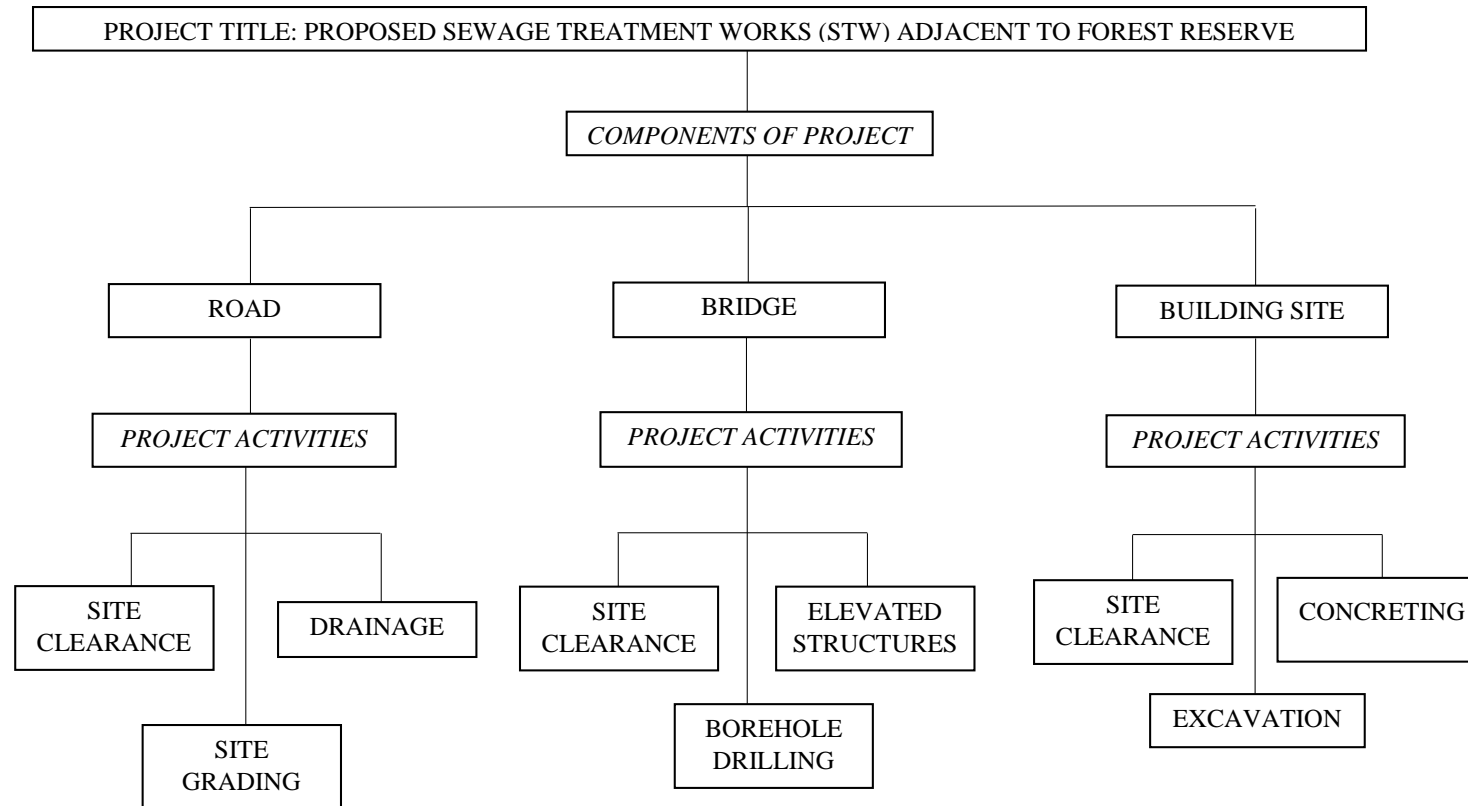
e) *Export excavated soil* – Exporting the excavated soil or earth materials out of excavation site, as well as by-products from the treatment of the construction wastewaters.

Component – Building Site; Activity - Concreting: Although this component probably represents the major portion of the Contract for this project, its scope of work is given relatively less attention in the context of this Guidelines. The scope of work for this activity has been formulated to simply include the following works: *formwork; steelwork; concrete pour; and formwork removal*. As the scope of work has suggested, there are limited land disturbance activities that would be involved during the above works, except for the need to identify proper areas for stockpiling and storing the construction materials needed for the works and construction wastes generated from these scopes of work.

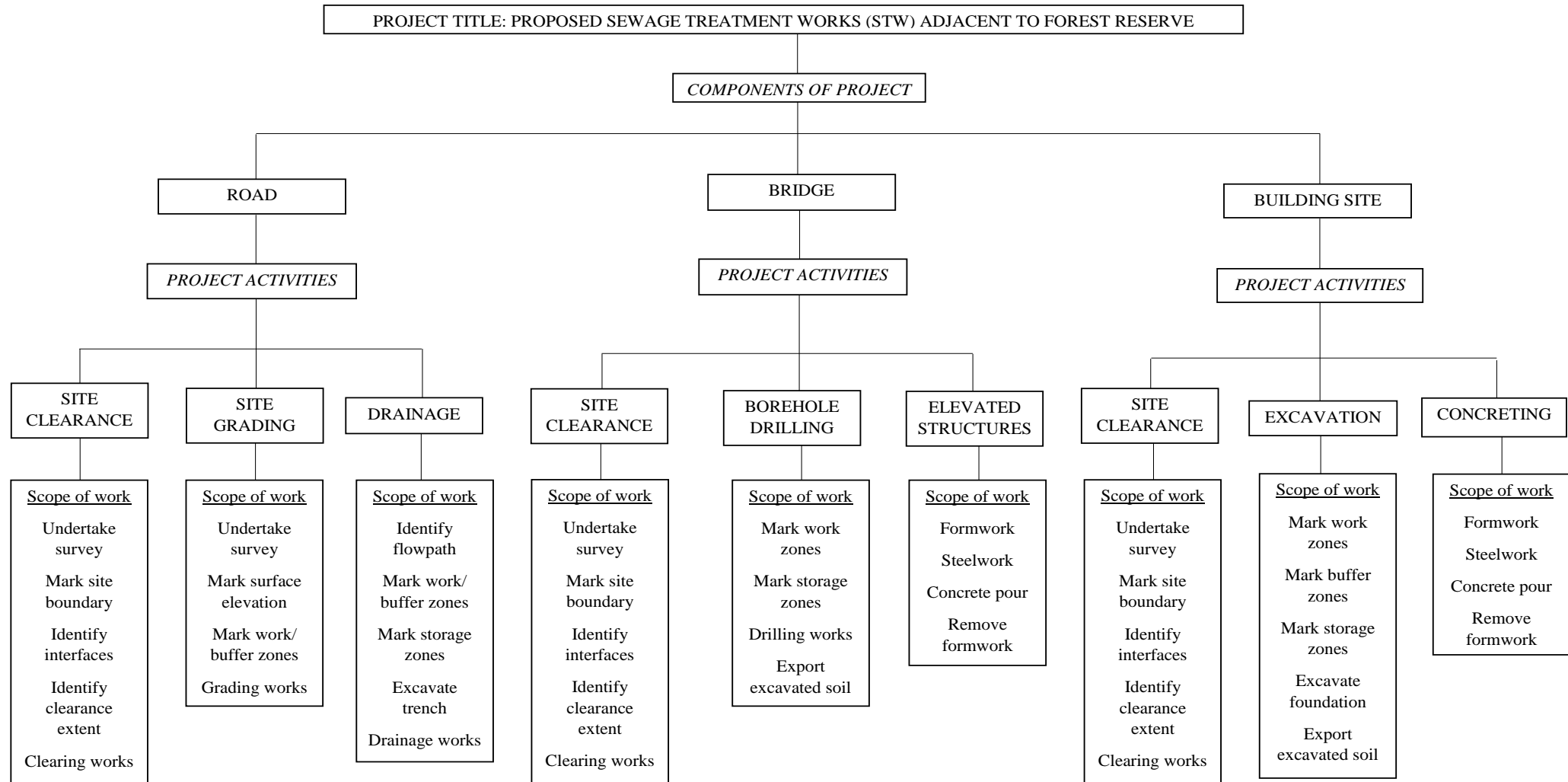
The above discussion on the proposed WBS for the sewage treatment project is illustrated in the following figures. In summary, it is important to remember that the proposed WBS is not meant to be an ‘engineering’ work breakdown, but rather for the purposes of this Guidelines, which is to identify the potential sources of land disturbing activities that are likely to result in erosion and sedimentation issues during the construction works. As can be seen, some of the scope of work appears to be iterative for the different activities, but if these are reviewed from the perspective of the potential erosion and sediment issues resulting from the nature of their activities, then it would make sense that why some of the scope of work is so fundamental for land disturbing activities. The problem with today’s site activities is that these fundamentals are either bypassed or “forgotten” for the sake of achieving progress or to save some money, which ultimately, resulted in the type of environmental catastrophes that we see today.



**Figure 4.21: A Simpler Alternative to Component Breakdown of STW Project**



**Figure 4.34: Identification of Possible Project Activities of STW Project**



**Figure 4.35: Identification of Possible Project Activities of STW Project**

### 4.7.3 Example 2 – Proposed Highway Project

In this example, let's take a look at how possible project activities could be identified for the project components for a proposed highway project as illustrated in **Figure 4.22**, namely, *Temporary Roads*, *Permanent Roads*, *Drainage System* and *River Crossings*. Following on from these components, we can then identify the possible project activities for each component as shown in **Figure 4.36**:

#### a) Component 1 – Temporary Roads

The proposed project is to provide a road connection between two existing highways through a relatively remote rural area, with the new road passing closely some existing village settings and crossing several streams and rivers. For this project component, the potential activities include the following:

- Site Clearance
- Site Grading
- Temporary Drainage, and
- Road Formation

This project is located within a remote rural setting whereby it is expected accessibility to construct the proposed road will be limited. As such, temporary roads to gain access into the site will be critical to the delivery of the project, and if the construction of these temporary roads is the initial project component in a green field (i.e., an undisturbed site), the anticipated activities will involve site clearance, site grading, temporary drainage, and the road formation works. Preparing the temporary road right-of-way or construction area will normally involve clearing and grubbing activities, and particularly so for this project which is within a rural area which expected to comprise forest and vegetated areas. During the clearing phase, trees would be felled, and stumps and organic debris are cleared and removed via the grubbing activity. After the clearing works, earthworks involving cut and fill of the existing land to a suitable level will take place to allow temporary road construction to begin, which also consists of construction of temporary drainage.

#### b) Component 2 - Permanent Roads

For this project component, the potential activities include the following:

- Site Grading
- Permanent Drainage, and

- Roadworks

This second component will involve the almost similar activities as the previous component, except that now, the permanent road will be laid. Whilst the temporary road provides initial access to the work site, the permanent road will be the final product to be delivered by the Contractor. After the site clearance has been completed, the anticipated activities will involve: site grading of the cleared land to form the ground for the permanent roadworks; creation of the permanent road drainage which is typically located within or adjacent to the road; and finally, the construction of the road. During the grading phase, more biomass or inert wastes will be generated, leaving the ground exposed. The permanent road and drainage works also will generate similar waste materials.

c) Component 3 – Drainage Systems

For a major project such as this one, it is not uncommon to provide a separate permanent drainage systems to not only receive the surface runoff from the impermeable surface of the new road but also to receive the runoff contributed from the adjacent catchment. One of the reasons for catering the catchment runoff is to avoid the new road to be disrupted or flooded. The project activities associated with this component would involve: *excavation*; *drainage works*; and *backfill*, whereby the process of the drainage commences with excavating a trench for the drainage works to be laid, and upon completion of the drain laying, backfilling will be done provide the cover for the drains.

d) Component 4 – River Crossings

To simplify the analysis for the river crossings (or bridges) construction, particularly with a view to focus only on those activities that may give rise to erosion and sedimentation, we can basically narrow down the related key activities to involve site clearance for the construction of the bridge piers, although the extent of the clearing works would be more limited and confined to the footprint of the piers (as compared to the extent required for the initial site clearance for the road works. Upon completion of establishing the work zones for the piers, the next key activity will involve excavation for the pier foundation. This could involve excavation for the foundation structures, which is then followed by the erecting of the pier and elevated structures. In summary, the project activities that are identified for the *Project Component River Crossings* includes simply the following: *site clearance*, *foundation works*, and *elevated structures*.

Illustration of the above project activities identification is shown in **Figure 4.36** below. Subsequent to the above identification of the project activities, the next task will be the further expansion of the work breakdown structure for the highway project, by identifying the corresponding *scope of work* for each of the project activities. Again, the key to this identification is to look at the process of work in a simple manner but with enough and sensible details to describe the activities required, with particular emphasis on erosion and sediment issues. Now let's take a look at how each of the project activities identified above is described with its dedicated scope of work.

Component – Temporary Roads; Activity - Site Clearance: Under the activity “*Site Clearance*”, it is anticipated that the typical scope of work to be undertaken (from a simplified perspective) might include the following:

- a) *Undertake survey* - Undertaking a comprehensive site survey of the rural settings to identify, amongst other things, topography of site, constraints for the temporary roads construction, sensitive receivers in the vicinity of the works areas, limits of the temporary road construction and to locate the ROW of the works, as interpreted from the construction drawings;
- b) *Mark site boundary* - Marking the site boundaries so as to delineate the project's right of way (ROW);
- c) *Identify interfaces* - Identifying any potential interfaces between the proposed works and any existing facilities in the surrounding vicinity of the project site, such as roads, rivers, vegetation, etc;
- d) *Identify clearance extent* - Identifying the extent of site clearance required for the temporary road construction, within the limits as specified in the construction drawings, as well as the clearance required to cater for working space, access, etc.; and
- e) *Clearing works* - Undertaking the clearing works which might include felling of existing trees and removal of other natural or manmade obstacles. This would be the first land disturbance activity envisaged for this project. During this scope of work, ground surfaces which were previously covered with plants and trees will now be cleared of their surface protection and the ground surfaces are anticipated to be exposed to the elements. If unprotected, the exposed surfaces are likely to be subject to erosion from the wind and rain, and sediment being carried off from the site to the nearby receptors such as existing road or rivers and streams.

Component – Temporary Roads; Activity - Site Grading: Under this activity, which was preceded by the previous site clearance works, the scope of work that could be prescribed include the following:

- a) *Undertake survey* – At the completion of the site clearance activities, a survey of the site should be undertaken so as to identify the limits of the road corridor as well as its associated working spaces such as temporary stockpile areas, material storage yard, construction machinery accesses, etc. These information facilitates the marking of the extent of the road works on site as stipulated in the construction drawings;
- b) *Mark surface elevation* – For road works, this is a relatively important task, which involve marking physically on site the final surface levels of the finished road. Not undertaking this step may involve abortive work at the later stage, or if not rectified after the road construction, may result in defects in terms of incorrect surface runoff flows, ponding, etc.;
- c) *Mark work/buffer zones* – This involves physically marking on the ground the boundaries or work limits allowed for the roadworks, as well as marking the buffer limits or zones. The former marking is to ensure that the subsequent works for the road construction are generally maintained within the prescribed area, and to avoid encroachment into areas outside of the ROW, whilst the buffer zone identification on site is to protect the nearby sensitive receivers, including trees and forested area for this example. Marking of the buffer zone provides a visible reminder to the workers on site to avoid venturing into these areas or damaging the environment outside of their work areas;
- d) *Grading works* – Upon completion of the marking activities, grading of the site will then be undertaken to form the recently cleared land to the desired formation to facilitate the road construction. This activity is expected to generate further exposed ground surfaces (subsequent to the site clearance activity) due to the scrapping or cutting of the ground in the process of the grading works. Additionally, further volumes of biomass and excavated soil will be generated from this activity.

Component - Temporary Roads; Activity – Temporary Drainage: This activity should come sequentially after the site grading works are completed, and generally is performed concurrently with the road construction. It is noted that this activity should not be confused with the “Activity – Permanent Drainage” under the “Component – Permanent Road”; although both serve to drain off surface runoff, former temporary drainage (as its name implies) is of a short term nature, and eventually will be removed

and replaced by the permanent drainage. The likely scope of work for this project activity may include the following:

- a. *Identify flowpath* – The flowpath for a temporary drainage is usually more robust than that for a permanent drainage, since until the final formation of the road is set, this landform may occasionally alter to suit the working conditions on site. As such, it is important for the drainage team to keep up with the evolving status of the landform and clearly mark physically on the site the functional invert levels of the temporary drainage works;
- b. *Mark work/buffer zones* – This involves physically marking on the ground the boundaries or work limits for the drainage works and buffer zones to confine works within prescribed works area and protect nearby sensitive receivers;
- c. *Mark storage zones* – This involves physically marking the dedicated areas reserved for stockpiling both excavated materials from the drainage works, as well as material storage areas for the construction materials and machineries;
- d. *Excavate trench* – This activity involves the excavation of the trench for forming the temporary drainage, which will generate construction waste materials from the excavation works and erosion potential, and hence requiring dewatering and stockpiling provisions;
- e. *Temporary Drainage works* – This step involves forming the temporary drainage to cater and convey runoff from the adjacent land-disturbing activities.

*Component - Temporary Roads; Activity – Road Formation:* This activity shall come after the completion of the above drainage works, which were created as a BMP to cater for runoff and sediment discharge from the temporary road works. The likely scope of work for this project activity includes the following:

- a) *Survey works* - Undertaking a comprehensive site survey to identify topography of site and to physically locate the extent of works to coincide with construction drawings;
- b) *Marking site boundaries* - Marking the boundaries to delineate the extent of the temporary road formation;

- c) *Mark work/buffer zones* – Marking the boundaries for the buffer limits or zones to avoid encroachment into areas outside of the limits, protect the nearby sensitive receivers, including trees and forested area for this example, to provide visible reminder to the workers on site to avoid venturing into these areas or damaging the environment outside of their work areas including any existing facilities in the surrounding vicinity of the project site, roads, rivers, vegetation, residences, etc;
- d) *Mark storage zones* – Marking the dedicated areas reserved for stockpiling both excavated materials from the temporary road works, as well as material storage areas for the construction materials and machineries; and
- e) *Road works* – Forming the temporary road works.

Component – Permanent Roads; Activity - Site Grading: This activity is essentially similar to the previous activity for the temporary road, except that the extent of the permanent roads shall be in accordance with the requirements prescribed by the contract drawings and specification. It should be kept in mind that the alignment and location of the Permanent Roads may or may not be similar to that utilised for the Temporary Roads. The scope of work that could be prescribed include the following:

- a) *Undertake survey* – A survey of the site should be undertaken to identify the limits of the permanent road corridor as well as its associated working spaces for the associated road furniture to be constructed such as road lighting, road barriers, sign posts, etc., and the related temporary stockpile areas;
- b) *Mark surface elevation* – This involves marking physically on site the final surface levels of the finished permanent road surface levels. Not undertaking this step may involve abortive work at the later stage, or if not rectified after the road construction, may result in defects in terms of incorrect surface runoff flows, ponding, etc.;
- c) *Mark work/buffer zones* – This covers marking of work limits and buffer zones to protect surrounding environment;
- d) *Grading works* – Upon completion of the marking activities, grading of the site will be undertaken to form the working area for the road construction. Biomass and excavated soil will be generated from this activity.

Component - Permanent Roads; Activity – Permanent Drainage: This activity should come after the site grading works, and its alignment may or may not be the same as the

previous temporary drainage alignment. The likely scope of work for this project activity includes the following:

- a. *Identify flowpath* – The flowpath for the permanent drainage must be in accordance with the prescribed contract drawings. This will involve marking on the site the required invert levels of the permanent drainage works;
- b. *Mark work/buffer zones* – This involves physically marking on the ground the boundaries or work limits for the drainage works and buffer zones to confine works within prescribed works area and protect nearby sensitive receivers;
- c. *Mark storage zones* – This involves physically marking the dedicated areas reserved for stockpiling of both excavated materials from the drainage works, as well as material storage areas for the construction materials and machineries;
- d. *Excavate trench* – This activity involves the excavation of the trench for forming the permanent drainage;
- e. *Permanent Drainage works* – This step involves constructing the permanent drainage as per the contract drawings.

Component - Permanent Roads; Activity – Road Formation: This activity may run concurrently with the permanent drainage works, but shall be after the completion of the site grading works. The likely scope of work for this project activity includes the following:

- a) *Survey works* - Undertaking a comprehensive site survey to physically locate the extent of the permanent works in strict accordance to the contract drawings;
- b) *Marking site boundaries* - Marking the boundaries to delineate the extent of the permanent road formation;
- c) *Mark work/buffer zones* – Marking the boundaries for the buffer limits or zones to avoid encroachment into areas outside of the limits, protect the nearby sensitive receivers, including trees and forested area, and to provide visible reminder to the workers on site to work within the prescribed limits so as to protect the environment and any existing

facilities in the surrounding vicinity of the project site including rivers, vegetation, residences, etc;

- d) *Mark storage zones* – Marking the dedicated areas reserved for stockpiling both excavated materials from the permanent road works, as well as material storage areas for the construction materials and machineries; and
- e) *Road works* – Construction of the permanent road works.

Component – Drainage Systems; Activity - Excavation: Excavation of the drainage systems can be one of the significant activities due to the extent (length) of work involved, basically covering the whole of the ten (10) kilometres of the new highway. If not properly controlled, the excavation works are likely to generate erosion issues culminating in discharge of eroded materials and wastewaters to the nearby environment. The scope of work for this activity includes the following:

- a) *Mark work zones* – Prior to commencement of the excavation activity, it is important to mark the required working zones and limits for the construction of the permanent drainage systems. Adequate working space to accommodate the heavy machineries that will be deployed during the digging, to implement relevant pollution prevention mitigation measures such as noise or visual barriers, dewatering facilities, silt traps, sediment ponds or settling basins, drainage, to name a few, shall be provided;
- b) *Mark buffer zones* – This involves physically marking on the ground the boundaries of the buffer zones to protect the nearby sensitive receivers during the excavation works. This marking will help to remind the workers on site to avoid carrying out their works outside of the stated limits to protect the nearby environment;
- c) *Mark storage zones* – Appropriate storage yards or dedicated zones shall be clearly marked at the site (at or in the vicinity of the excavation locations) for the temporary stockpiling of construction materials to be used for the excavation and drainage works, as well as for construction waste materials such as excavated soil and earth that are not immediately transported out of the work areas. One of the significant facilities for the excavation works includes appropriate receiving and treatment facility for wastewater generated from the excavated void during an rain event, that needs to be drained out for underground works to be undertaken;

- d) *Excavate foundation* - Undertaking the excavation works, and as mentioned above, which would generate both construction solid waste and wastewaters;
- e) *Export excavated soil* – Exporting the excavated soil or earth materials out of excavation site, as well as by-products from the treatment of the construction wastewaters.

Component – Drainage Systems; Activity – Drainage Works: This activity shall commence upon completion of the excavation works. The likely scope of work for this project activity includes the following:

- a. *Identify flowpath* - It is important for the drainage team to clearly mark physically on the site the proposed final invert levels of the finished drainage systems, as per the contract drawings;
- b. *Mark work/buffer zones* – Marking on the ground the boundaries or work limits prescribed for the drainage works, as well as for the buffer limits or zones;
- c. *Mark storage zones* – Marking on the ground the dedicated areas reserved for stockpiling both excavated materials from the drainage works, as well as material storage areas for the construction materials and machineries;
- d. *Excavate trench* - Excavation of the trench for the drainage placement. This activity is expected to generate construction waste materials from the excavation works, and once the trench is formed, possible dewatering works to maintain the trench in a dry condition to lay the drainage works.
- e. *Drainage works* – Involves laying of the drainage component and water tests.

Component – Drainage Systems; Activity – Backfilling: This activity shall commence upon completion of the drainage works installation. The likely scope of work for this project activity includes the following:

- a. *Mark storage zones* - Marking the dedicated areas reserved for stockpiling backfill materials which will be imported into the site, as well as storage areas for other construction materials and machineries;
- b. *Import Backfill* – This is more a logistical task whereby backfill materials will be imported from an outside source and transported to the works areas.

The backfill materials shall be stored and protected from the rain at the designated storage areas mentioned above;

- c. *Compaction* – Upon backfilling the trench, compaction will take place and limited erosion and sediment issues are expected from this activity.

Component – River Crossing; Activity - Site Clearance: The scope of work for this activity shall be carefully planned due to proximity of the works to residential areas as well as sensitive receivers such as the rivers or streams. Due to the nature and location of this component, the likely scope of work include the following:

- a) *Undertake survey* – Site survey to identify the locations of the permanent structures of the river crossings (or bridges). In terms of erosion and sediment, the most critical of these structures would be the foundations of the river crossings, as well as the surrounding permanent works to protect the river banks and slopes. The survey will essentially locate and mark the extent of these works as interpreted from the construction drawings;
- b) *Mark site boundary* - Marking the site boundaries of the physical structures of the river crossing such as its foundation in the form of piers or columns, or any embankments which is part of the river crossing's design, with the aim to make sure that the works team is aware of where the prescribed works area within which the structural construction is confined to, and to avoid encroachment into areas outside of the footprint of these structures;
- c) *Identify interfaces* - Identifying any potential interfaces between the proposed river crossing works and any existing facilities in the surrounding vicinity of the project site, particularly the river over which the bridge will cross;
- d) *Identify clearance extent* - Identifying the extent of site clearance required as per the construction drawings and/or per construction methodology, for example to cater for working space, access, etc.; and
- e) *Clearing works* - Undertaking the clearing works to facilitate the construction of the bridge piers, embankment and other permanent works at or near the river. This scope may include felling of existing trees and removal of large vegetation. For this component, this activity would be another land disturbance activity that may potentially result in erosion and sediment being discharged to the nearby river. During this scope of work, ground surfaces will now be cleared of their surface protection (cover crops) and be exposed to the elements of the weather. If left to be eroded

indiscriminately, it is anticipated that loose sediment would be carried off from the site via surface runoff.

Component – River Crossing; Activity – Foundation Works: Under this activity and viewing the process of this foundation work from a simplified perspective, the scope of work for this activity includes the following:

- a) *Mark work zones* – It is important to mark the required working zones and limits for the construction of the foundation works, noting that adequate working space for other ancillary activities other than the physical column sizes shall be allowed. This allows space to accommodate the heavy machineries that will be deployed during the excavation, and also space to implement the relevant pollution prevention mitigation measures;
- b) *Mark storage zones* – Appropriate storage yards or dedicated zones should be clearly marked at the site for the temporary stockpiling of construction materials to be used for the excavation works, as well as for construction waste materials such as excavated soil and earth that are not immediately transported out of the work areas.
- c) *Mark work/buffer zones* – Marking on the ground the boundaries or work limits prescribed for the foundation works, as well as for the buffer limits or zones to protect all necessary sensitive receivers;
- d) *Excavate foundation* - Excavation of the foundation is expected to generate construction waste materials that shall be stored properly as well as requiring dewatering works to maintain the excavated pit to be in a dry condition to construct the foundation;
- e) *Formwork, steelwork, concrete pour* - Limited land disturbing activities would be involved during the above works, except for the need to identify proper areas for stockpiling and storing the construction materials needed for the works and construction wastes generated from these scopes of work.

Component – River Crossing; Activity – Elevated Structures: The scope of work for this activity has been formulated to simply include the following works: *formwork; steelwork; concrete pour; and formwork removal*. As the scope of work has suggested, there are limited land disturbance activities that would be involved during the above works, except for the need to identify proper areas for stockpiling and storing the construction materials needed for the works and construction wastes generated from these scopes of work.

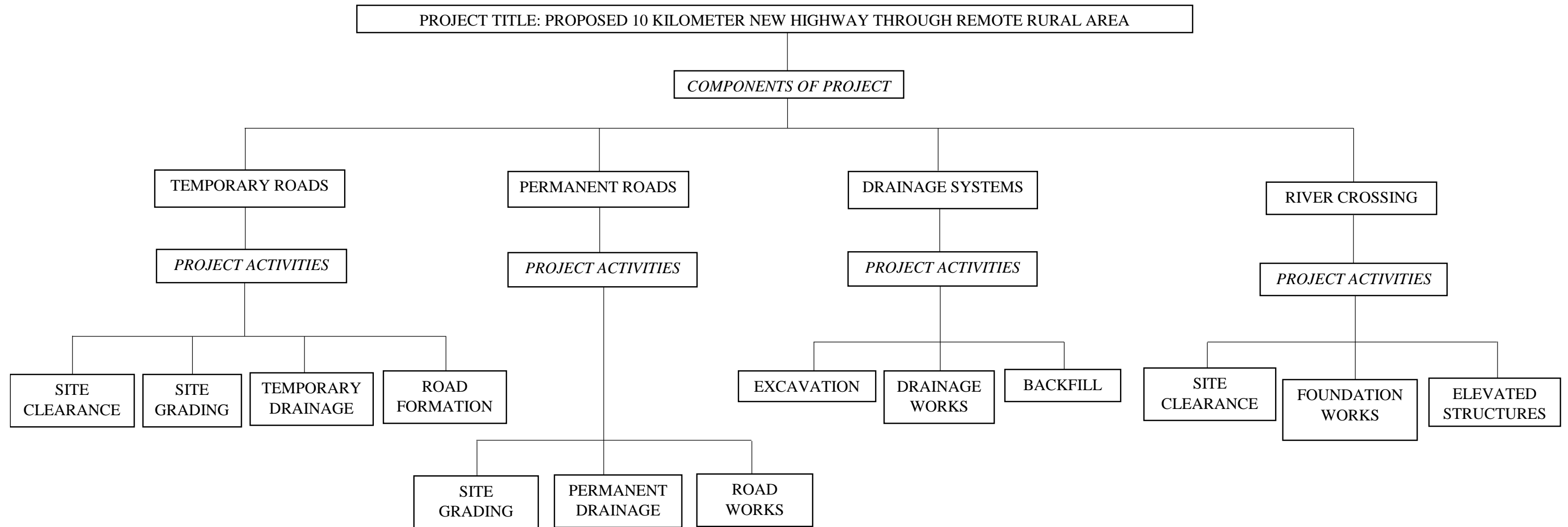


Figure 4.36: Possible Project Activities of a Highway Project

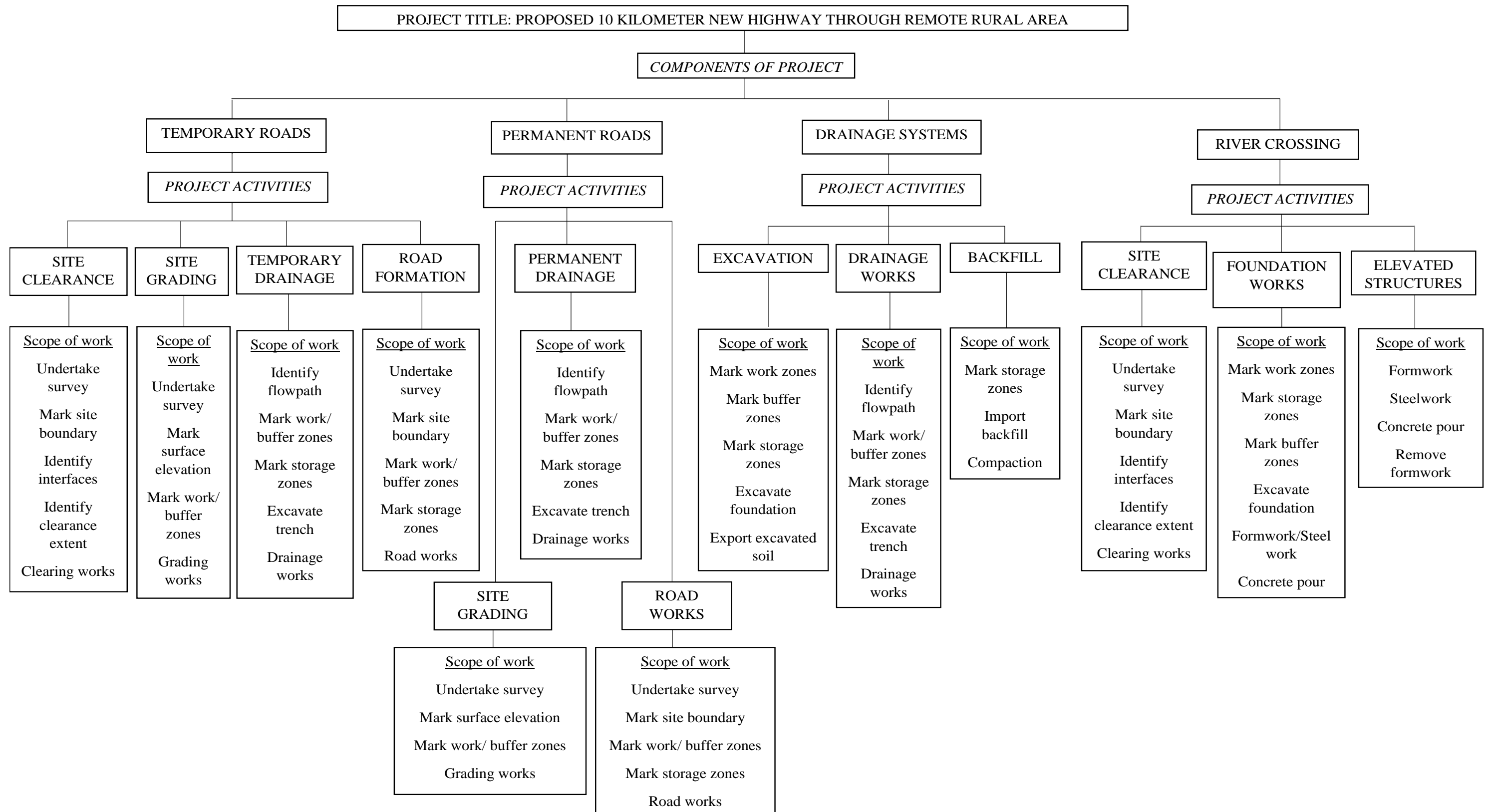


Figure 4.37: Identification of Possible Scope of Work of Highway Project

#### 4.7.4 Example 3 – Proposed Housing Development Project

If a comparison is made between the project components for this housing development example with the preceding two projects, one will start to see a close similarity between these projects, in terms of the project components, although the end deliverables of each project are significantly different. This can also be taken to mean that regardless of the nature of a major civil engineering project, the pre-construction activities which mainly involve land disturbing activities are basically quite similar when compared to other projects except for certain site specific conditions. In this regard, let's review the possible project activities that could be identified for this housing project as illustrated in **Figure 4.24**. As discussed previously, the associated project components for this example consist of namely *Forest Clearance, Roads, Drainage, Buildings* and *Pumphouse/STW*. Following on, we can then identify the possible project activities for each component as shown in **Figure 4.38**:

a) Component 1 – Forest Clearance

The potential activities include the following:

- Site Clearance
- Temporary Roads

b) Component 2 - Roads

For this project component, the potential activities include the following:

- Site Grading
- Roadworks
- Drainage

c) Component 3 – Drainage

The project activities associated with this component include:

- Excavation
- Drainage works
- Backfill

d) Component 4 – Buildings

For this project component, the potential activities include the following:

- Site Clearance
- Excavation
- Foundation

e) Component 5 – Pumphouse/STW

For this project component, the potential activities include the following:

- Site Clearance
- Excavation
- Foundation

Again, a simple comparison of the above project activities with those described for the STW and Highway examples reveals much similarities. To avoid repetitions, the corresponding *scope of work* for each of the project activities will only be listed below without detailed elaboration, except for those scopes of work which were not covered previously above.

Component – Forest Clearance; Activity - Site Clearance: Typical scope of work includes:

- Undertake survey*
- Mark site boundary*
- Identify interfaces*
- Identify clearance extent*
- Clearing works*

Component – Forest Clearance; Activity – Temporary Roads: Typical scope of work includes:

- Undertake survey*
- Mark site boundary*
- Mark work/buffer zones*
- Mark storage zones*
- Roadworks*

Component – Roads; Activity – Site Grading: Typical scope of work includes:

- Undertake survey*
- Mark surface elevation*
- Mark work/buffer zones*
- Grading works*

Component – Roads; Activity – Roadworks: Typical scope of work includes:

- Undertake survey*
- Mark site boundary*
- Mark work/buffer zones*
- Mark storage zones*
- Roadworks*

Component – Roads; Activity – Drainage: Typical scope of work includes:

- Identify flowpath*

- b) *Mark work/buffer zones*
- c) *Mark storage zones*
- d) *Excavate trench*
- e) *Drainage works*

Component – Drainage; Activity – Excavation: Typical scope of work includes:

- a) *Mark work zones*
- b) *Mark buffer zones*
- c) *Mark storage zones*
- d) *Excavate foundation*
- e) *Export excavated soil*

Component – Drainage; Activity – Drainage works: Typical scope of work includes:

- a) *Identify flowpath*
- b) *Mark work/buffer zones*
- c) *Mark storage zones*
- d) *Excavate trench*
- e) *Drainage works*

Component – Drainage; Activity – Backfill: Typical scope of work includes:

- a) *Mark storage zones*
- b) *Import backfill*
- c) *Compaction*

Component – Buildings; Activity - Site Clearance: Typical scope of work includes:

- a) *Undertake survey*
- b) *Mark site boundary*
- c) *Identify interfaces*
- d) *Identify clearance extent*
- e) *Clearing works*

Component – Buildings; Activity - Excavation: Typical scope of work includes:

- a) *Mark work zones*
- b) *Mark buffer zones*
- c) *Mark storage zones*
- d) *Excavate foundation*
- e) *Export excavated soil*

Component – Buildings; Activity - Foundation: Typical scope of work includes:

- a) *Mark work zones*
- b) *Mark storage zones*

- c) *Mark buffer zones*
- d) *Excavate foundation*
- e) *Formwork/Steelwork*
- f) *Concrete pour*

Coincidentally, the project activities and scope of work for the *Component – Pumphouse/STW* are the same as the preceding component; therefore, the list is not repeated here.

The overall scope of work for all the project components and activities is illustrated in **Figure 4.39**.

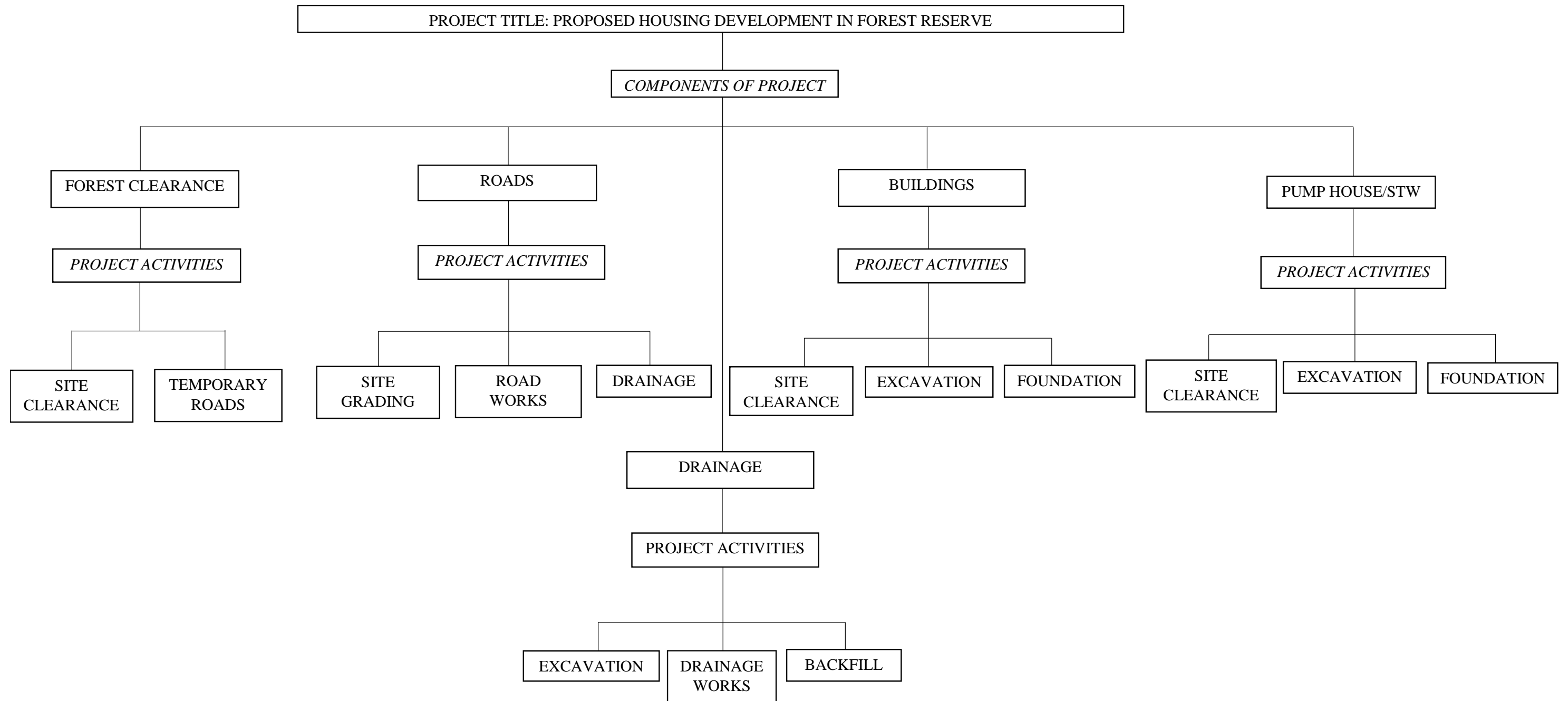


Figure 4.38: Possible Project Activities of a Housing Development Project

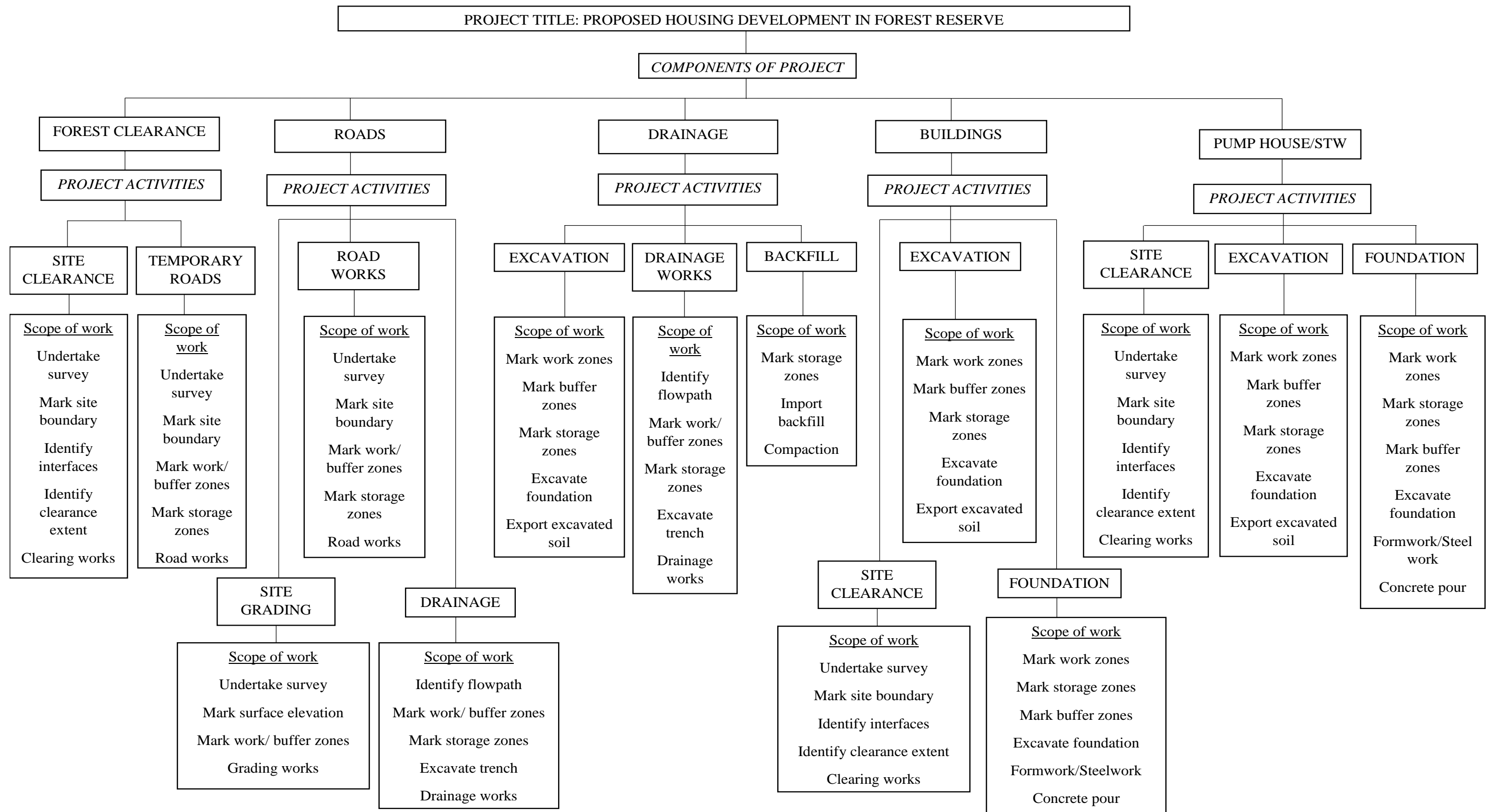


Figure 4.39: Possible Scope of Work of a Housing Development

#### 4.7.5 Example 4 – Proposed Main Drainage Project

For the proposed project layout as indicated in **Figure 4.27** for this main drainage development, the key project components have been previously identified to be *trenching; roads; drainage;* and *pump house*, with possible land disturbing activities comprising the following:

- *Land clearing*
- *Excavation works*
- *Cut and fill for slope formation*
- *Stockpiling of earthwork materials*
- *Dewatering of trench*
- *Earthworks for land formation*
- *Roadworks and drainage;*and
- *Backfilling*

Again, the project activities associated with their relevant components for this example project are quite similar to the previous examples already discussed in the above sections, and are listed in **Table 4.1** below:

**Table 4.1: Project Activities for Main Drainage Project**

<b>Project Component</b>	<b>Project Activities</b>
1. Trenching	Site Clearance Road Diversion Excavation Backfill
2. Roads	Site Grading Roadworks Road Drainage
3. Drainage	Excavation Drainage Works Backfill
4. Pump house	Site Clearance Excavation Concreting

Description of the scope of work for nearly all of the project activities listed in the above table has previously been discussed for the earlier example projects, except for the activity “Road Diversion”. As seen in **Figure 4.27**, the new main drainage consisting of 1500mm x 1500mm box culvert is proposed to be laid below an existing 4.5m wide road, which is currently a “live road”. To facilitate the drainage works, some form of traffic diversion

will be needed, either to reduce the road capacity by temporary suspending the use of 1 lane to facilitate construction, or to build a temporary road diversion on the shoulder of the existing road. For the latter option, which is the assumed mode of road diversion adopted for this example, land disturbing activities will be involved during the construction of the temporary road. In this regard, the scope of work for this particular project activity includes:

- a) *Undertake survey*
- b) *Mark site boundary*
- c) *Mark work/buffer zones*
- d) *Mark storage zones*
- e) *Roadworks*

The overall scope of work for all the project components and activities for this example project is illustrated in **Figure 4.41**.

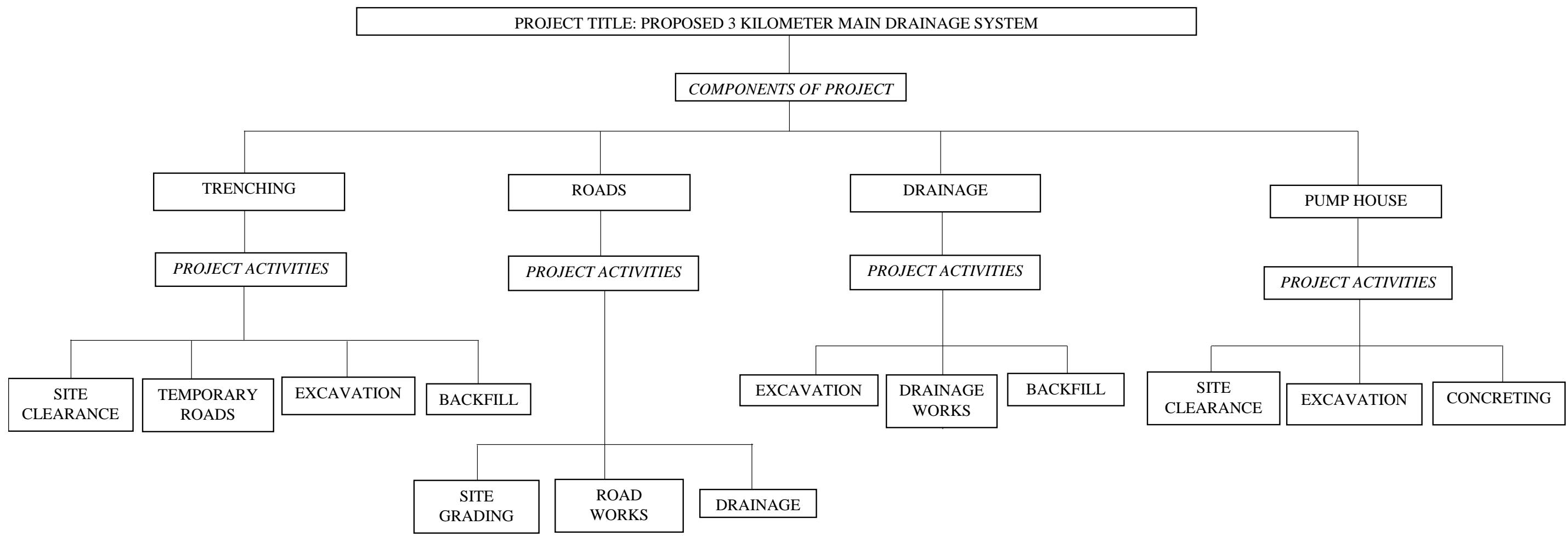
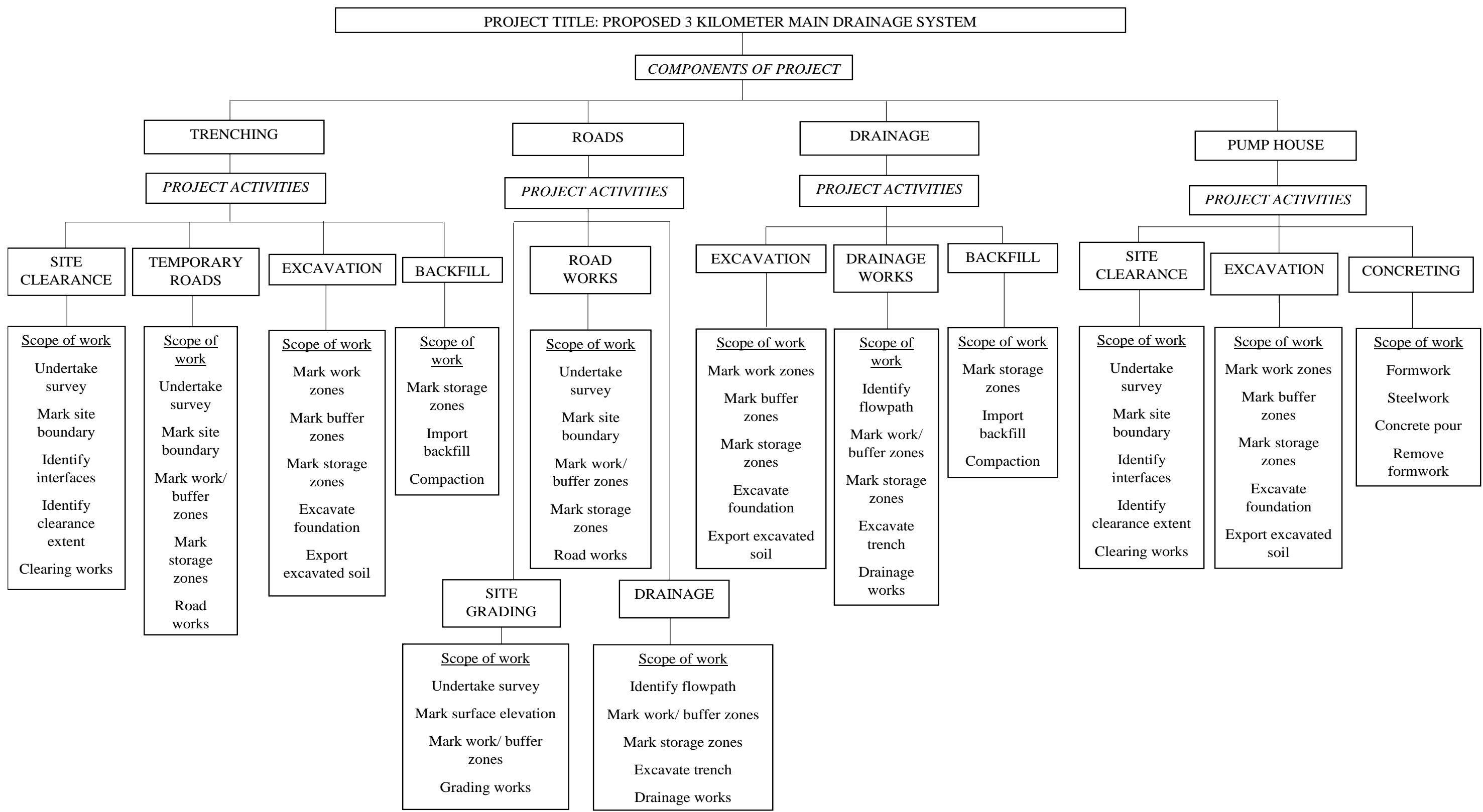


Figure 4.40: Possible Project Activities of a Main Drainage Project



**Figure 4.41: Possible Scope of Work of a Main Drainage Project**

#### 4.7.6 Example 5 – Proposed River Check Dam Project

A river check dam is typically provided for various reasons, including for a water supply source (for irrigation, potable use, etc), for small scale power generation facilities, or for application of some form of physical treatment to the water (e.g., sediment removal). Regardless of the purposes for creating a river check dam, the major civil engineering processes that would be involved in the check dam creation normally consist of:

- Formation of a new temporary channel to divert existing river flow from the proposed check dam site location;
- Formation of upstream and downstream cofferdam or barriers to keep check dam works site in a dry working condition;
- Diversion of main river flow to temporary channel;
- Excavation of main river (now in a dry condition) to formation level;
- Construction of check dam;
- Removal of cofferdams / barriers to redivert river flow into original alignment; and
- Rehabilitation of defunct diversion channel.

In view of the above, a possible breakdown of the project components of a river check dam project can include: *river works* and *dam structures*, and the associated land disturbing activities that need to be adequately controlled and protected against the elements of erosion and sedimentation can be identified as follows:

- *Land clearing*
- *Excavation of diversion channel*
- *Protection of channel bed, slopes and bank*
- *Stockpiling of earthwork materials*
- *Excavation of river bed for dam foundations*
- *Dewatering, and*
- *Concreting*

The project activities associated with their relevant components for this example project are listed in **Table 4.2**:

**Table 4.2: Project Activities for River Check Dam Project**

<b>Project Component</b>	<b>Project Activities</b>
1. River Works	Site Clearance River Crossing Excavation Diversion Works
2. Dam Structures	Excavation Roadworks Drainage Foundation Concreting

Except for the activity “Diversion Works”, description of the scope of work for the other project activities listed in the above table has previously been discussed. In simple terms, the creation of a diversion channel comprises excavating a new trench or channel on the adjacent ground next to the existing river, with the alignment of the diversion channel more or less being parallel to the section of the existing river where works will take place. At the upstream and downstream ends of the connections (or diversion) points between the existing river and the new channel, cofferdams will be built to act as separator between these two watercourses. Essentially, once the “diversion” has been made, the diversion channel will act as if the existing river is still there, but in fact, that section of the existing river is actually now dry to allow construction works to take place. Once the check dam or any other intended works are completed in the dry river section, the river flow from the diversion channel will then be diverted back to the original river alignment, and the temporary channel will be backfill to ground level followed by removal of the cofferdams. In this regard, the scope of work for this particular project activity includes:

- a) *Mark work zones*
- b) *Mark buffer zones*
- c) *Create diversion*

The overall scope of work for all the project components and activities for this example project is illustrated in **Figure 4.43**.

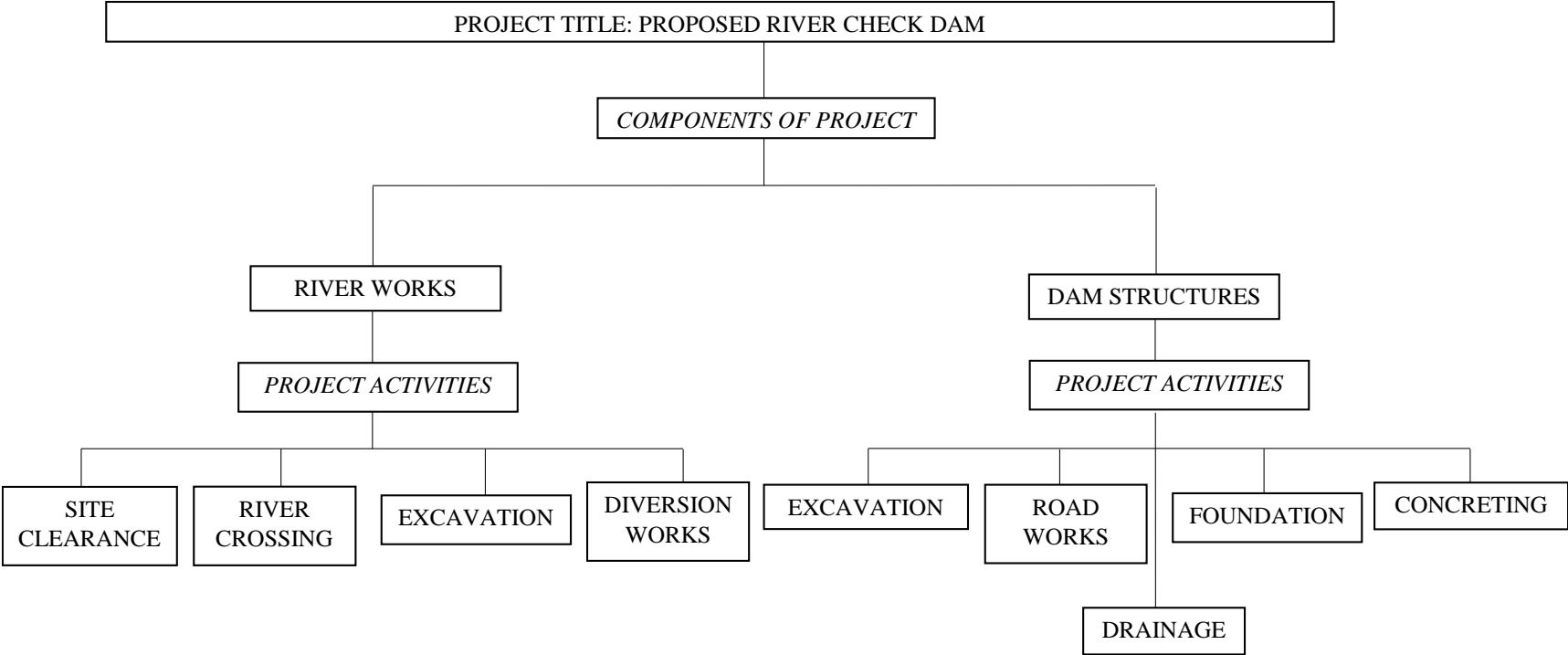


Figure 4.42: Possible Project Activities of a River Check Dam Project

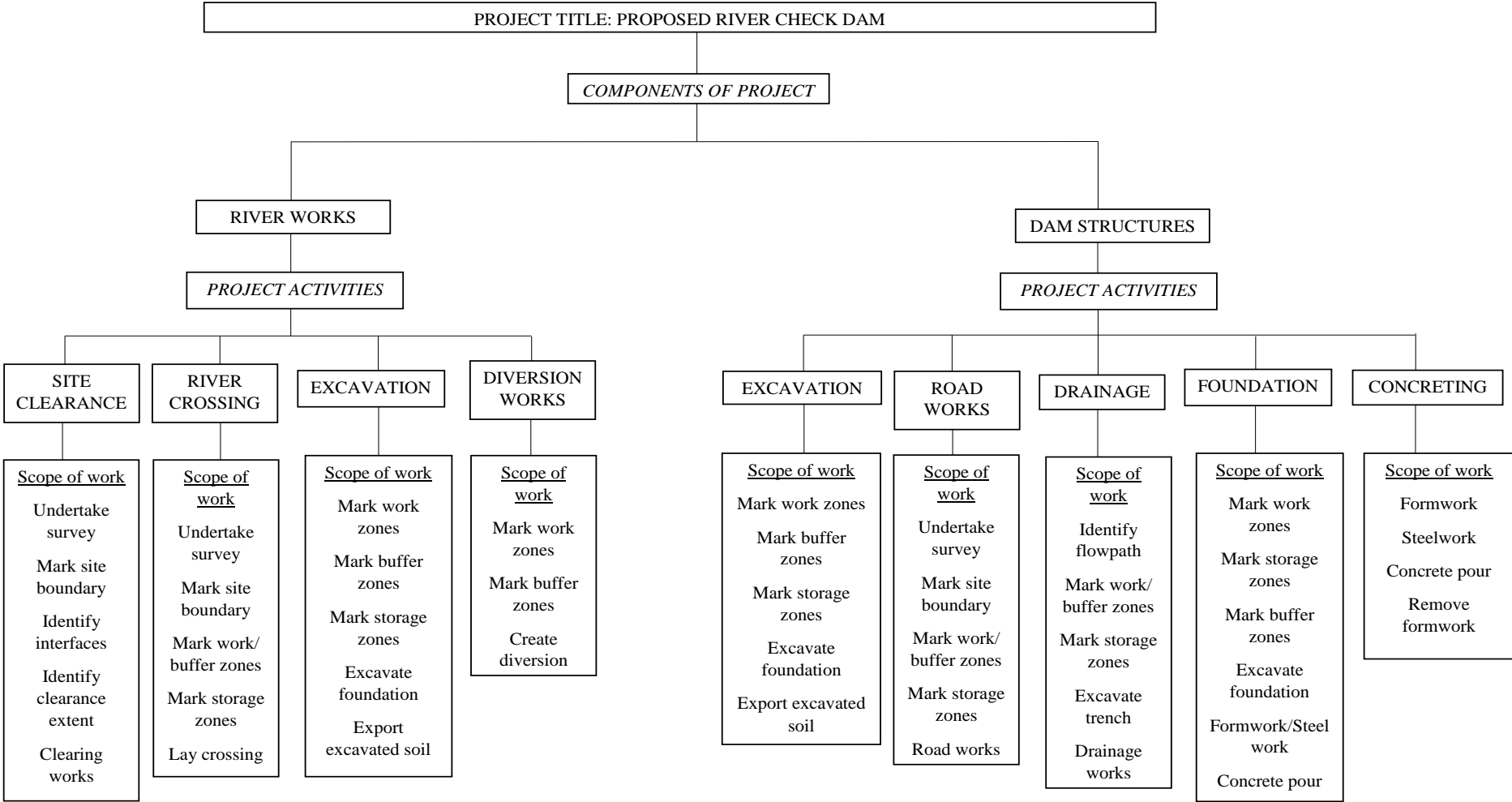


Figure 4.43: Possible Scope of Work of a River Check Dam Project

#### 4.7.7 Example 6 – Proposed Forest Redevelopment Project

A forest redevelopment project typically involves the harvesting of an existing forest for the valuable timber and upon completion of the logging activities, the remaining forested area will be completely cleared to prepare the site for plantation of dedicated seeds (oil palm, rubber trees, etc). The typical components for such type of project can be broken down to include earthworks, civil works and horticultural works, with the following associated land disturbing activities that need to be adequately controlled and protected against the elements of erosion and sedimentation:

- *Forest clearing*
- *Stockpiling of biomass*
- *Earthworks consisting of cutting and filling for slope and land formation*
- *Stockpiling of earthwork materials*
- *Exposing ground surfaces for temporary and permanent access road formation, excavation for road foundations*
- *Roadwork including utility trenches, pavements, laying of road structures, river diversion, river bank protection, excavation for crossings foundation, culvert placement*
- *Excavation for drainage*

The project activities for this example project are listed in **Table 4.3** below:

**Table 4.3: Project Activities for Forest Redevelopment Project**

<b>Project Component</b>	<b>Project Activities</b>
1. Forest Clearing	Site Clearance Temporary Roads Field Establishment
2. Roads	Site Grading Roadworks
3. Drainage	Excavation Drainage Backfill

The overall scope of work for this example project is illustrated in **Figure 4.45**.

#### 4.7.8 Summary

The term “project activities” is taken to mean the *specific tasks needed to be done in order to produce the project's deliverables* in project management,

but can also be applied to the topic of erosion and sediment control by identifying the related project activities and their associated *scope of work* following the identification of the *project components*.

The identification of project activities and scope of work for a particular component is underlined by the notion of “looking at the big picture” or “taking a bird’s eye view” of the tasks needed to achieve or produce the project components, and not be bogged down by the details or intricacy of the technology involved. Always remember that the focus of the activities or scope identification is always on those actions that would result in erosion and sediment issues.

It was shown in the few examples that regardless of the nature of a major civil engineering project, the pre-construction activities which mainly involve land disturbing activities are basically quite similar when compared to other projects except for certain site specific conditions. The key point to remember during the breaking down or identifying these activities and/or scope of work is that the purpose is to establish these project activities particularly to those relating to land disturbing activities so that suitable environmental method statements can subsequently be developed.

Again, it should be stressed that the key objective of these identification is not to dictate or define the methodology on how the Contractor should carry out his works, but more so for assisting his project team to be aware of those activities that would typically alter a stable site condition into one where the rate of erosion and sedimentation becomes accelerated (as compared to the natural process), to the extent that such alterations of the natural conditions are likely to pollute the downstream sensitive receivers such as rivers or water intakes.

The task of attempting to identify the project activities may be conceived by a LD-P2M2 practitioner to be a challenging one, especially if the practitioner has not received any formal educational training in civil engineering or has limited experience in civil engineering construction projects. However, it is fair to note that even without the above two “qualifications”, it is imperative that anyone who is involved in the field of erosion and sedimentation ought to have some basic understanding of the process within a construction project, to be able to reasonably predict the potential cause and source of these two phenomena so as to adequately mitigate against their occurrence. The simple rule to remember is this: the key purpose of this *Guidelines* of going through with these identification exercises is that we are not trying to override the way

on how the Contractor executes his project, but rather to highlight to the attention of the Project Proponent and his Contractor on the “where” and “when” and “how” erosion and sedimentation may occur from their particular project site, so that early attention could be given by these parties on the resources required and the measures to be implemented prior to the actual physical works. The important thing to note is that the WBS and associated project activities have adequately covered the major land disturbance activities that would be involved for those particular project components, and this should be a relatively easier task to undertake.

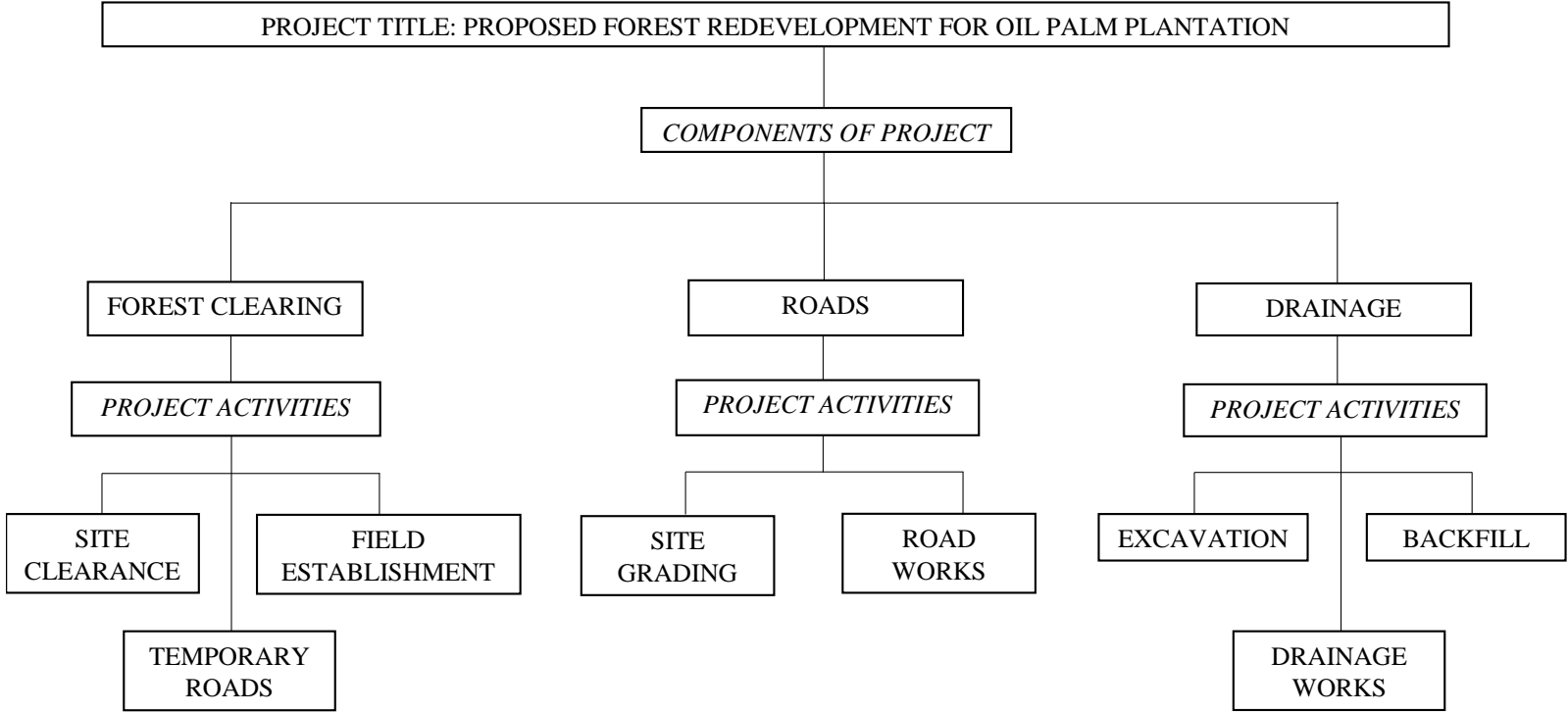


Figure 4.44: Possible Project Activities of a Forest Redevelopment Project

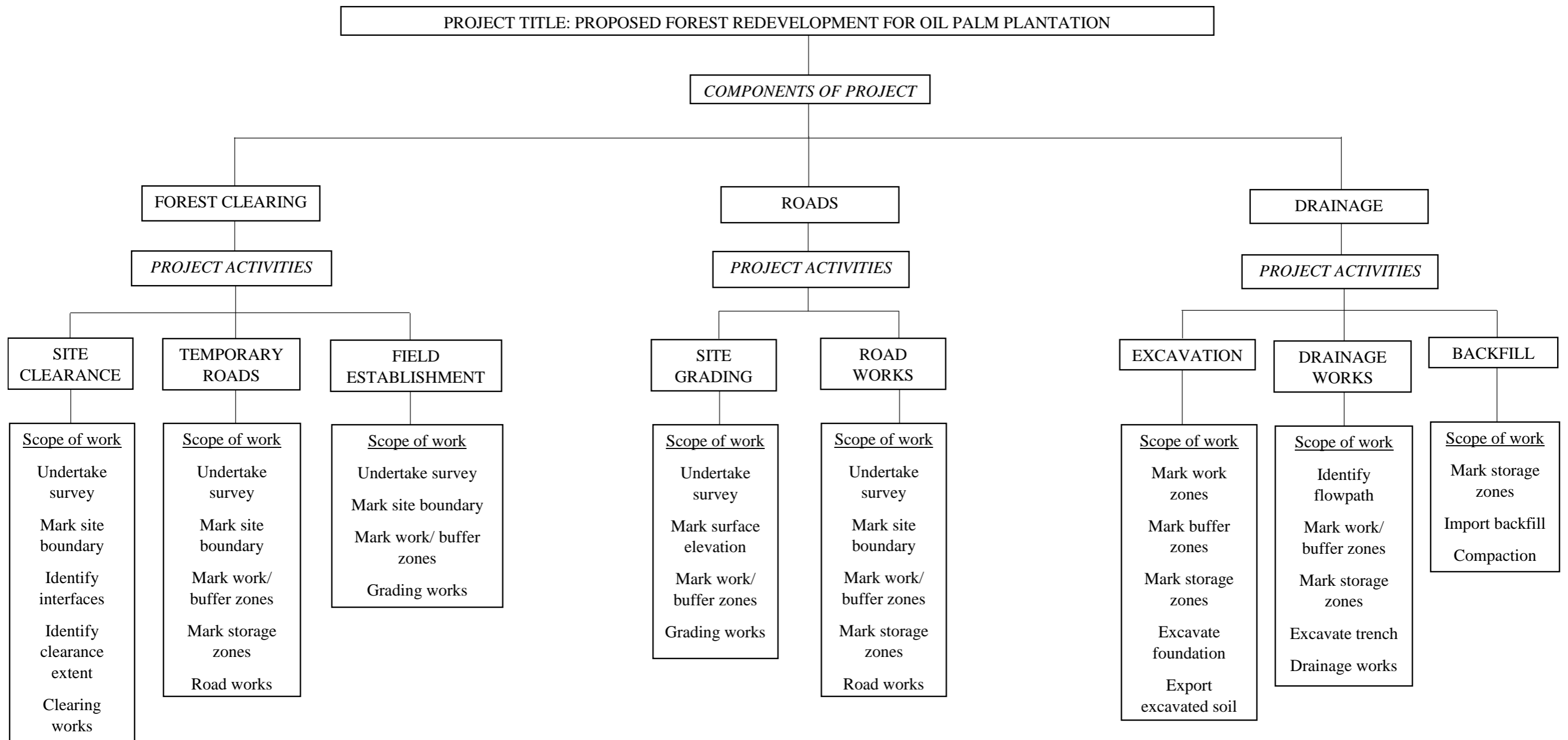


Figure 4.45: Possible Scope of Work of a Forest Redevelopment Project

## 4.8 IDENTIFYING ENVIRONMENTAL METHOD STATEMENTS

### 4.8.1 Application to this Guidelines

A “Method Statement” is typically a prescriptive document that lays out the roadmap or detailed step-by-step procedures completing or undertaking a task. In the context of this Guidelines, the method statement refers to “*Environmental Method Statement*” (EMS) that details how, what, where, why, and when the elements of environmental protection or P2M2s will be integrated and implemented into each of the land disturbing activities that may cause the discharge of pollutants, particularly suspended solids.

For each of the WBS formulated for the preceding six example projects, the associated EMS for the identified project activities are listed in the following **Figures 4.46 to 4.51**. As can be seen from these figures, the attention given by these EMS is not on the “technical knowhow” on how to do the work, but rather on the pollution prevention and mitigation measures that shall be implemented during the undertaking of the scope of work for that particular project activity.

Based on the example STW Project, the respective environmental method statements for the various project activities identified in the preceding section are listed below.

**Table 4.4: List of EMS for STW Project**

<p><b>PROJECT ACTIVITY:</b> <b><u>SITE CLEARANCE</u></b></p> <ul style="list-style-type: none"> <li>➤ Identify sensitive receivers</li> <li>➤ Identify/mark perimeter controls</li> <li>➤ Identify/mark environmental buffer zones</li> <li>➤ Identify limits of works, 100m clearance</li> <li>➤ Identify stockpile locations</li> <li>➤ Mark BMPs on drawings:               <ul style="list-style-type: none"> <li>- Perimeter drainage along site boundary</li> <li>- Entrance controls for vehicles</li> <li>- Boundary for environmental buffer</li> </ul> </li> </ul>	<p><b>PROJECT ACTIVITY:</b> <b><u>SITE GRADING</u></b></p> <ul style="list-style-type: none"> <li>➤ Identify/mark perimeter controls</li> <li>➤ Identify/mark environmental buffer zones</li> <li>➤ Identify limits of works, 100m clearance</li> <li>➤ Identify stockpile locations</li> <li>➤ Mark BMPs on drawings:               <ul style="list-style-type: none"> <li>- Perimeter drainage along site boundary</li> <li>- Boundary for environmental buffer zones</li> <li>- Location of silt fences</li> <li>- Indicate limits of works</li> <li>- Indicate type/extent of erosion</li> </ul> </li> </ul>
--	--

<p>zones</p> <ul style="list-style-type: none"> <li>- Location of silt fences</li> <li>- Indicate limits of works</li> <li>- Indicate type/extent of erosion controls</li> <li>- Mark temporary drainage</li> <li>- Indicate silt traps location</li> </ul> <p>➤ Add Construction Notes</p>	<p>controls</p> <ul style="list-style-type: none"> <li>- Mark temporary drainage</li> <li>- Indicate silt traps/sediment ponds</li> </ul> <p>➤ Add Construction Notes</p>
<p><b>PROJECT ACTIVITY:</b> <b><u>DRAINAGE</u></b></p> <ul style="list-style-type: none"> <li>➤ Identify dewatering discharge location</li> <li>➤ Identify/mark perimeter controls</li> <li>➤ Identify/mark environmental buffer zones</li> <li>➤ Identify limits of works, 100m clearance</li> <li>➤ Identify stockpile locations</li> <li>➤ Mark BMPs on drawings: <ul style="list-style-type: none"> <li>- Boundary for environmental buffer zones</li> <li>- Location of sediment pond location</li> <li>- Indicate limits of works</li> <li>- Indicate type/extent of erosion controls</li> </ul> </li> <li>➤ Add Construction Notes</li> </ul>	<p><b>PROJECT ACTIVITY:</b> <b><u>BOREHOLE DRILLING</u></b></p> <ul style="list-style-type: none"> <li>➤ Identify dewatering discharge location</li> <li>➤ Identify/mark perimeter controls</li> <li>➤ Identify/mark environmental buffer zones</li> <li>➤ Identify limits of works, 100m clearance</li> <li>➤ Identify stockpile locations</li> <li>➤ Mark BMPs on drawings: <ul style="list-style-type: none"> <li>- Boundary for environmental buffer zones</li> <li>- Location of silt fences</li> <li>- Location of sediment pond location</li> <li>- Indicate limits of works</li> <li>- Indicate type/extent of erosion controls</li> </ul> </li> <li>➤ Add Construction Notes</li> </ul>
<p><b>PROJECT ACTIVITY:</b> <b><u>ELEVATED STRUCTURES</u></b></p> <ul style="list-style-type: none"> <li>➤ Identify limits of works, 100m clearance</li> <li>➤ Identify stockpile locations</li> <li>➤ Mark BMPs on drawings: <ul style="list-style-type: none"> <li>- Perimeter drainage along site boundary</li> <li>- Location of silt fences</li> <li>- Indicate limits of works</li> <li>- Indicate stockpile location</li> <li>- Mark temporary drainage</li> <li>- Indicate silt traps location</li> </ul> </li> </ul>	<p><b>PROJECT ACTIVITY:</b> <b><u>EXCAVATION</u></b></p> <ul style="list-style-type: none"> <li>➤ Identify dewatering discharge location</li> <li>➤ Identify/mark perimeter controls</li> <li>➤ Identify/mark environmental buffer zones</li> <li>➤ Identify limits of works, 100m clearance</li> <li>➤ Identify stockpile locations</li> <li>➤ Mark BMPs on drawings: <ul style="list-style-type: none"> <li>- Boundary for environmental buffer zones</li> </ul> </li> </ul>

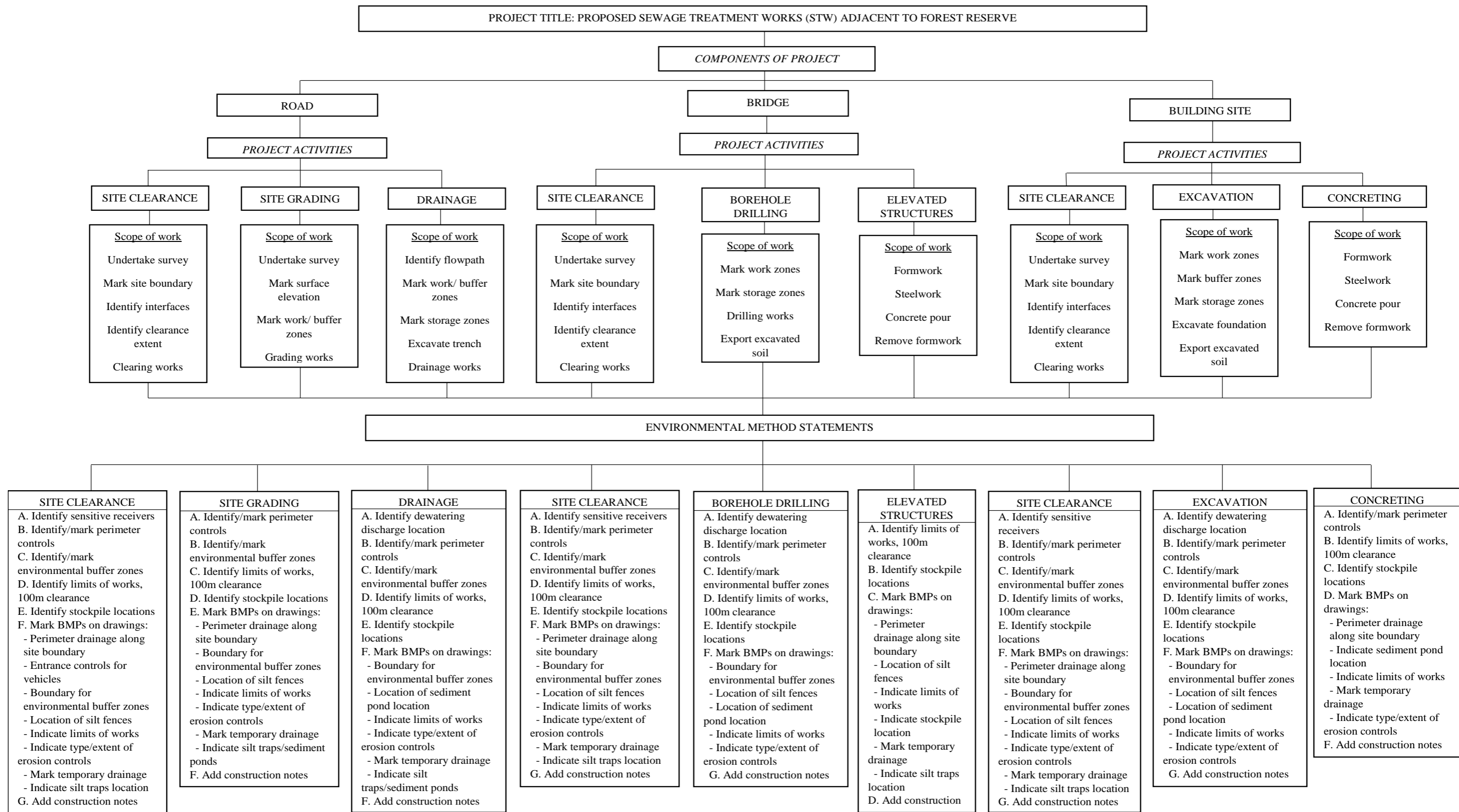
<ul style="list-style-type: none"> <li>➤ Add Construction Notes</li> </ul>	<ul style="list-style-type: none"> <li>- Location of silt fences</li> <li>- Location of sediment pond location</li> <li>- Indicate limits of works</li> <li>- Indicate type/extent of erosion controls</li> <li>➤ Add Construction Notes</li> </ul>
<p><b>PROJECT ACTIVITY:</b> <b><u>CONCRETING</u></b></p> <ul style="list-style-type: none"> <li>➤ Identify/mark perimeter controls</li> <li>➤ Identify limits of works, 100m clearance</li> <li>➤ Identify stockpile locations</li> <li>➤ Mark BMPs on drawings: <ul style="list-style-type: none"> <li>- Perimeter drainage along site boundary</li> <li>- Indicate sediment pond location</li> <li>- Indicate limits of works</li> <li>- Mark temporary drainage</li> <li>- Indicate type/extent of erosion controls</li> </ul> </li> <li>➤ Add Construction Notes</li> </ul>	

As seen from the above table, one may wonder why the majority of the EMS listed above is quite similar to one another even though the EMS are dedicated for different project activities. The answer is really quite straightforward, and it is because the sole objective of these EMS is to control erosion and sediment issues due to these land disturbing activities. As such, if the basic principles of LD-P2M2 are applied diligently into each of the land disturbing activities, it is not surprising then to see a set of the environmental method statements being reapplied from one project activity to another, all for the sake of achieving the same goal: to minimise (or prevent if possible) the impacts of erosion and sediment from these activities.

The basic principles of LD-P2M2 are discussed and elaborated in the other Chapters of this Guidelines, but are listed below again in view of their importance:

- ❖ Integrate project design with site constraints.
- ❖ Preserve and stabilize drainage ways.
- ❖ Minimize the extent and duration of disturbance.
- ❖ Control runoff flows onto, through and from the site in stable drainage structures.
- ❖ Install perimeter controls.
- ❖ Stabilize disturbed areas promptly in a timely manner.
- ❖ Protect steep slopes.
- ❖ Use sediment controls to prevent off-site damage.
- ❖ Protect inlets, storm drain outfalls, and culverts.
- ❖ Provide access and general construction controls.
- ❖ Inspect and maintain best management practices and control measures.
- ❖ Employ experienced and competent personnel and consistently conduct relevant training.

The above EMS has been formulated specifically for the various project activities that were identified in the example projects for illustration purposes. EMS can also be formulated generically to target each of the land disturbing activities which were discussed in **Chapter 3** and these are included in the Appendix.



**Figure 4.46: Environmental Method Statements for STW Project**

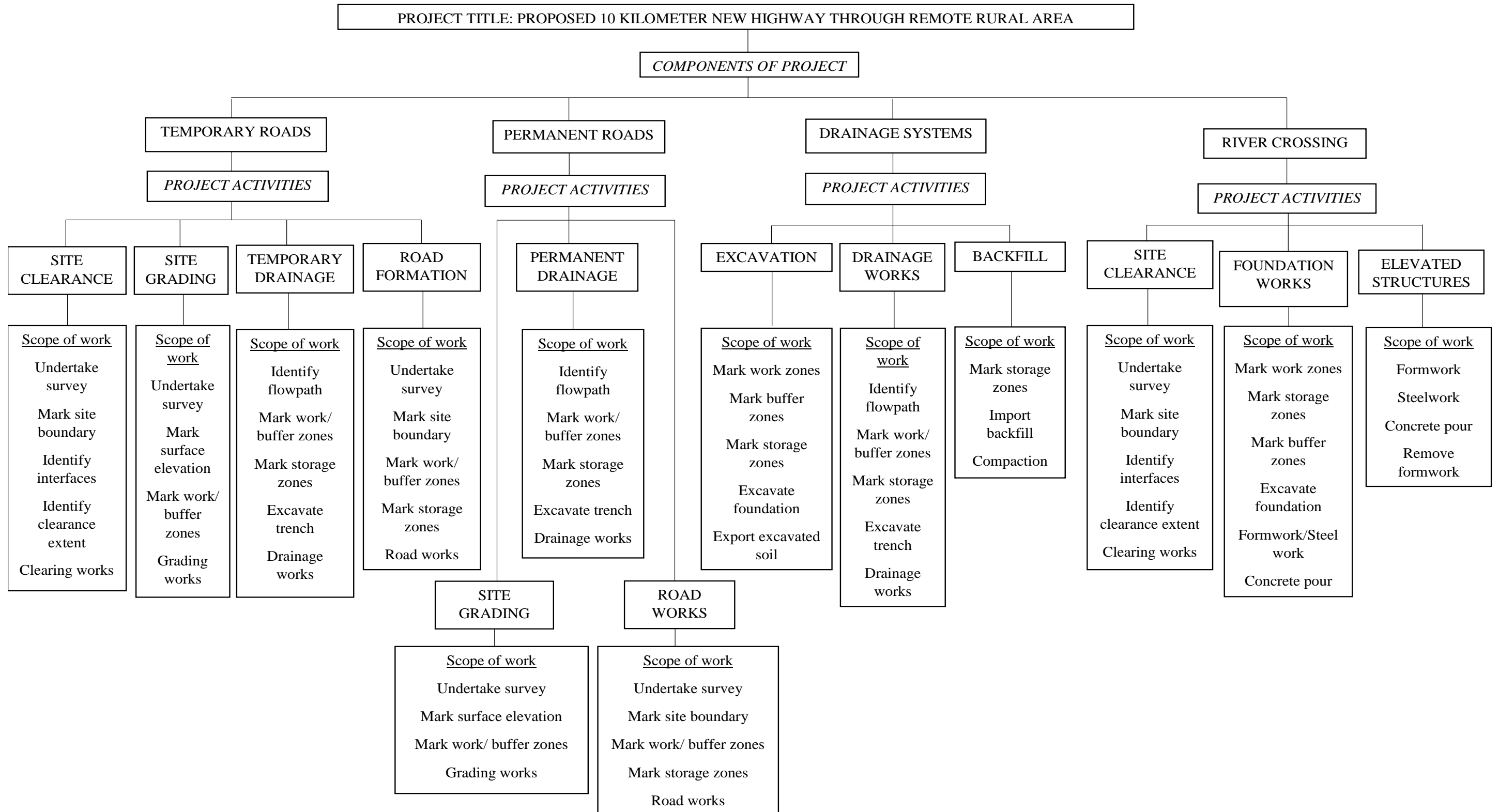


Figure 4.47: Environmental Method Statements for Highway Project

PROJECT TITLE: PROPOSED 10 KILOMETER NEW HIGHWAY THROUGH REMOTE RURAL AREA

ENVIRONMENTAL METHOD STATEMENTS

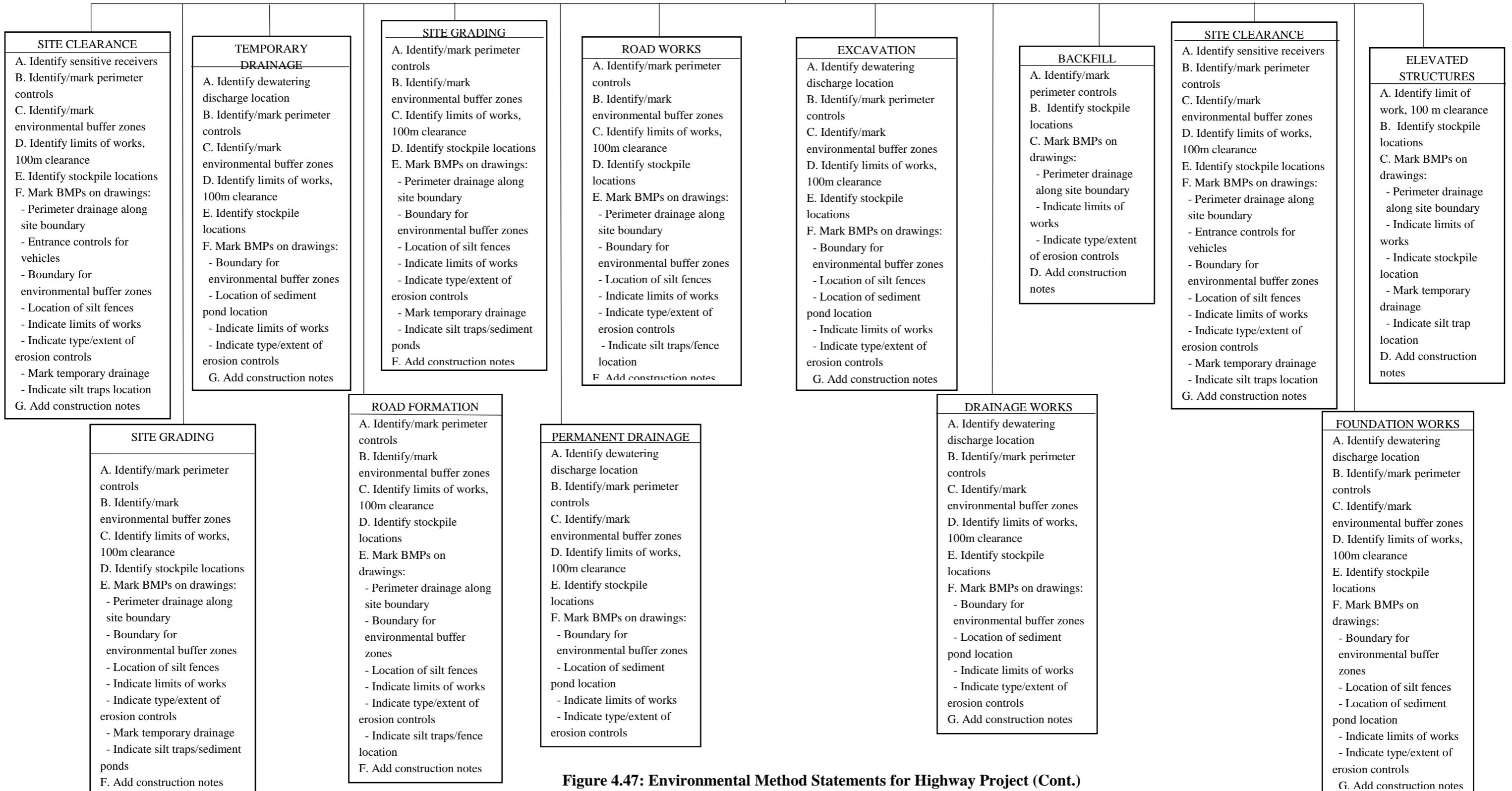


Figure 4.47: Environmental Method Statements for Highway Project (Cont.)

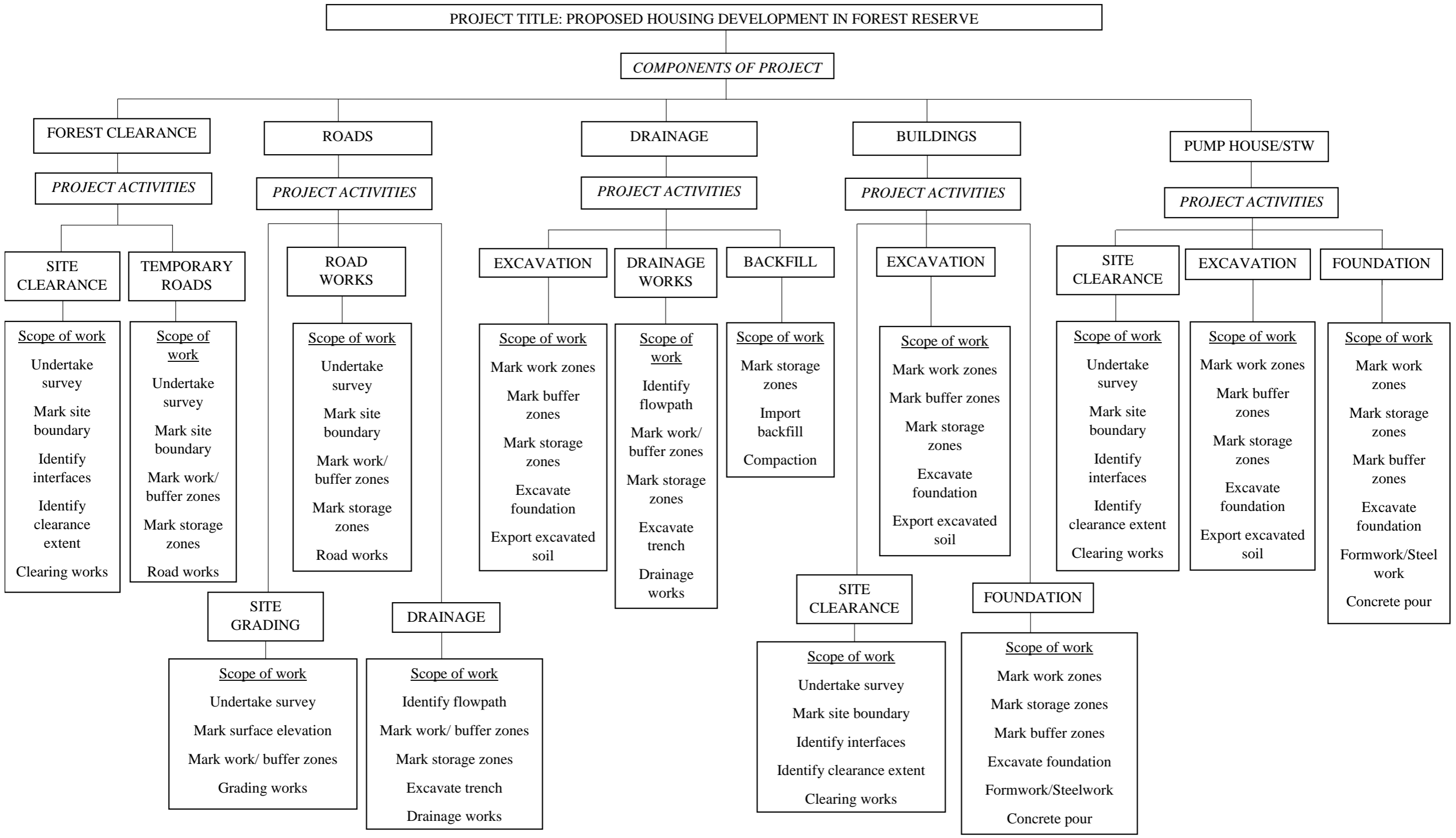


Figure 4.48: Environmental Method Statements for Housing Project

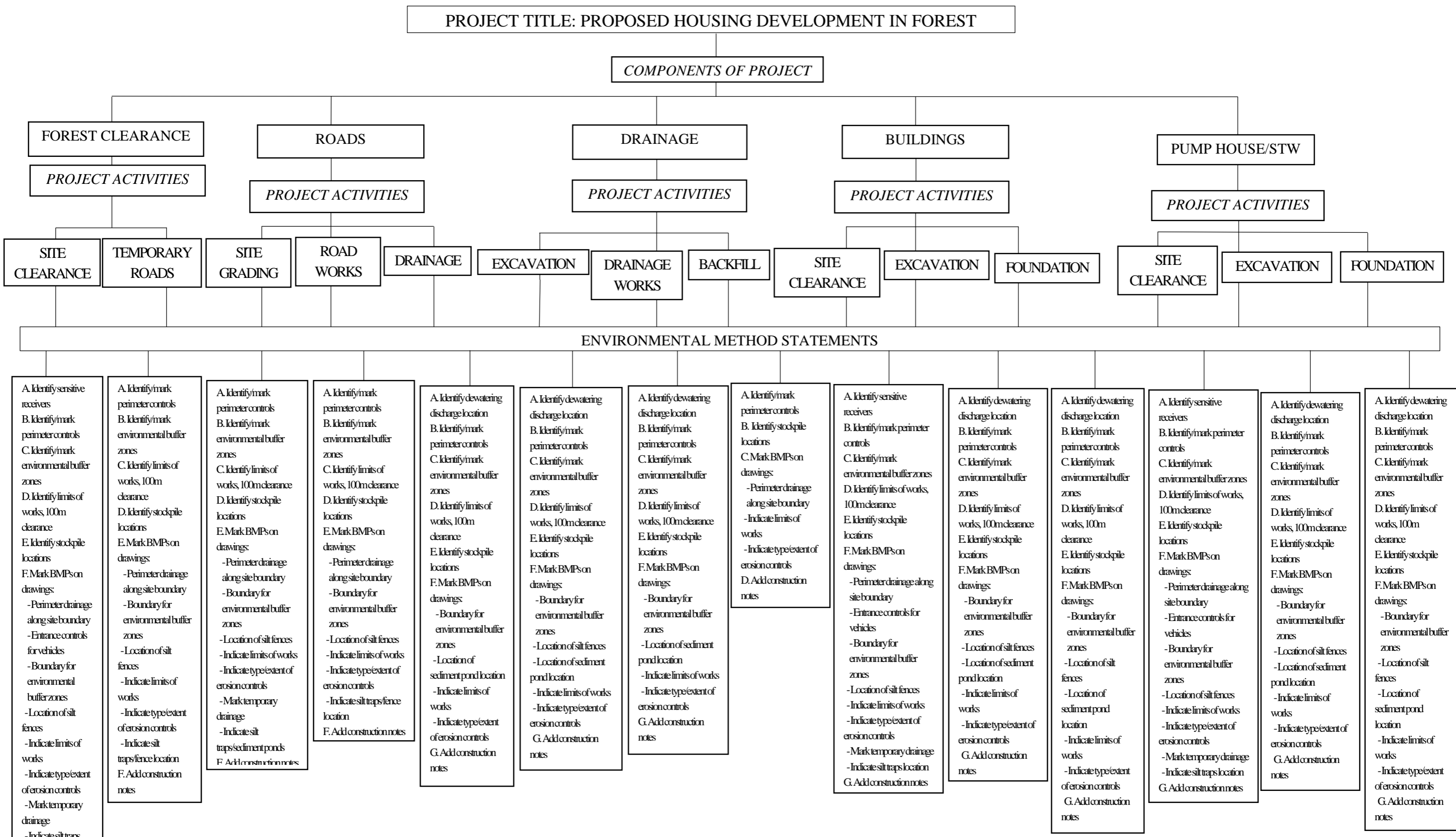
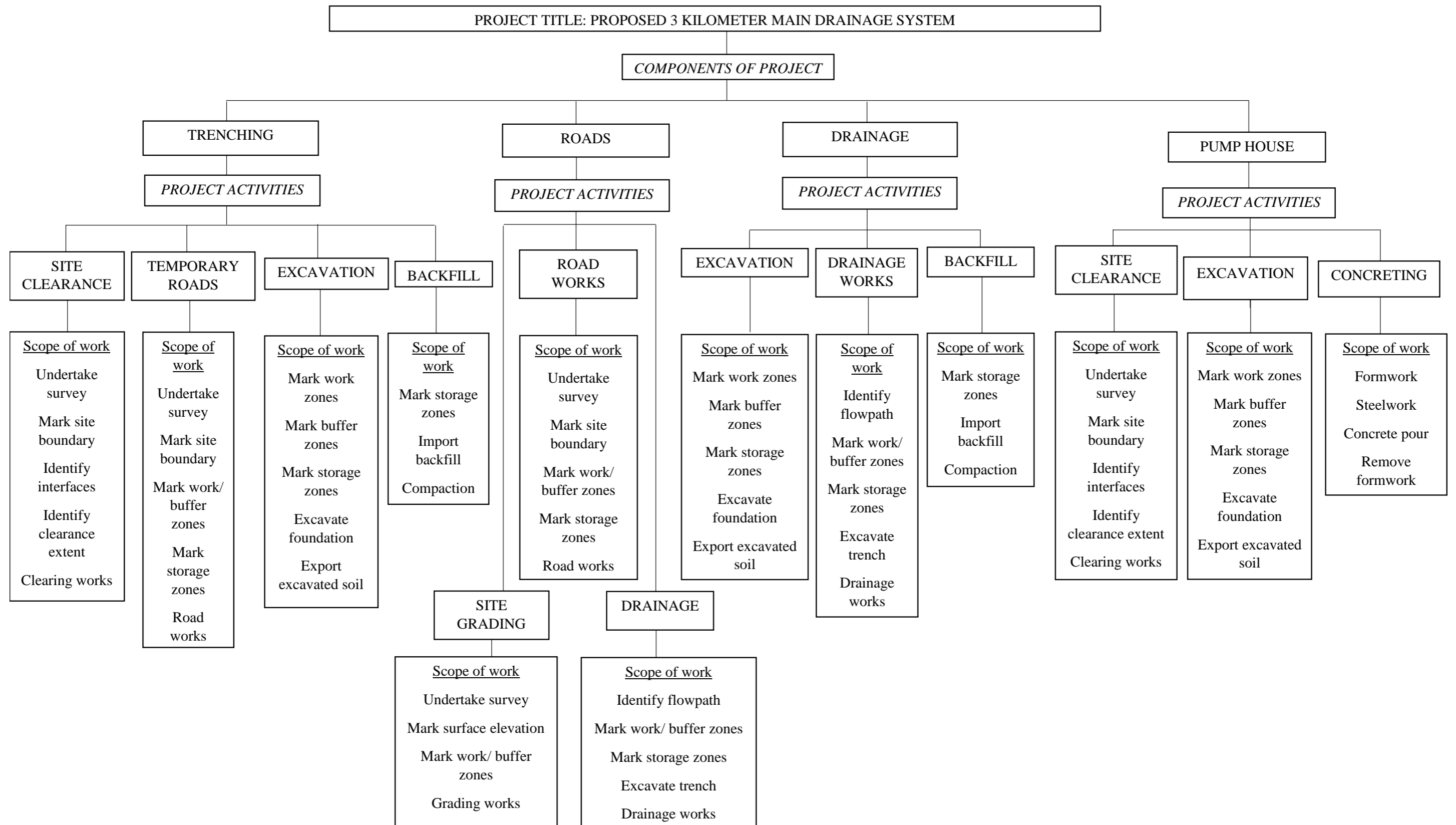


Figure 4.48: Environmental Method Statements for Housing Project (Cont.)



**Figure 4.49: Environmental Method Statements for Drainage Project**

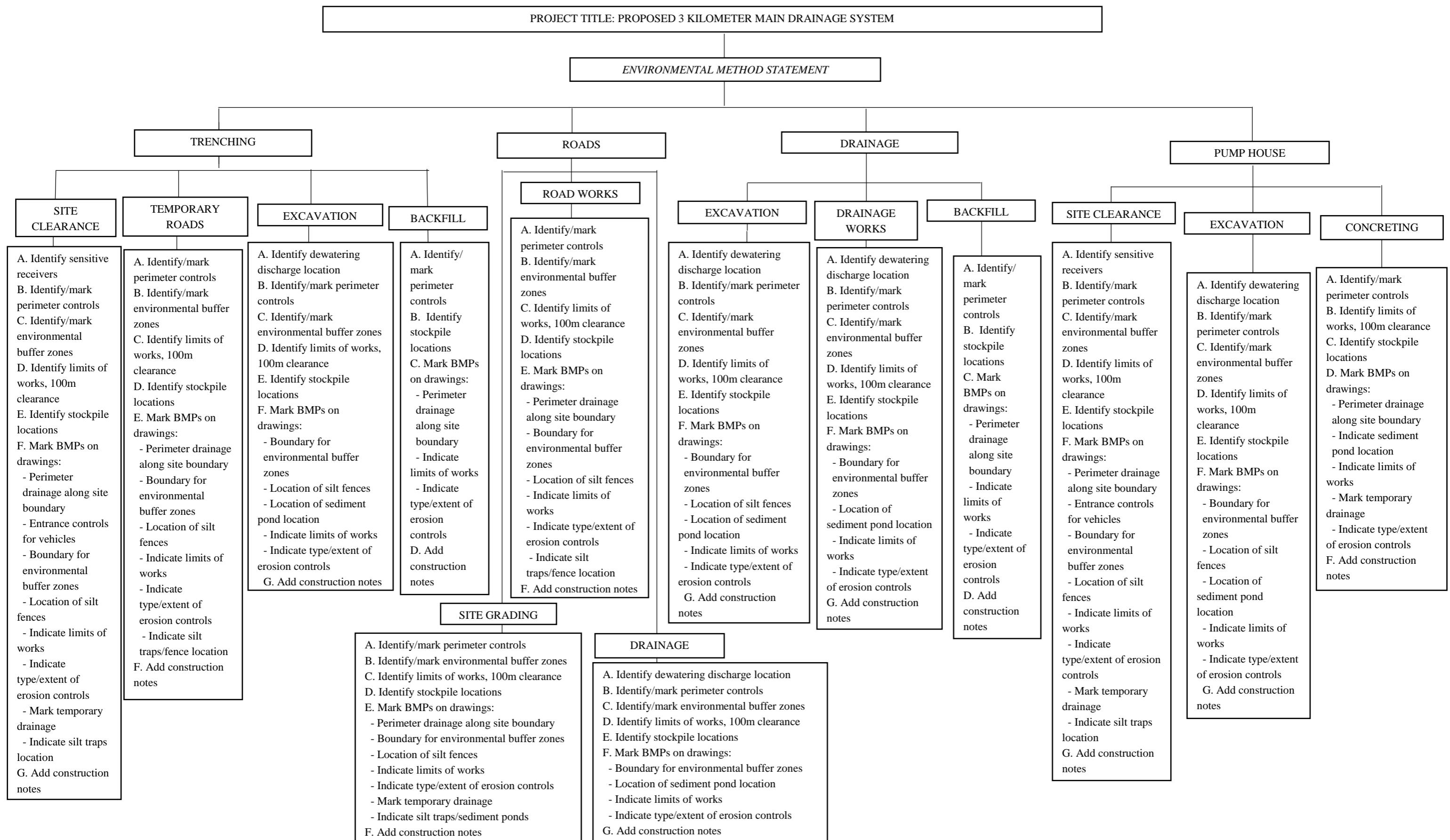


Figure 4.49: Environmental Method Statements for Drainage Project (Cont.)

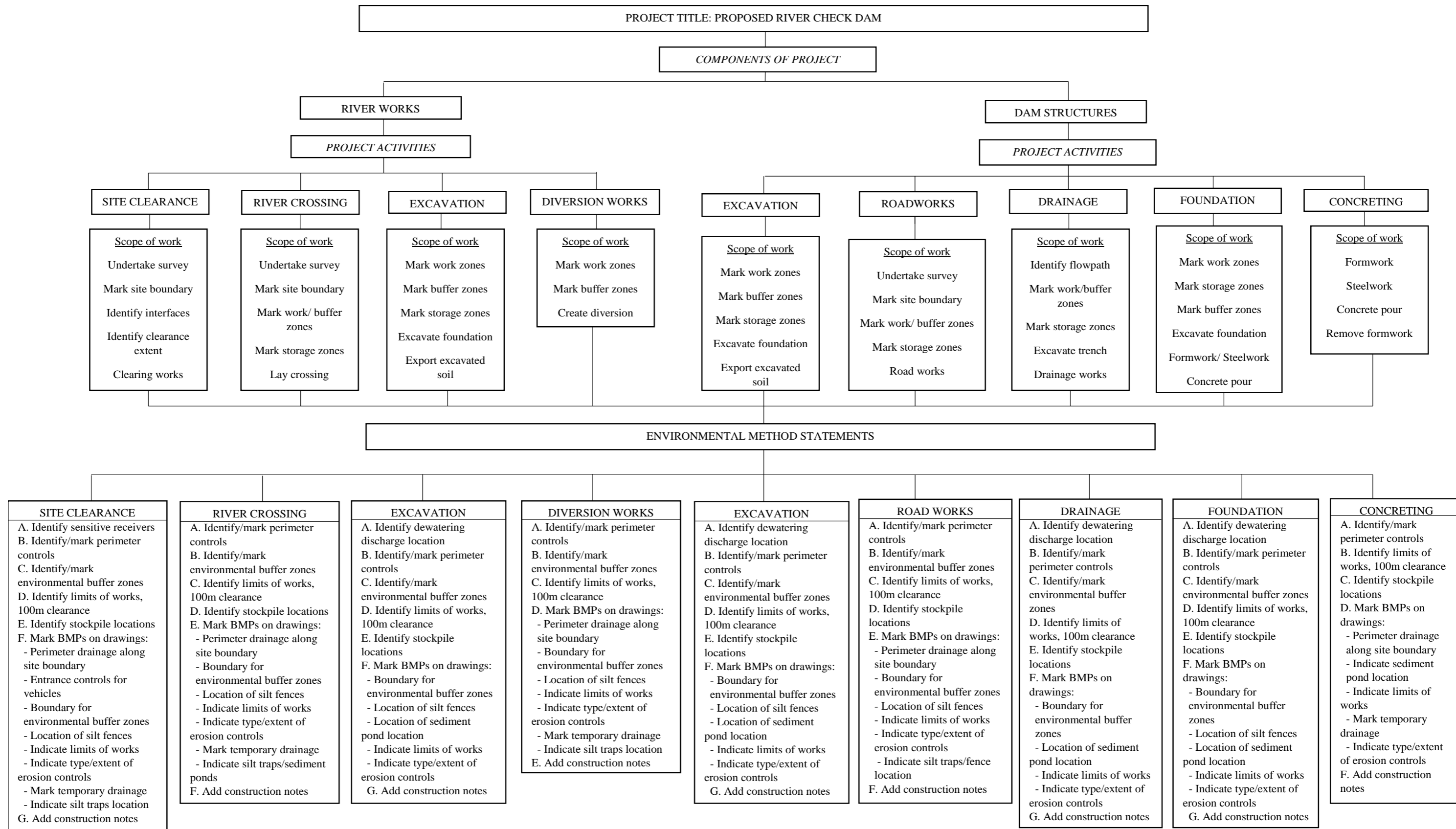


Figure 4.50: Environmental Method Statements for River Check Dam Project

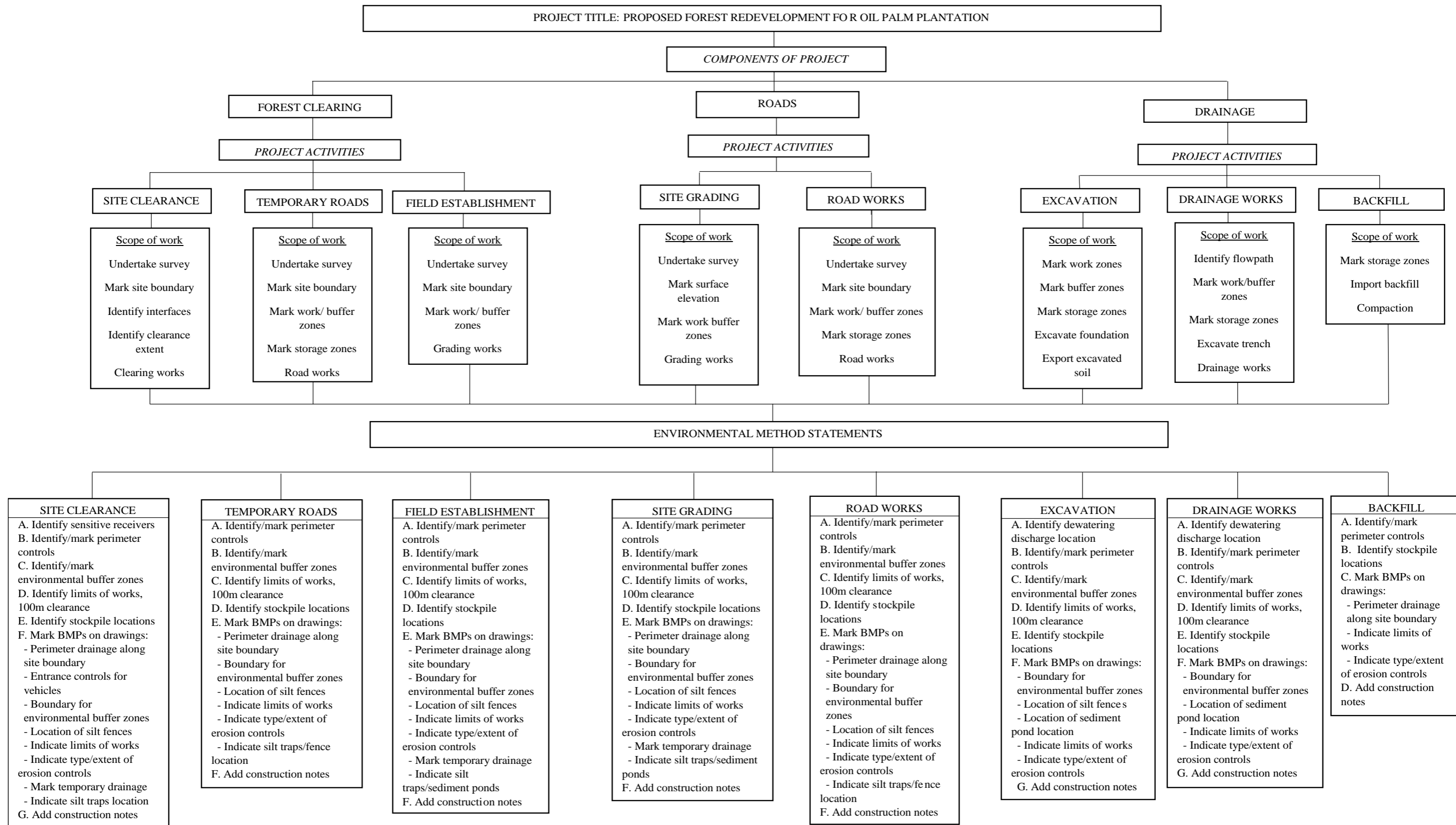


Figure 4.51: Environmental Method Statements for Forest Redevelopment Project

## **4.9 IDENTIFYING PROJECT SEQUENCES & SCHEDULING**

### **4.9.1 Application to this Guidelines**

Every construction project has a specific construction master programme which identifies the order in which the project is developed from day one (award of contract) until the last date when the completed project is handed over to the Project Proponent. From this master programme, and based on the Contractor's WBS, sub-programmes are then formulated to predict and monitor the progress of the site works against the Contract programme.

One of the major issues associated with erosion and sediment in our construction sites today is the lack of project phasing and sequencing/scheduling of the site activities, which as a result, subjected the construction sites to large extent of unprotected exposed ground surfaces or absence of appropriate mitigation measures during the land disturbing activities. The aspect of project phasing has been discussed earlier in this Chapter.

In the context of this Guidelines, project sequencing/scheduling is a type of BMP which has a high degree of importance in terms of application into the land disturbing activities. Essentially, each phase of construction shall have a specific construction sequence which identifies the order in which the site is developed, brought to finished grade and stabilized. The removal of particular BMPs or P2M2s needs to be identified in the construction sequence prior to commencement of the site activities, and suitably during the preparation of the detailed LD-P2M2 document.

Project sequencing/scheduling is basically the coordination of the construction schedule with the necessary erosion, runoff, sediment, site planning and general construction control BMPs installation, with the key intention to minimise (or prevent if practical) the extent of on-site erosion and off-site sedimentation.

To aid the site operations, a good project sequence/schedule shall present an orderly listing of all major land disturbing activities together with the dedicated P2M2s in order to prepare and inform the contractor of the necessary actions to be taken prior to the start of works.

### 4.9.2 Examples of Project Phasing, Sequences & Scheduling

All construction projects can benefit from upfront planning to phase and sequence construction activities to minimize the extent, duration and potential impacts of the inevitable land disturbing activities. Larger projects and linear construction projects may benefit most from construction sequencing or phasing, but even small projects can benefit from construction sequencing that minimizes the duration of disturbance. Typically, erosion and sediment controls needed at a site will change as a site progresses through the major phases of construction.

### 4.9.3 Example 1 – Proposed Sewage Treatment Works Project

In the earlier section, we have looked at how the STW project can be broken down to its *project components*, *project activities*, *scope of work*, and *environmental method statements*, all done from the point of view to focus on land disturbing activities that will result in erosion and sediment issues during a construction of an EIA project.

Recall from the earlier sections that this example project was divided into three 3 project components, namely, *Road*, *Bridge* and *Building Site*: basically a combination of linear-type (road) and concentrated-type (bridge & building) construction works. The factors to be considered when planning for the phasing of a project were discussed in Section 5.4.

For the purposes of this STW example, the information adopted to respond to the above factors of consideration is shown in **Table 4.5**.

**Table 4.5: Consideration Factors for Phasing STW Project**

Factors	Description
Size of site	<ul style="list-style-type: none"> <li>• New road: Total length of about 3km</li> <li>• Building footprint: Area about 1000 square</li> </ul>
Existing land use	<ul style="list-style-type: none"> <li>• Majority of site area covered by pristine forest reserve</li> <li>• Connection to existing road</li> <li>• Road to be constructed within existing pristine forest reserve</li> <li>• Road will cross an existing river</li> <li>• No villages or commercial activities in the vicinity</li> </ul>
Types of land disturbance activities	<ul style="list-style-type: none"> <li>• Site clearance for temporary/permanent roads &amp; drainage, bridge and building site</li> <li>• Site grading for temporary/permanent roads &amp; drainage</li> </ul>

	<p>and building site</p> <ul style="list-style-type: none"> <li>• Excavation for drainage, road foundation, STW foundation</li> <li>• Borehole drilling</li> <li>• Dewatering</li> <li>• Stockpile management</li> <li>• Disposal area management</li> </ul>
Topography	<ul style="list-style-type: none"> <li>• Generally sloping ground from the existing road towards the river</li> <li>• Generally soft ground along new road alignment</li> </ul>
Weather	<ul style="list-style-type: none"> <li>• Not known</li> </ul>
Type of soil	<ul style="list-style-type: none"> <li>• Not known</li> </ul>
Environmental Sensitive areas	<ul style="list-style-type: none"> <li>• Trees, vegetation</li> <li>• River</li> <li>• Public hazard</li> </ul>
Practicality of BMP installation	<ul style="list-style-type: none"> <li>• Temporary roads need to be created to access sensitive areas to be protected to install BMPs</li> </ul>
Rate of production	<ul style="list-style-type: none"> <li>• Not known</li> </ul>

In view of the above consideration, it can be proposed for the STW project to be broken down into the several phases:

- *Phase 1:* To construct the first one (1) kilometre section of the proposed 4m wide road, commencing from the existing road, in the river direction;
- *Phase 2:* To construct the second one (1) kilometre section of the proposed 4m wide road, continuing from Phase 1 works;
- *Phase 3:* To construct the bridge over river upon completion of Phase 2;
- *Phase 4:* To continue with construction of the new 4m road (approx. 1km section)
- *Phase 5:* To construct the STW facilities

The general sequence of the phasing works, and the arrangement of the project phases are shown in **Figure 4.52** and **Figure 4.53**, respectively.

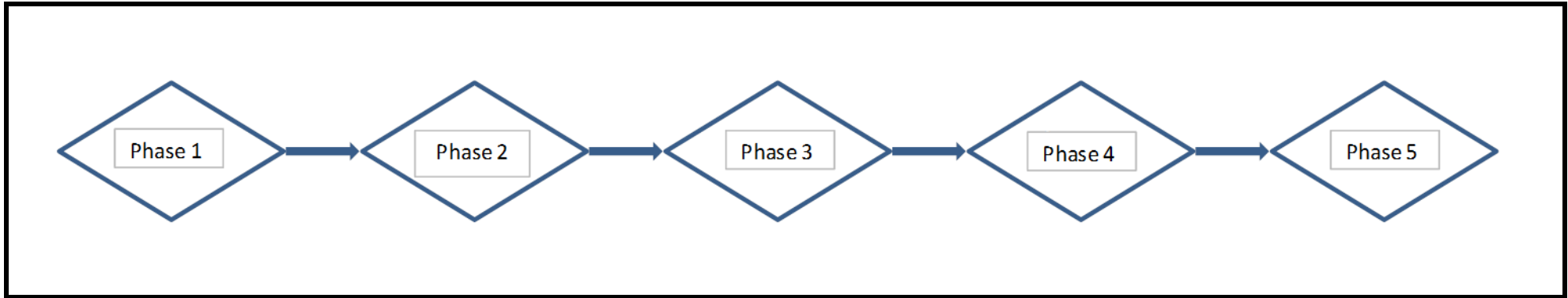
Based on the above project phasing, the potential land disturbing activities that can be identified for the individual phases are shown in **Table 4.6**.

**Table 4.6: Identified Land Disturbing Activities**

<b>Land Disturbing Activities</b>	<b>Description</b>
<b><i>Phase 1</i></b>	
Site clearing	Site clearance works to be provided at the junction of the existing 7m road and the new 4m road to establish site entry point; Site clearance works to be provided commencing from site entry point to form temporary road access and drainage; Forest clearance to the extent of the final road limits
Site grading	Site grading to prepare works area for roadworks
Excavation	Excavation for permanent drainage and road foundation
Stockpile management	Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials
<b><i>Phase 2</i></b>	
Site clearing	Site clearance works to be provided from the completion of Phase 1 to form temporary road access and drainage; Forest clearance to the extent of the final road limits
Site grading	Site grading to prepare works area for roadworks
Excavation	Excavation for permanent drainage and road foundation
Stockpile management	Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials
<b><i>Phase 3</i></b>	
Site clearing	Site clearance works to be provided from the completion of Phase 2 to prepare area for bridge construction
Borehole drilling	Drilling to form bridge foundation
Dewatering	Dewatering activities during drilling process

Stockpile management	Stockpiling of bentonite and construction materials for the drilling works; Stockpiling of excavated soil materials
Disposal area management	Disposal sites for excavated soil materials
<b>Phase 4</b>	
Site clearing	Site clearance works to be provided from the completion of Phase 3 to form temporary road access and drainage; Forest clearance to the extent of the final road limits
Site grading	Site grading to prepare works area for roadworks
Excavation	Excavation for permanent drainage and road foundation
Stockpile management	Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials
<b>Phase 5</b>	
Site clearing	Site clearance works to be provided from the completion of Phase 4 to form the temporary road access and drainage; Forest clearance to prepare works area for the building site
Site grading	Site grading to prepare works area for building site
Excavation	Excavation for permanent drainage and road foundation; Excavation of STW basement/foundation works
Dewatering	Dewatering activities from the excavated basement
Stockpile management	Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials

In view of the above land disturbance activities and the planned project phases as discussed above, project sequences for the initial phases is shown in **Figures 4.54** and **4.55**, respectively.



**Figure 4.52: Recommended Project Sequence for Phases of Work for STW Project**

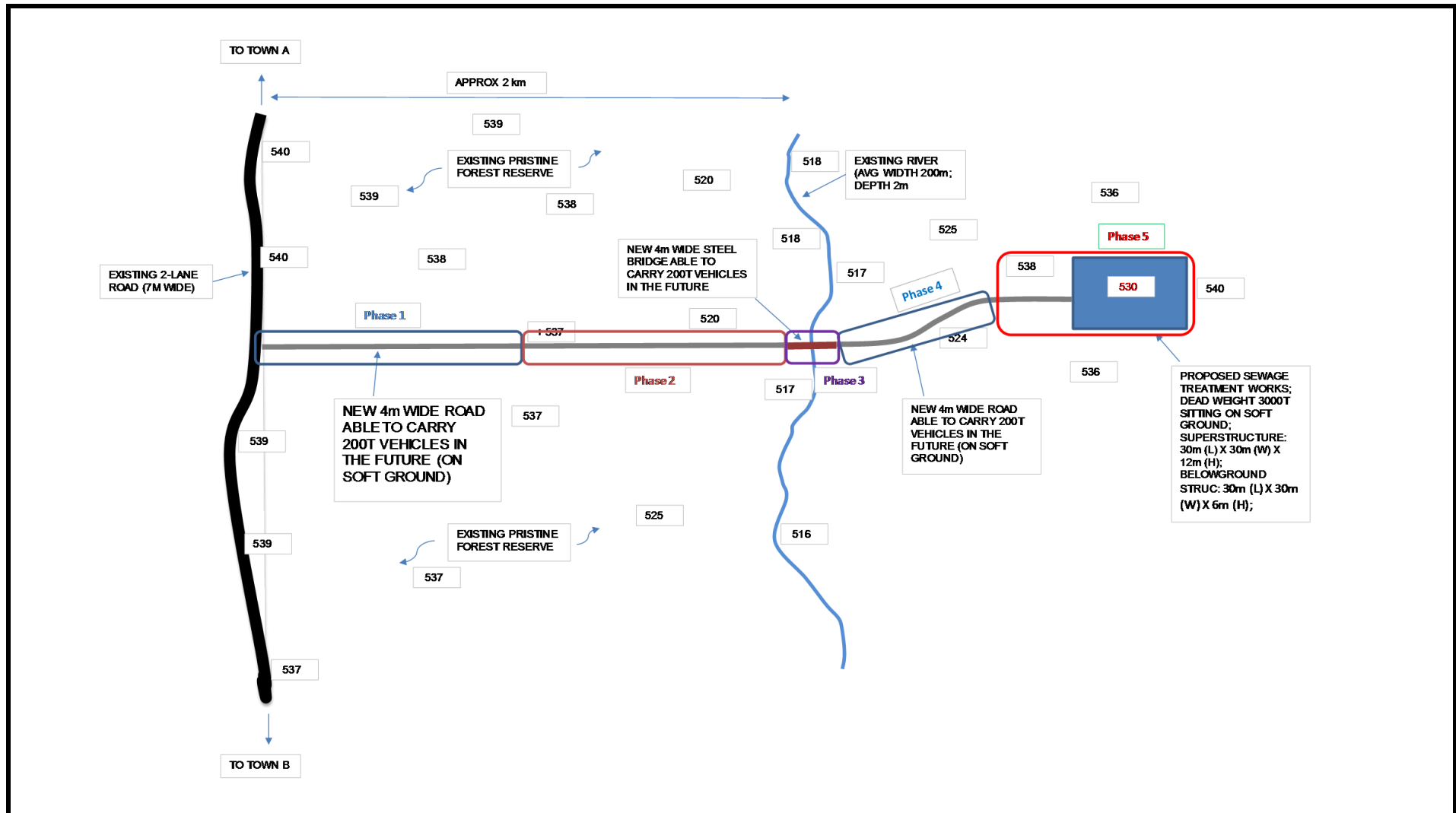


Figure 4.53: Proposed Phasing for Sewage Treatment Works Project

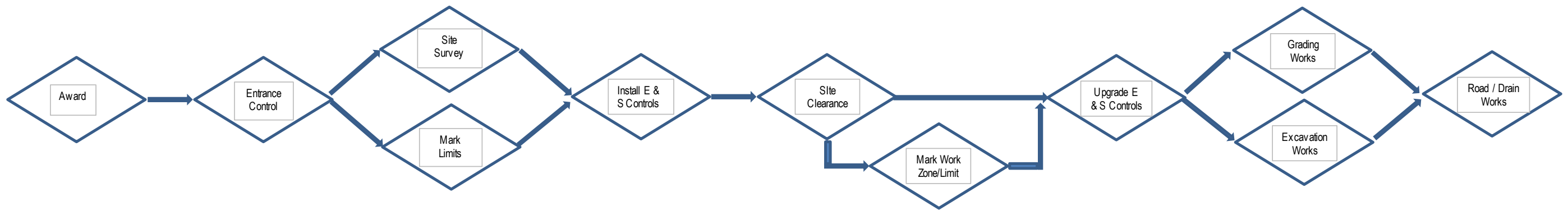


Figure 4.54: Proposed Project Sequence for Phase 1

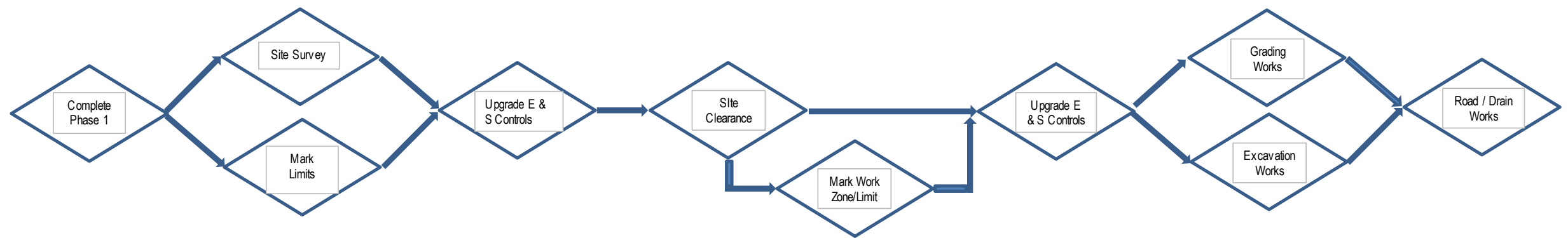


Figure 4.55: Proposed Project Sequence for Phase 2

The construction sequence for the Phase 1 works is described below.

**Table 4.7: Project Sequence for Phase 1**

Activities	Sequence of Work
<b>Activity 1: Site Clearance</b>	<ul style="list-style-type: none"> <li>A. Establish entrance to site; construction access; construction routes, areas designated for equipment parking, and entrance controls for vehicles</li> <li>B. Undertake site survey to identify:               <ul style="list-style-type: none"> <li>➤ Interfaces with existing facilities</li> <li>➤ Environmental sensitive receivers</li> <li>➤ Limits of works and site boundary</li> </ul> </li> <li>C. Mark site boundary</li> <li>D. Install perimeter controls such as drainage</li> <li>E. Mark environmental buffer zones</li> <li>F. Mark clearance extent &amp; limits of works</li> <li>G. Install silt fences</li> <li>H. Install silt traps / sediment basin</li> <li>I. Identify and allocate stockpile &amp; disposal areas for biomass</li> <li>J. Commence site clearing works</li> <li>K. Inspection &amp; maintenance of silt fences / silt traps / sediment basin</li> </ul>
<b>Activity 2: Site Grading</b>	<ul style="list-style-type: none"> <li>A. Retake site survey to identify               <ul style="list-style-type: none"> <li>➤ Environmental buffer zones</li> <li>➤ Limits of works</li> <li>➤ Marking of surface elevations</li> </ul> </li> <li>▪ Mark/remark site boundary</li> <li>▪ Install new or upgrade perimeter controls including drainage</li> <li>▪ Mark environmental buffer zones</li> <li>▪ Install silt fences</li> <li>▪ Install silt traps / sediment basin</li> <li>▪ Identify and allocate stockpile &amp; disposal areas for biomass</li> <li>▪ Commence site grading works</li> <li>▪ Inspection &amp; maintenance of silt fences / silt traps / sediment basin</li> </ul>
<b>Activity 3: Road &amp; Drainage works</b>	<ul style="list-style-type: none"> <li>A. Mark work limits and buffer zones</li> <li>B. Survey and mark flow paths</li> <li>C. Identify and mark perimeter controls</li> <li>D. Mark environmental buffer zones</li> </ul>

	<ul style="list-style-type: none"> <li>E. Allocate stockpile locations</li> <li>F. Identify dewatering discharge location and treatment facilities</li> <li>G. Install new or upgrade sediment pond</li> <li>H. Excavate trench for permanent drainage</li> <li>I. Laying or permanent drainage works and roadworks</li> </ul>
--	--

Upon completion of the Phase 1 works, Phase 2 can then commence, with its general sequences described below.

**Table 4.8: Project Sequence for Phase 2**

<b>Activities</b>	<b>Sequence of Work</b>
<b><i>Activity 1: Site Clearance</i></b>	<ul style="list-style-type: none"> <li>A. Undertake site survey to identify:                             <ul style="list-style-type: none"> <li>➤ Interfaces with existing facilities</li> <li>➤ Environmental sensitive receivers</li> <li>➤ Limits of works and site boundary</li> </ul> </li> <li>B. Mark site boundary</li> <li>C. Install perimeter controls such as drainage</li> <li>D. Mark environmental buffer zones</li> <li>E. Mark clearance extent &amp; limits of works</li> <li>F. Install silt fences</li> <li>G. Install silt traps / sediment basin</li> <li>H. Identify and allocate stockpile &amp; disposal areas for biomass</li> <li>I. Commence site clearing works</li> <li>J. Inspection &amp; maintenance of silt fences / silt traps / sediment basin</li> </ul>
<b><i>Activity 2: Site Grading</i></b>	<ul style="list-style-type: none"> <li>A. Retake site survey to identify                             <ul style="list-style-type: none"> <li>➤ Environmental buffer zones</li> <li>➤ Limits of works</li> <li>➤ Marking of surface elevations</li> </ul> </li> <li>B. Mark/remark site boundary</li> <li>C. Install new or upgrade perimeter controls including drainage</li> <li>D. Mark environmental buffer zones</li> <li>E. Install silt fences</li> <li>F. Install silt traps / sediment basin</li> <li>G. Identify and allocate stockpile &amp; disposal areas for biomass</li> <li>H. Commence site grading works</li> </ul>

	I. Inspection & maintenance of silt fences / silt traps / sediment basin
<b>Activity 3: Road &amp; Drainage works</b>	<ul style="list-style-type: none"> <li>A. Mark work limits and buffer zones</li> <li>B. Survey and mark flow paths</li> <li>C. Identify and mark perimeter controls</li> <li>D. Mark environmental buffer zones</li> <li>E. Allocate stockpile locations</li> <li>F. Identify dewatering discharge location and treatment facilities</li> <li>G. Install new or upgrade sediment pond</li> <li>H. Excavate trench for permanent drainage</li> <li>I. Laying or permanent drainage works and roadworks</li> </ul>

Phase 3 can commence only after completion of Phase 2. Its project sequences are described below.

**Table 4.9: Project Sequence for Phase 3**

<b>Activities</b>	<b>Sequence of Work</b>
<b>Activity 1: Site Clearance</b>	<ul style="list-style-type: none"> <li>A. Undertake site survey to identify:                             <ul style="list-style-type: none"> <li>➤ Interfaces with existing facilities</li> <li>➤ Environmental sensitive receivers</li> <li>➤ Limits of works and site boundary</li> </ul> </li> <li>B. Mark site boundary</li> <li>C. Install perimeter controls such as drainage</li> <li>D. Mark environmental buffer zones</li> <li>E. Mark clearance extent &amp; limits of works</li> <li>F. Install silt fences</li> <li>G. Install silt traps / sediment basin</li> <li>H. Identify and allocate stockpile &amp; disposal areas for biomass</li> <li>I. Commence site clearing works</li> <li>J. Inspection &amp; maintenance of silt fences / silt traps / sediment basin</li> </ul>
<b>Activity 2: Borehole Drilling</b>	<ul style="list-style-type: none"> <li>A. Mark work limits and buffer zones</li> <li>B. Mark environmental buffer zones</li> <li>C. Identify and install perimeter controls</li> <li>D. Install silt fences</li> <li>E. Allocate stockpile locations</li> <li>F. Identify dewatering discharge location and treatment</li> </ul>

	<p>facilities</p> <p>G. Install new or upgrade sediment pond</p> <p>H. Commence drilling works</p> <p>I. Export excavated soil &amp; wastewater</p> <p>J. Inspect &amp; maintain silt fences / sediment ponds</p>
<b>Activity 3: Elevated structures</b>	<p>A. Mark work limits and buffer zones</p> <p>B. Allocate stockpile locations</p> <p>C. Identify and mark perimeter controls</p> <p>D. Mark environmental buffer zones</p> <p>E. Structural works</p>

Phase 4 shall start only after completion of Phase 3, and its project sequences are similar to those for Phase 2 and are not repeated here.

Upon and after completion of Phase 4, the last phase of this STW project can then commence, with the majority of the works involving structural and building works but also covering some land disturbing activities (some of which are quite significant also, such as excavation works for the STW foundation structures. The project sequences for Phase 5 are described below.

**Table 4.10: Project Sequence for Phase 5**

<b>Activities</b>	<b>Sequence of Work</b>
<b>Activity 1: Site Clearance</b>	<p>A. Undertake site survey to identify:</p> <ul style="list-style-type: none"> <li>➤ Interfaces with existing facilities</li> <li>➤ Environmental sensitive receivers</li> <li>➤ Limits of works and site boundary</li> </ul> <p>B. Mark site boundary</p> <p>C. Install perimeter controls such as drainage</p> <p>D. Mark environmental buffer zones</p> <p>E. Mark clearance extent &amp; limits of works</p> <p>F. Install silt fences</p> <p>G. Install silt traps / sediment basin</p> <p>H. Identify and allocate stockpile &amp; disposal areas for biomass</p> <p>I. Commence site clearing works</p> <p>J. Inspection &amp; maintenance of silt fences / silt traps / sediment basin</p>
<b>Activity 2: Site Grading</b>	<p>A. Retake site survey to identify</p> <ul style="list-style-type: none"> <li>➤ Environmental buffer zones</li> <li>➤ Limits of works</li> </ul>

	<ul style="list-style-type: none"> <li>➤ Marking of surface elevations</li> <li>B. Mark/remark site boundary</li> <li>C. Install new or upgrade perimeter controls including drainage</li> <li>D. Mark environmental buffer zones</li> <li>E. Install silt fences</li> <li>F. Install silt traps / sediment basin</li> <li>G. Identify and allocate stockpile &amp; disposal areas for biomass</li> <li>H. Commence site grading works</li> <li>I. Inspection &amp; maintenance of silt fences / silt traps / sediment basin</li> </ul>
<p><b>Activity 3: Road &amp; Drainage works</b></p>	<ul style="list-style-type: none"> <li>A. Mark work limits and buffer zones</li> <li>B. Survey and mark flow paths</li> <li>C. Identify and mark perimeter controls</li> <li>D. Mark environmental buffer zones</li> <li>E. Allocate stockpile locations</li> <li>F. Identify dewatering discharge location and treatment facilities</li> <li>G. Install new or upgrade sediment pond</li> <li>H. Excavate trench for permanent drainage</li> <li>I. Laying or permanent drainage works and roadworks</li> </ul>
<p><b>Activity 4: Excavation for STW subsurface works</b></p>	<ul style="list-style-type: none"> <li>A. Mark work limits and buffer zones</li> <li>B. Mark environmental buffer zones</li> <li>C. Identify and install perimeter controls</li> <li>D. Install silt fences</li> <li>E. Allocate stockpile locations</li> <li>F. Identify dewatering discharge location and treatment facilities</li> <li>G. Install new or upgrade sediment pond</li> <li>H. Commence drilling works</li> <li>I. Export excavated soil &amp; wastewater</li> <li>J. Inspect &amp; maintain silt fences / sediment ponds</li> </ul>
<p><b>Activity 5: Above-ground &amp; Elevated structures</b></p>	<ul style="list-style-type: none"> <li>A. Mark work limits and buffer zones</li> <li>B. Allocate stockpile locations</li> <li>C. Identify and mark perimeter controls</li> <li>D. Mark environmental buffer zones</li> <li>E. Structural works</li> </ul>

#### 4.9.4 Other Examples

The same application in identifying project phasing and sequencing for the other example projects previously discussed in this Chapter can also be performed, based on the following proposals.

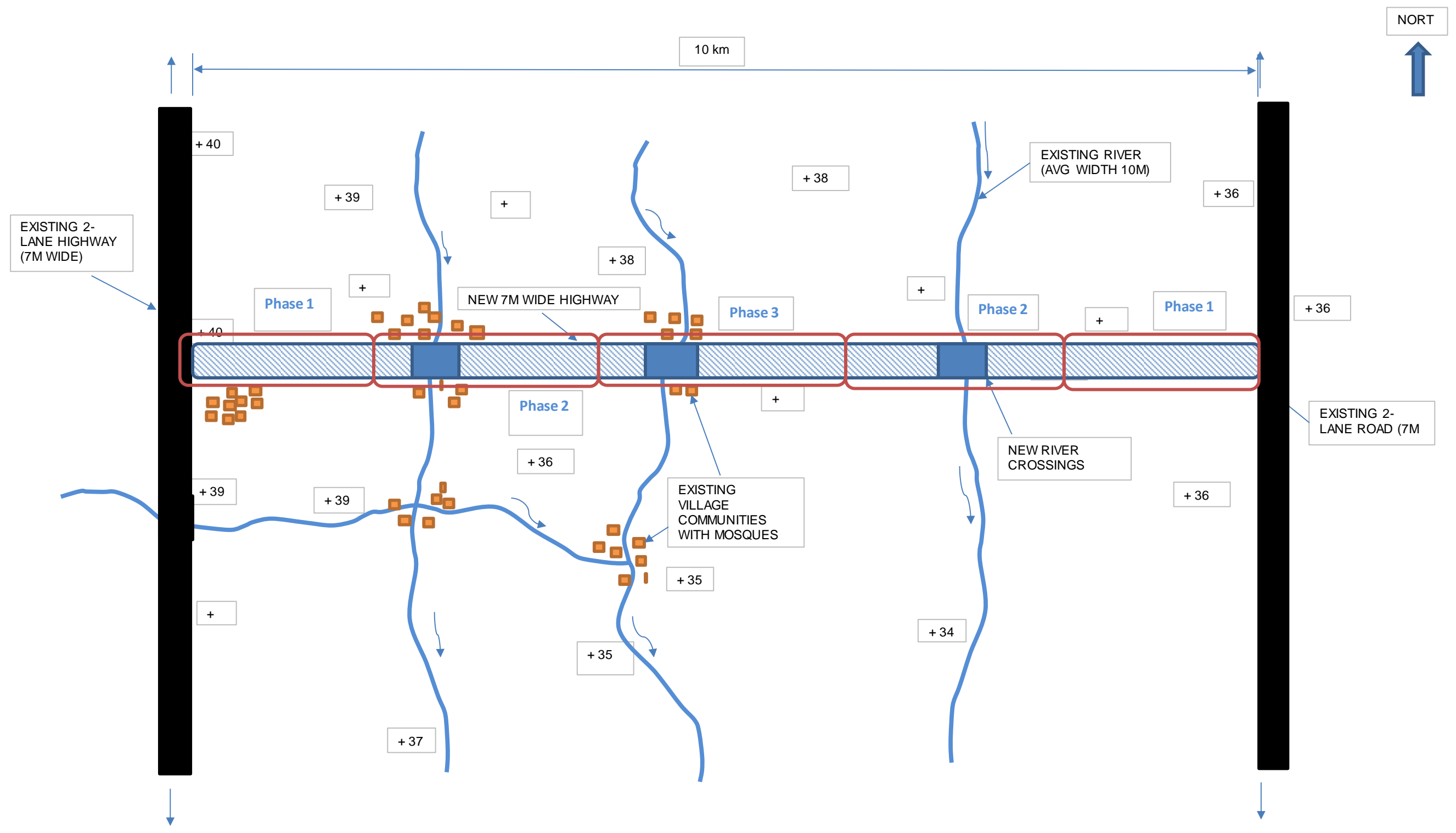


Figure 4.56: Proposed Phasing for Highway Project

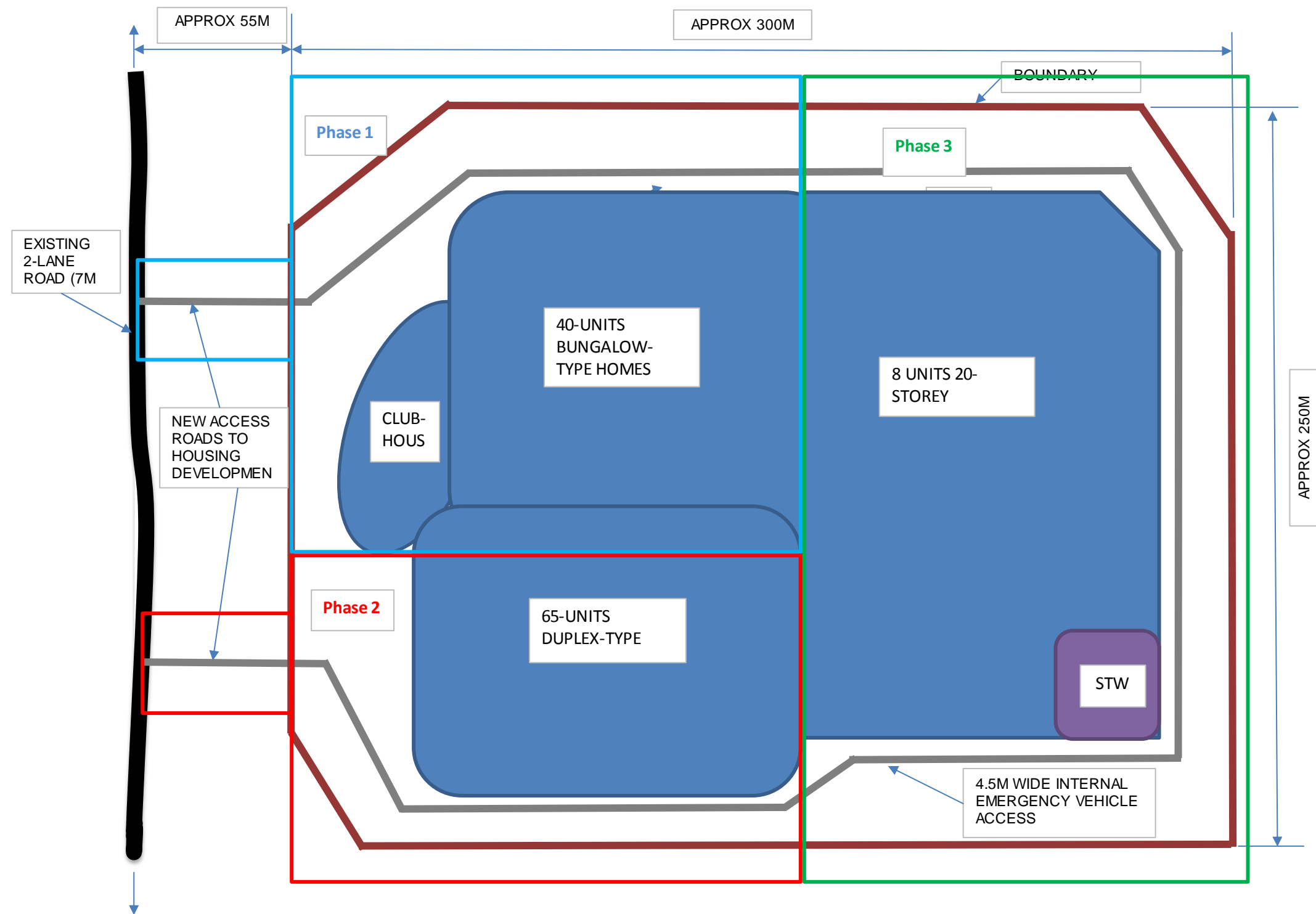


Figure 4.57: Proposed Phasing for Housing Project

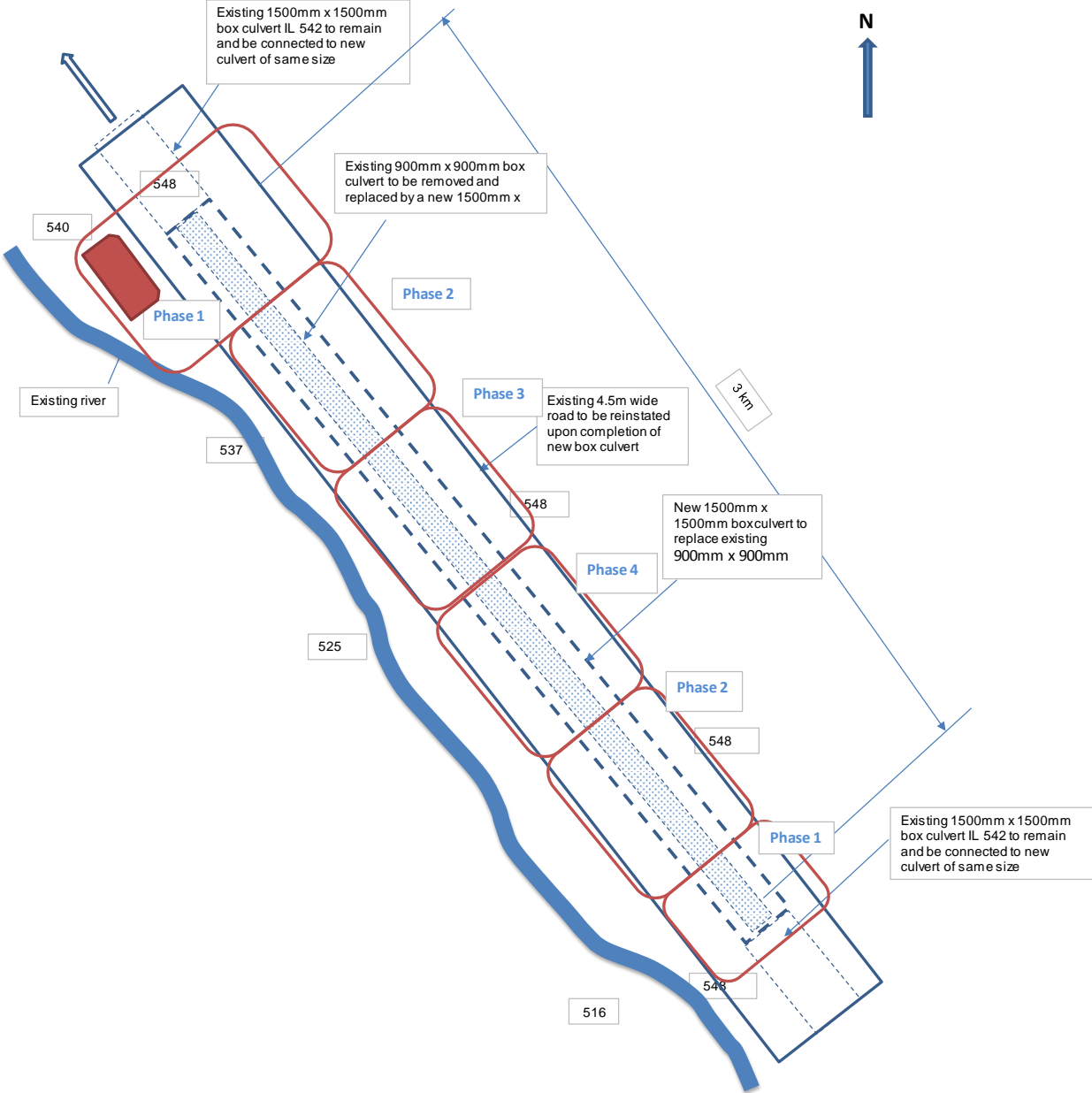


Figure 4.58: Proposed Phasing for Drainage Project

#### 4.9.5 Summary

In summary, **Chapter 4** has covered one of the key components of LD-P2M2, namely on the topic of subjecting a project to appropriate phasing, identifying project components / project activities / scope of work as well as allocating the suitable environmental method statements to these project activities, and lastly, to combine all the above elements into project sequence of work with the incorporation of the required P2M2s into the project.

From the above examples, the following observations can be made:

- Information on the site operations should be made available or known to the LD-P2M2 preparer in order for a reasonable representative WBS and project phases/sequencing to be formulated;
- When such information is not available or known, then some rule of thumbs or assumptions should be made to prepare at least a conceptual LD-P2M2 document, until such time when more accurate information is made available. At such time, the conceptual LD-P2M2 shall be upgraded with the latest information available;
- Irregardless of the status of the LD-P2M2 document, the objective of LD-P2M2 remains the same throughout, that is, to focus on the principles and utilising the minimum standards requirements to prevent or minimise erosion or sediment issues in construction practices;
- LD-P2M2 practitioners shall be careful to note the robustness of the LD-P2M2 in that mitigation measures and BMPs are not necessary 'static' but subject to revision, upgrading or total new installations to suit the ever evolving site conditions; and lastly,
- Inspection and maintenance play a continuous role in ensuring the effectiveness and suitability of the installed P2M2s and shall always be programmed into the Contractor and Environmental Officer's work plans.

## CHAPTER 5

### PROJECT IMPLEMENTATION TECHNIQUES

#### 5.1 OVERARCHING REQUIREMENTS

Up to this point, the Guidelines has covered the essential fundamentals and elements of land disturbing pollution prevention and mitigation measures, and how erosion and sediment issues in a construction site can be effectively controlled or minimized during the site activities. This Chapter will discuss some of the techniques to be used to apply the LD-P2M2 measures into the construction activities.

Foremost, let's review the overarching requirements for the application of LD-P2M2 into an EIA project, most of which have been already covered elsewhere:

- Legal obligations;
- Maximizing the most of LD-P2M2 basic principles;
- LD-P2M2's minimum standards requirements;
- Roles and responsibilities of project parties; and
- Site application practices

##### 5.1.1 Legal Obligations

The legal requirements for the planning and implementation of LD-P2M2 are discussed in Chapter 2 of this *Guideline*, covered under Section 34A of the EQA 1974 (Amended) 2012. In short, it is not a choice whether the Project Proponent and Contractor will or will not implement LD-P2M2 in an EIA project and associated site activities, as both are required to do so under the Act.

#### 5.2 BASIC PRINCIPLES OF LD-P2M2

Maximizing the basic principles of LD-P2M2 in land disturbing activities have been covered in several preceding chapters, and these represent the core fundamentals to be adopted to prevent and minimize the occurrence of erosion and sediment issues at the project sites, if diligently applied:

- Integrate project design with site constraints.
- Preserve and stabilize drainage ways.
- Minimize the extent and duration of disturbance.
- Control runoff flows onto, through and from the site in stable drainage structures.
- Install perimeter controls.

- Stabilize disturbed areas promptly in a timely manner.
- Protect steep slopes.
- Use sediment controls to prevent off-site damage.
- Protect inlets, storm drain outfalls, and culverts.
- Provide access and general construction controls.
- Inspect and maintain best management practices and control measures.
- Employ experienced and competent personnel and consistently conduct relevant training.

### 5.2.1 Minimum Standards Requirements of LD-P2M2

Likewise, the listing of the minimum standards requirements of the P2M2s to be adopted during land disturbing activities in EIA projects have been mentioned previously (see Appendix B), and include the following:

- Schedule of Phasing, Staging and Sequencing
- Scheduled Site Meeting
- Construction Markers
- Stabilized Construction Entrance
- Stream/drainage way/waterway/watercourse buffers
- Perimeter Control
- Sediment Basin/Trap
- Runoff Management
- Temporary or permanent watercourse diversion
- Temporary or permanent watercourse crossing
- Temporary or permanent roadways
- Temporary Stabilization
- Stockpile Soil Management
- Spoil Management Area (Disposal Area)
- Dewatering practices
- Active Treatment System (ATS)
- Discharge
- Corrective Actions
- Site Inspections
- Maintenance
- Standards and Specifications for P2M2s
- Establishment of Environmental Performance Monitoring Committee (EPMC) and Performance Monitoring Documentation

The above standard requirements are covered repeatedly in various forms throughout the remaining of this Chapter.

### 5.3 ROLES AND RESPONSIBILITIES OF PROJECT PARTIES

The main project parties who would be involved in applying LD-P2M2 are discussed in Chapter 2, with specific roles being played by the Project Proponent (PP), Consultants, Contractors and Environmental Officers (EO). Essentially, all the principles, standards requirements, tools and documents on their own are pretty much non-functional unless they are effectively applied to the construction sites by these pertinent parties. The techniques for the application of LD-P2M2 into the construction phases shall commence from the planning stage and brought down to the construction phases.

#### 5.3.1 Who are Key Players?

The stakeholders who will be involved in LD-P2M2 consist namely the following parties:

- Project Proponent;
- Consultants;
- Contractors;
- Environmental Officers; and
- Government Agencies

#### 5.3.2 Project Proponent (PP)

The PP is not only legally responsible for ensuring regulatory compliance, but is the driver for mainstreaming the environmental agenda in all stages of project implementation. In principle, the Project Proponent (PP) shall be responsible for the implementation of the LD-P2M2.

The PP may be from the public or the private sector and he may be represented by a consultant. The PP is responsible for all aspects related to the development of the project including the environmental planning of the project and its associated cost. He may delegate the task of conducting the environmental impact assessment of the project to his project consultant or to another organization but he remains ultimately responsible for the content of the EIA Report on his project.

The PP is responsible for formulating an Environmental Policy (EP) of the company with respect to the EIA project, which shall be communicated to the stakeholders, consultants, contractors and other parties involved in the project planning and implementation.

The PP is responsible for establishing an organizational structure which clearly shows the emplacement of a Registered EIA Consultant and an Environmental Officer (EO), where they are charged with specific responsibilities to ensure environmental aspects are taken into consideration and pollution prevention and

mitigation measures (P2M2) are integrated into every stage of project planning and implementation.

The PP is responsible for allocating sufficient funds for all steps in the EIA process and every stage of project planning and implementation with itemized budget required for amongst other environmental aspects, for implementation of Environmental Management Plan (EMP) and LD-P2M2 including temporary pollution prevention and mitigation measures (P2M2). P2M2 shall be those which can be described as state of the art technologies, best available technologies (BATs), or industry best practices.

The PP is responsible for appointing an Environmental Officer (EO), at the stage of post submission of EIA Report to be charged with responsibilities to execute environmental quality control and performance monitoring functions during the construction and operation phases of the project implementation.

The PP is responsible for establishing a project Environmental Performance Monitoring Committee (EPMC) to monitor the environmental performance, effectiveness of pollution prevention and mitigation measures (P2M2), and status of regulatory compliance of the project. The EPMC shall be represented by all relevant parties involved in project implementation and chaired by a senior member representing the PP. The chairman who shall be formally appointed by the PP shall be responsible for ensuring the decisions of the meeting are responsibly executed. The EPMC shall meet at a minimum, once in a quarter and the minutes of the meeting shall be maintained.

The PP is responsible for setting up a “mini laboratory”, wherever appropriate, to facilitate the implementation of environmental performance monitoring program. This mini laboratory shall be adequately equipped with relevant resources including staff and portable analytical testing equipment.

The PP is responsible for ensuring the Environmental Management Plan (EMP) including temporary and permanent pollution prevention and mitigation measures (P2M2) are implemented and maintained according to industry’s best practices.

### **5.3.3 Consultants**

The EIA Consultant is an individual who has been tasked by the Project Proponent to conduct the Environmental Impact Assessment (EIA) of the project. The Consultant is typically the leader of a team of consultants from various disciplines relevant to the proposed project and is responsible to the Project Proponent. The EIA team leader who may work for an EIA consulting firm and the subject matter experts shall be DOE-registered consultants who shall maintain professionalism in

conducting a comprehensive EIA study and produce a quality EIA Report that is useful for decision-making purposes.

The EIA Consultant plays a major role in the preparation of the EIA report, including the LD-P2M2 Document and environmental monitoring programmes in accordance with the objectives and requirements of the EIA, whilst ensuring compliance with the relevant regulations and standards. He is entrusted with the responsibilities for ensuring environmental impacts from a project are correctly identified, assessed, and mitigated.

When preparing the LD-P2M2 Document, the Consultant is responsible to obtain all the relevant information for analysis and interpretation, in order to produce the requirements to address erosion and sediment issues during the execution of the project. Amongst the key information include the following:

- (a) Weather and rainfall data
- (b) Site runoff velocity and flow rate, both pre and during development
- (c) Description of site soil characteristics:
  - i. Soil types
  - ii. Soil test erodibility
  - iii. Soil hydrologic group
  - iv. Dispersible fine clay: Percentage of dispersible material
  - v. Anticipated excavation depth for the proposed land disturbing activity
- (d) Description of adjacent areas, such as streams, lakes, residential areas, and roads that might be affected by the land disturbance
- (e) List of streams and rivers identified on-site. (Use coding for unnamed streams and rivers)
- (f) List of receiving streams and rivers. (Use coding for unnamed streams and rivers)
- (g) List of existing drainage identified on-site.
- (h) List of P2M2s proposed.
- (i) Identify access roads and other outsourced components (such as mobile batching or premix plant) that are located outside the proximity of the project boundary.
- (j) Earthworks cut and fill volume
- (k) Availability of rocks material
- (l) Biomass management
- (m) Solid (construction waste) and domestic waste management
- (n) Spill Prevention and Control from fuel and chemical use or storage
- (o) Hazardous Waste Management
- (p) Soil loss prediction using the Universal Soil Loss Equation (USLE), sediment yield calculation using Modified Universal Soil Loss Equation (MUSLE) and runoff estimation for pre, during and post development accounted for both with and without the implementation of LDP2M2s. All of the data and

parameters used in the calculations shall be measured or rationally determined, and identified. If secondary sources are used, they shall be clearly identified.

- (q) Calculation of proposed sediment trap/basin based on drainage area disturbed and projected runoff flow direction from each disturbed land segment that will drain into the proposed sediment trap/basin.

The EIA Consultant is responsible for preparing the LD-P2M2 Document to comply with requirements as stated in this *Guideline*, including the incorporation of the minimum standards requirements into the LD-P2M2 Document.

#### **5.3.4 Contractors**

The Contractor who successfully wins the tender for the project will go into an agreement with the PP to execute the construction of the project in accordance with the contract drawings, specification and all documents that are contractually bound to the agreement.

The Contractor is responsible to review and understand the contents of the approved LD-P2M2 Document, and where applicable, to integrate the findings of the document into his work plans to fulfill the contract. As mentioned earlier, the LD-P2M2 Document may require updating based on the availability of more detailed information.

The Contractor needs to be cognizant of the recommendations in the LD-P2M2 Document including all the minimum standards requirements of P2M2s and to incorporate all these information into the work plans. Based on the site conditions and his method statements, the Contractor may need to refine the Document from time to time as the site conditions evolve.

#### **5.3.5 Environmental Officers (EO)**

The Environmental Officer (EO) is the main project personnel responsible for ensuring regulatory compliance at the project implementation stage (post submission of EIA Report).

The EO is responsible for implementing the environmental management plan (EMP), and ensuring the temporary and permanent pollution prevention and mitigation measures (P2M2) are installed correctly.

The EO is responsible for preparing Environmental Performance Monitoring Document (EPMD). PMD describes in detail how EIA approval conditions are going to be complied and how performance monitoring\* of the various pollution prevention and mitigation measures (P2M2) will be conducted to ensure the optimal functionality of the P2M2 is maintained. The details shall include, among others: performance monitoring equipment/instruments, sampling protocols and analysis,

monitoring parameters, sampling frequency, preventive and corrective maintenance procedure for the P2M2, discharge compliance, record keeping, etc. EPMD also includes compliance monitoring (CM) and impact monitoring (IM) wherever relevant.

Performance monitoring in this context refers to the monitoring of certain characteristics that would indicate that a P2M2 is functioning in an optimal manner. It also includes the preventive and corrective maintenance of the P2M2 to maintain their optimal performance. P2M2 refers to all measures to prevent and mitigate pollution and includes temporary pollution prevention and mitigation measures.

The EO is responsible for performing or supervising the conduct of performance monitoring (PM) program as specified in the PMD.

The EO is responsible for preparing Performance Monitoring Report (PMR). The PMR discusses the results of the performance monitoring conducted as described in the PMD. Wherever relevant, PMR shall include data interpretation and assessment of the effectiveness of the pollution prevention and mitigation measures (P2M2) by making comparison of the performance monitoring parameters with their recommended ranges (or standards). Statistical techniques and graphical presentation of the performance monitoring parameters should be used wherever appropriate. PMR shall also make some definitive conclusions on the overall performance of the P2M2 and suggest improvement measures to be taken if necessary. PMR shall be submitted to the Environmental Performance Monitoring Committee (EPMC) as established by the Project Proponent for the EIA project and maintained for the inspection of the DOE officers.

The EO is responsible for communicating the status of environmental regulatory compliance of the project during construction and operation phases to the Project proponent.

The EO is responsible for maintaining a detailed record of major upset conditions encountered, if any, for the duration of the project construction and operation phases. The date of occurrence, nature and causes of upset conditions, and the corrective actions taken shall be recorded. Upset conditions refer to failures of pollution prevention and mitigation measures (P2M2) which result in noncompliance with the EIA approval conditions or discharge/emission standards, or pollution that affects the immediate neighbourhood or seriously threatens the environment or public health and safety.

The EO is responsible for acting as an environmental advisor to the Project Proponent in advising him to undertake additional efforts, if any, to further ensure effective implementation environmental management plan (EMP) including temporary pollution prevention and mitigation measures (P2M2) on a sustained basis.

## 5.4 LD-P2M2 APPLICATION DURING PLANNING STAGE

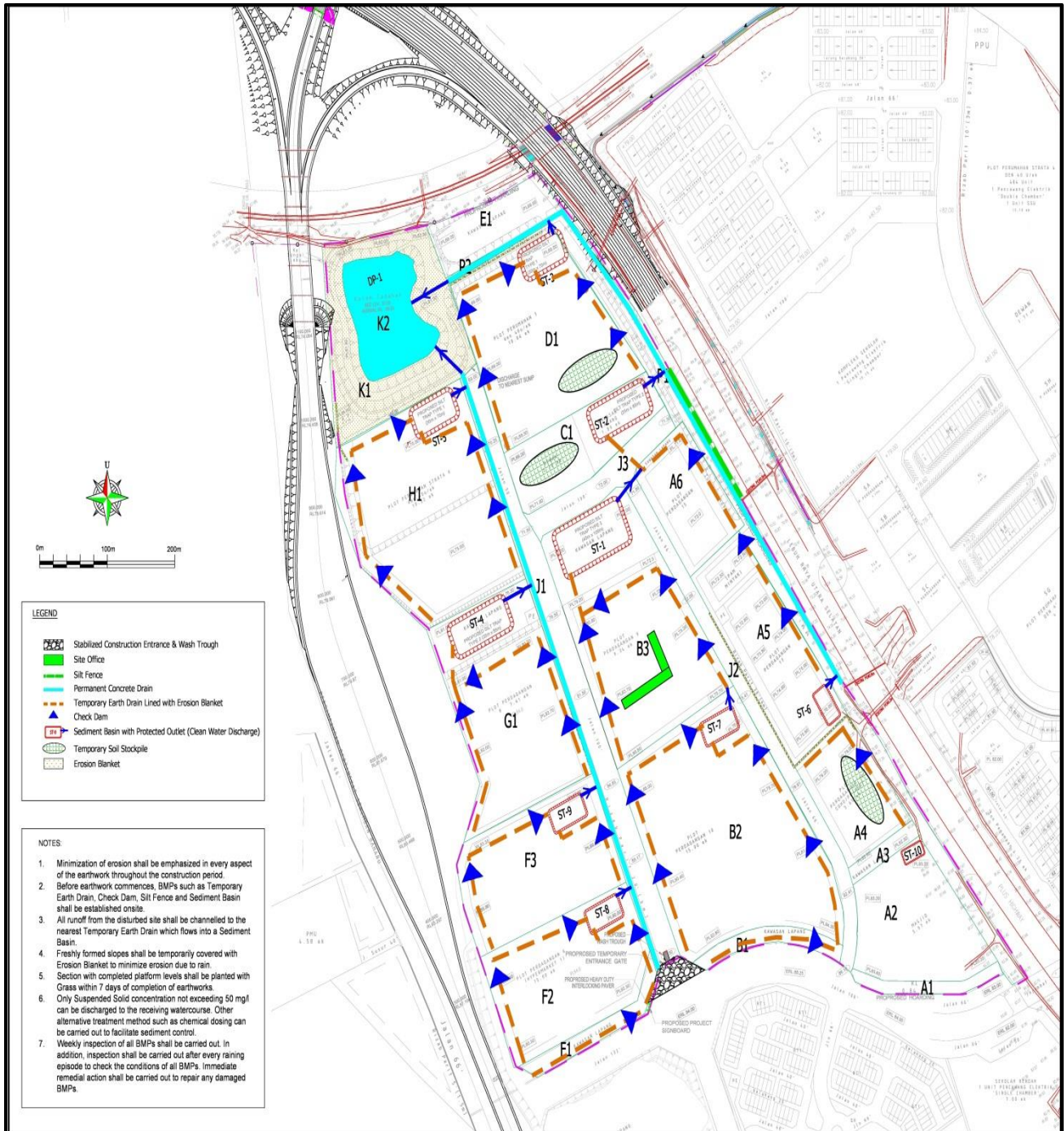
### 5.4.1 How Project Proponents and Consultants Apply LD-P2M2

First of all, the planning stage herein includes all those activities since the conception of the project up to the award of the contract, which covers, amongst other things, the EIA, detailed design, and tender documentation processes.

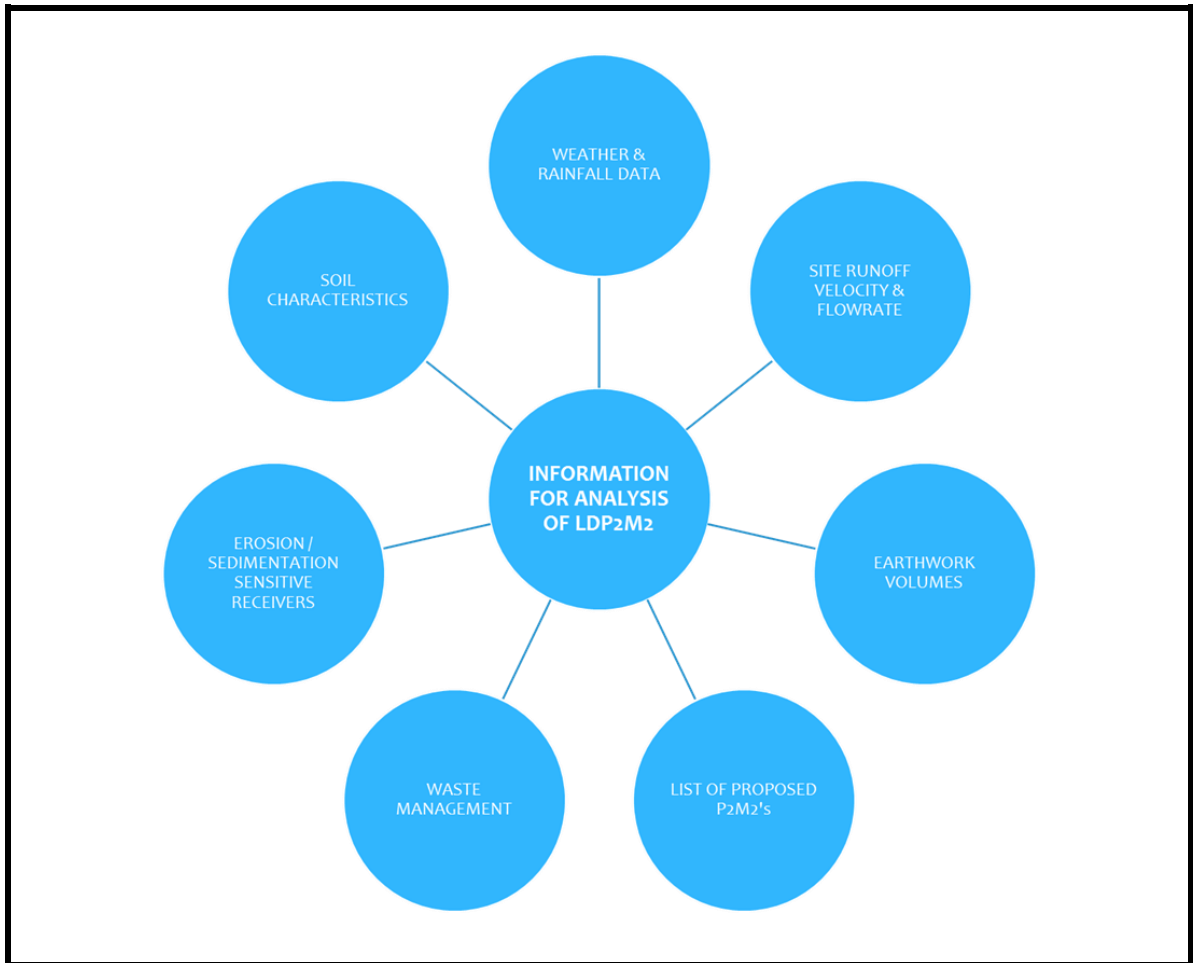
To effectively apply LD-P2M2 at this stage of the project, the Project Proponent (and his Consultants) shall:

- Make a real commitment to address soil erosion and sediment matter at the very stage of the Project;
- Proactively obtain and/or collect all the pertinent information relating to this subject matter, as shown in **Figure 5.1**;
- Review the potential construction sequencing and site operations prior to award of construction contracts, particularly with respect to land disturbing activities;
- Allocate sufficient funds at every stage of project planning / design for implementation of EMP including temporary & permanent land disturbing pollution prevention and mitigation measures;
- Prepare LD-P2M2 Document as part of submission with EIA Report for DOE's approval, and update LD-P2M2 Document during the EMP submission if required;
- Ensure that the Contract Documents include provisions for compliance with environmental requirements including for LD-P2M2 and its associated drawing (a sample of such drawing is shown in **Plate 1** and associated sample calculation for an active construction site is shown in **Appendix I** which incorporated the concept of project phasing);
- Appoint competent Environmental Officers on LD-P2M2 to be stationed on site throughout the construction period;

- Evaluate Tenderer's compliance with tender document, including planning for addressing erosion and sediment issues, implementation and operation of environment mitigation measures, and monitoring program;
- Ensure all the environmental requirements relating to erosion and sediment are included in the Contract Documents for the Contractor's information and incorporation into his plan of work.



**Plate 1: Sample LD-P2M2 Drawing**



**Figure 5.1: Information for LD-P2M2 Analysis**

## 5.5 LD-P2M2 APPLICATION DURING CONSTRUCTION STAGE

### 5.5.1 How Project Proponents Apply LD-P2M2

The “Construction” essentially includes two distinct phases: *Pre-construction* where in this *Guidelines* is taken to mean all those preliminary or early site activities to prepare the platforms for the construction works, whilst *Construction* is taken to mean all those activities involved in the creation or building of the *permanent works* of the project. In either phase, the Project Proponent shall:

- Establish a project Environmental Performance Monitoring Committee (EPMC) to monitor environmental performance, effectiveness of pollution prevention and mitigation measures (P2M2), and status of regulatory compliance of project;
- Appoint Chairman of EPMC to be responsible for ensuring the decisions of the meeting are responsibly executed;

- Review with Contractor the environmental performance periodically, including, amongst others, overall monitoring program, environmental controls and mitigation measures, and identify improvements to avoid breaches of limit levels;
- Monitor Contractor's performance with respect to compliance with contract specifications, including effective implementation and operation of environment mitigation measures and other aspects of the monitoring program; adherence to agreed protocols or those in the contract specifications; assurance that work is within the scope of the contract and other tender conditions.

### **5.5.2 How the Environmental Officers Apply LD-P2M2**

During this stage of the project, the Environmental Officers shall:

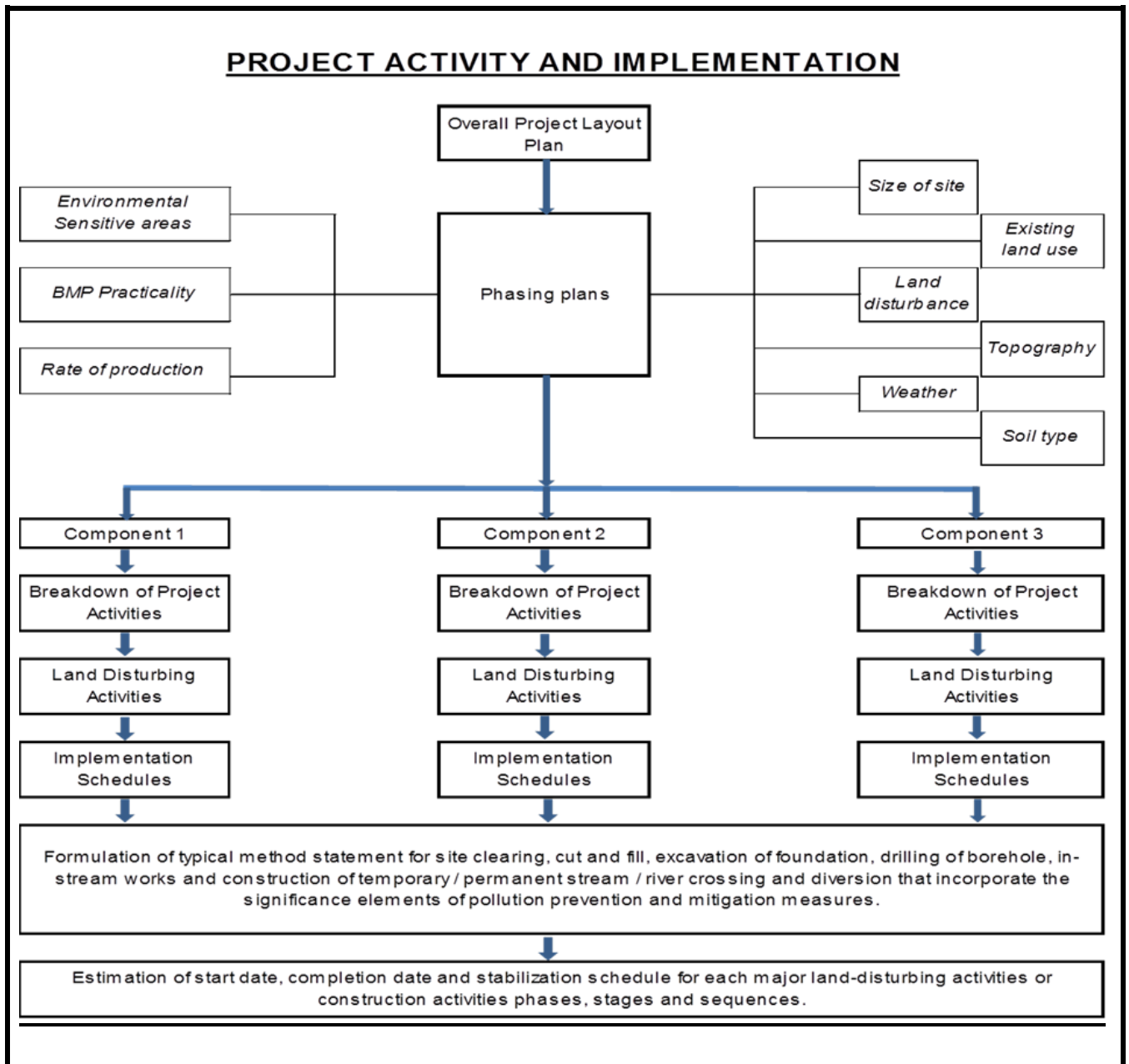
- Ensure the EMP is implemented diligently, and that all temporary and permanent P2M2s are correctly installed as required;
- Prepare Environmental Performance Monitoring Document (EPMD) to describe how EIA approval conditions are to be complied with;
- Document how performance monitoring of P2M2s will be conducted;
- Monitor conduct of performance monitoring program and prepare Performance Monitoring Report (PMR) to: discuss results of PM; include data interpretation and assessment of P2M2s effectiveness; and conclude on overall performance of P2M2 and suggest improvement measures where necessary;
- Maintain detailed record of major upset conditions encountered (e.g., failures of P2M2s resulting in non-compliances, etc.);
- Communicate status of environmental regulatory compliance to PP;
- Advise PP on additional efforts to further ensure effective implementation of EMP including temporary pollution prevention and mitigation measures.

### **5.5.3 How the Contractors Apply LD-P2M2**

During this stage of the project, the Contractors shall:

- Fully understand the requirements of the LD-P2M2 Document during the tender stage and to allow in the tender budget for the anticipated land disturbance pollution prevention and mitigation measures;

- Integrate the requirements of LD-P2M2 Document into his master planning for site works and update this Document as necessary for submission to DOE;
- Apply diligently all the relevant elements of erosion and sediment controls into the project, as illustrated in the LD-P2M2 framework in **Figure 5.2**;
- Comply with Contract Documents including provisions for environmental requirements on LD-P2M2;
- Appoint competent project Environmental Officers for EMP implementation including LD-P2M2;
- Plan and implement measures for controlling erosion and sediment issues, operation of environment mitigation measures, and monitoring program;
- Participate actively in EPMC and collaborate with Committee in ensuring compliance to regulatory and EIA Approval Conditions, etc;
- Review with Project Proponent on environmental performance of the project;
- Provide full assistance to the PP's Environmental Officer in executing his duties and responsibilities with regard to ensuring compliance to Contract Document and regulatory requirements, particularly on environmental performance, operation of environment mitigation measures, and monitoring program, amongst others



**Figure 5.2: LD-P2M2 Implementation Framework**

## 5.6 SITE APPLICATION PRACTICES

### 5.6.1 Usage of Project Information and P2M2s

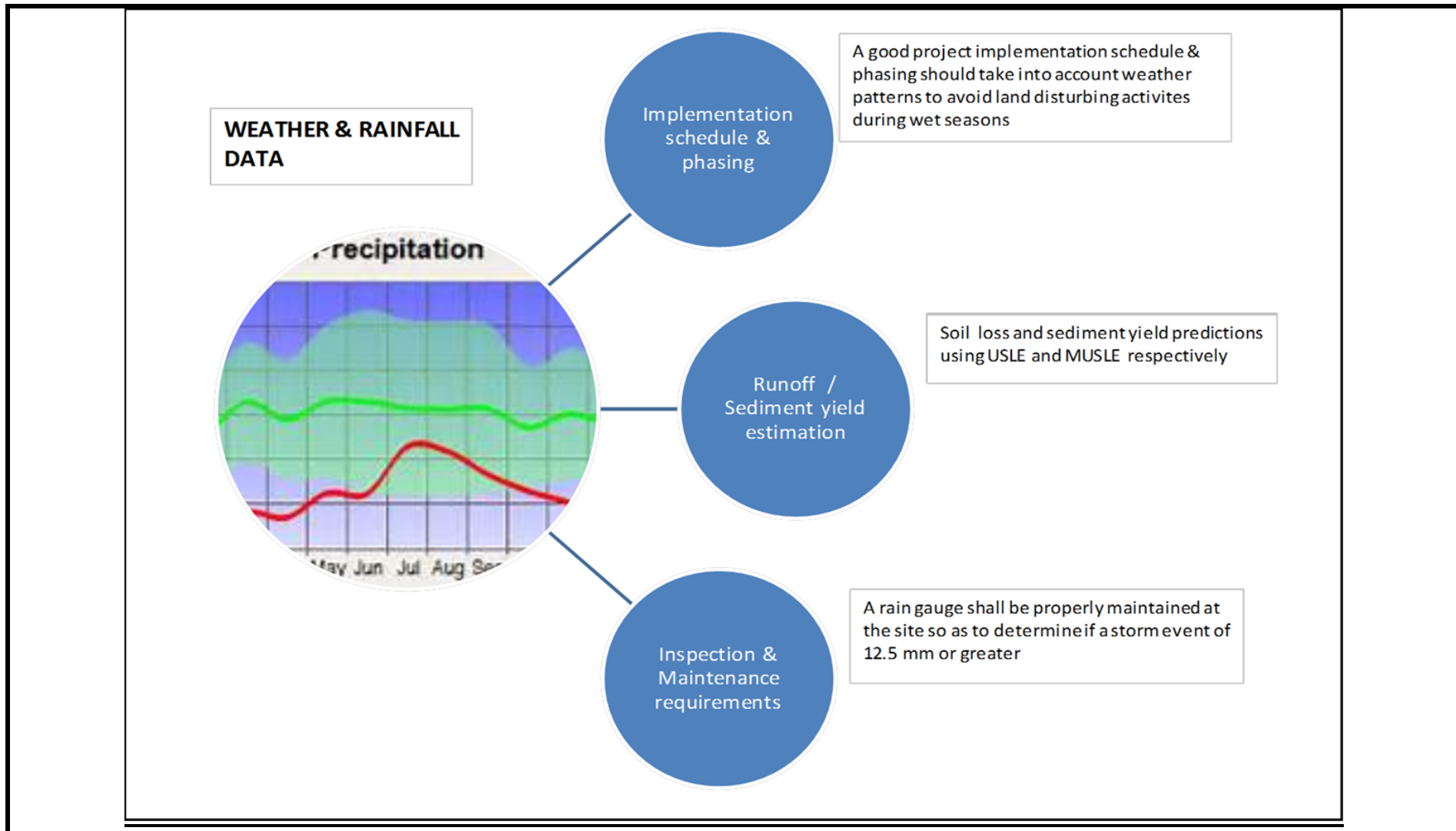
In **Figure 5.1** above, information to be used for the analysis of LD-P2M2 for a project site included the following:

- ❖ Weather and rainfall data;
- ❖ Site runoff velocity and flow rate;
- ❖ Earthwork volumes;

- ❖ Soil characteristics;
- ❖ Erosion and sedimentation sensitive receivers;
- ❖ Waste management; and
- ❖ List of proposed P2M2s

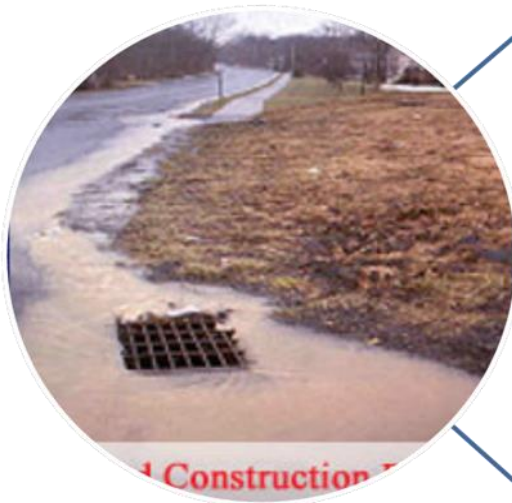
The crux to a successful application of LD-P2M2 to a project site is being able to make use of the above information, either individually or collectively depending on the situation, to plan, select and execute the correct P2M2s on site accordingly. **Figures 5.3 to 5.9** illustrate the self-explanatory match ups of these two elements, i.e., type of information and P2M2s.

In addition, **Appendix F** presents a collection of steps on a guide to manage erosion and sediment controls on project sites.



**Figure 5.3: Weather/Rainfall Data and Related P2M2s**

**SITE RUNOFF VELOCITY  
& FLOWRATE**



**Perimeter  
Control**

Such as, filter or perimeter berms, silt fences, sediment traps, sediment basins, construction entrance, temporary diversion dikes or earth bunds and diversion drains that control discharges from the site.

**Runoff  
Management**

Such as, temporary earth drain, diversion channel and conveyance system, and to be combined with interval check dams to reduce the runoff velocity. For upslope runoff, slope drains, flexible pipe slope drains (PSD), rock lined drainage chutes or flume, cascade drain to avoid affecting slope surface.

**Temporary /  
Permanent  
Stabilization  
or Roadways**

Provide a temporary vegetative and/or non-vegetative protective cover to exposed areas. Include temporary seeding, geotextiles, mulches, and other techniques. For roadways, runoff conveyance system such as road ditch, temporary earth drain, catch drains, berm drains, toe drains, slope drains and in-slope or out-slope diversion shall be constructed to convey runoff to stabilized area.

Figure 5.4: Runoff Velocity /Flow rate and Related P2M2s

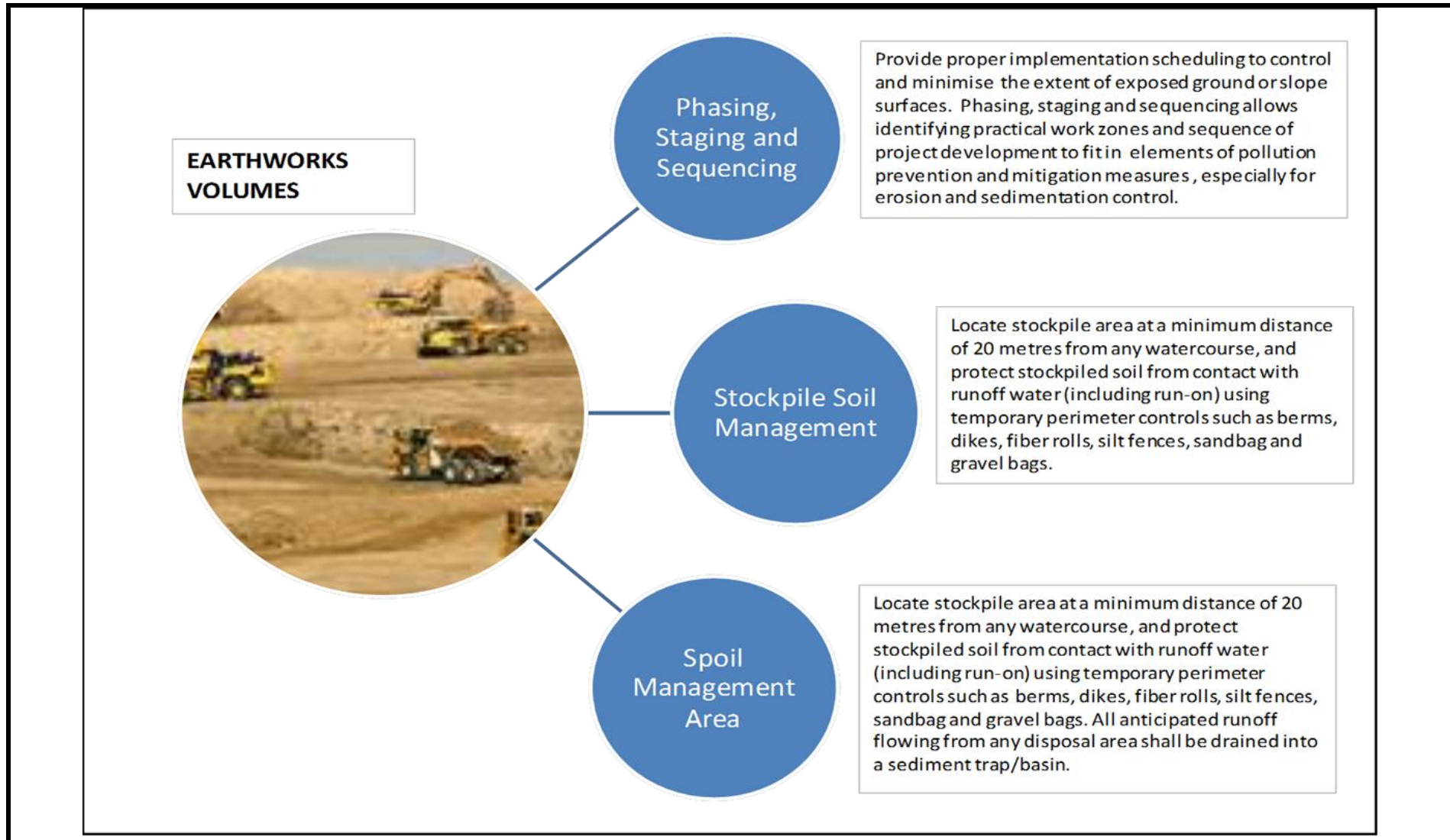


Figure 5.5: Earthwork Volumes and Related P2M2s

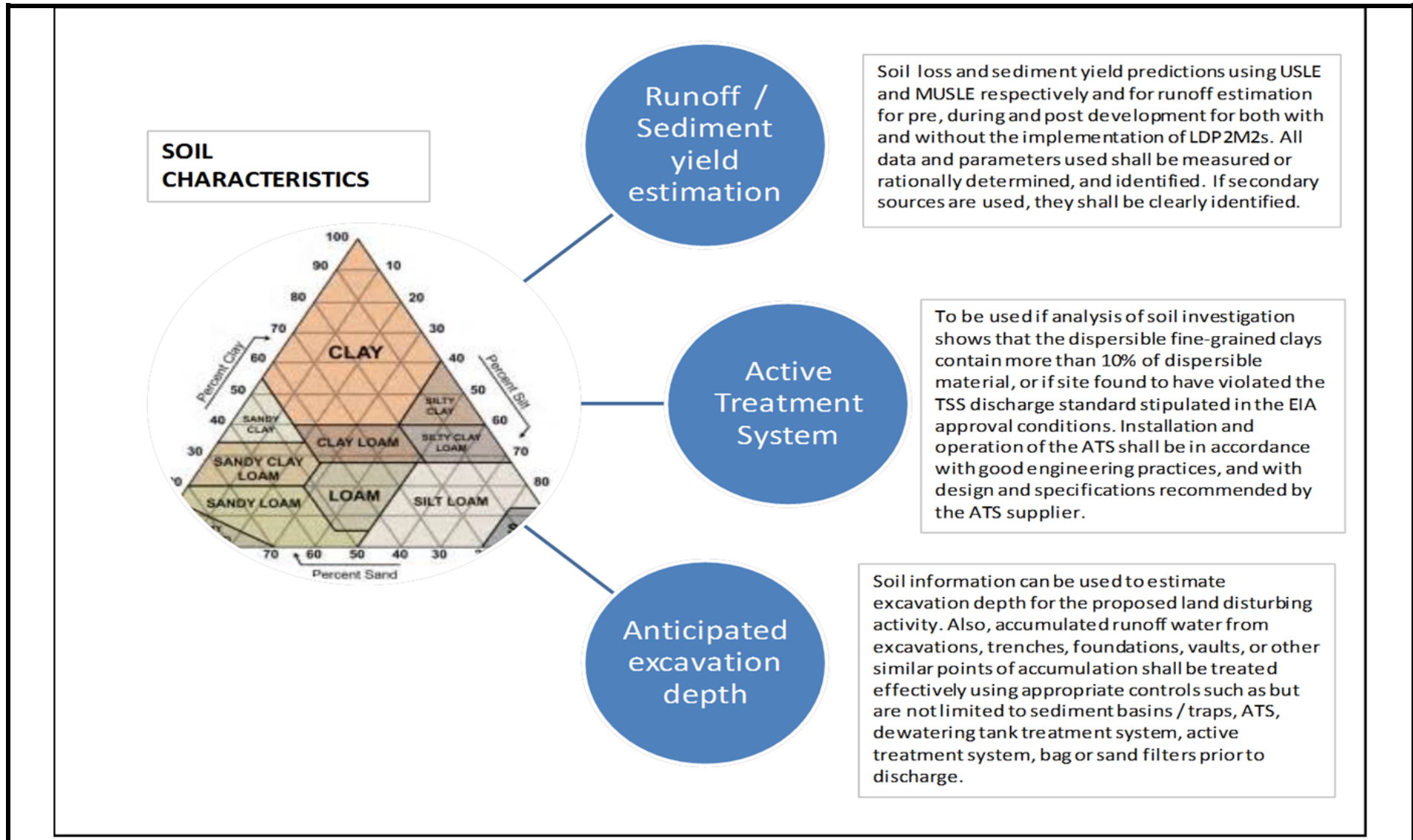
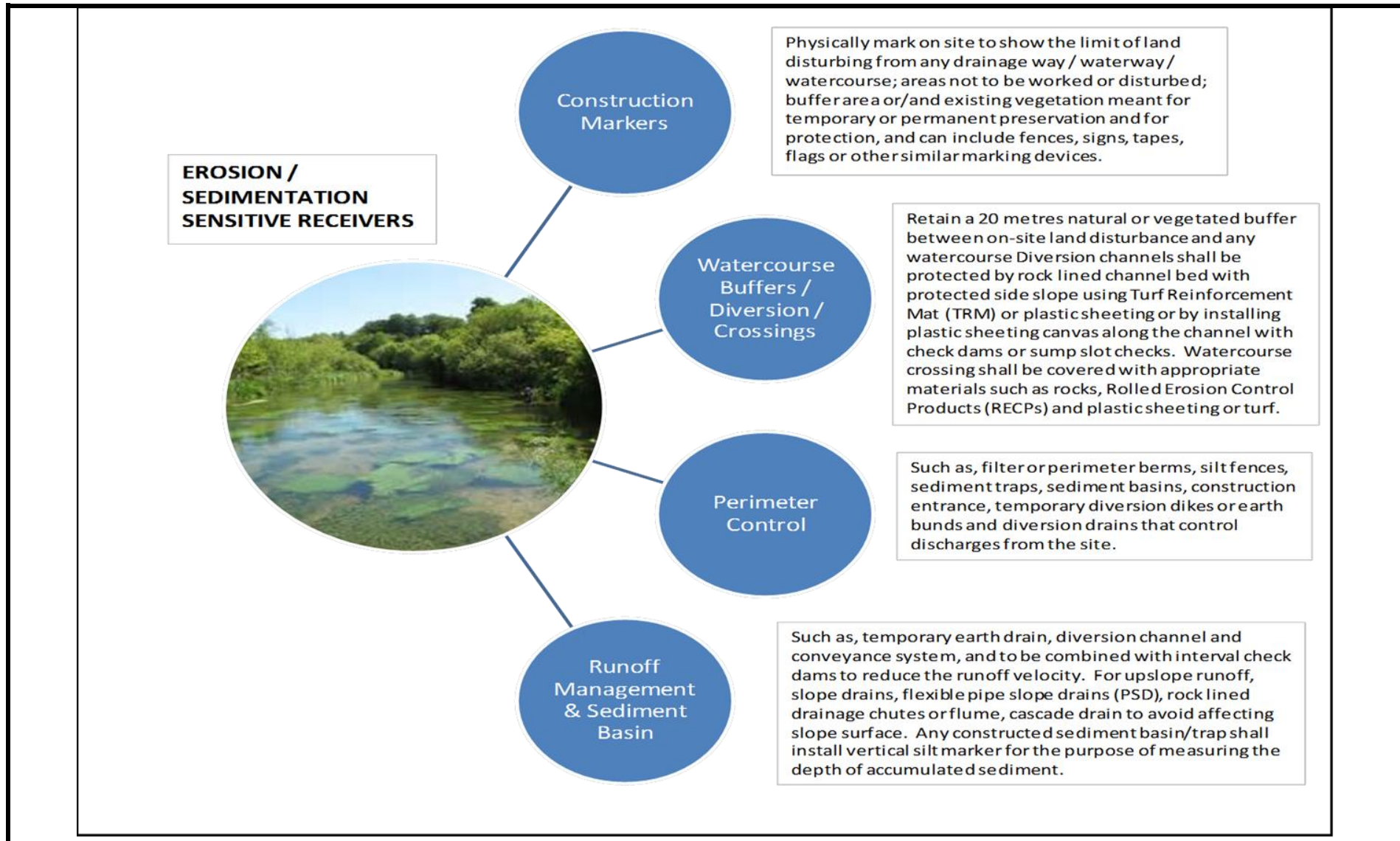
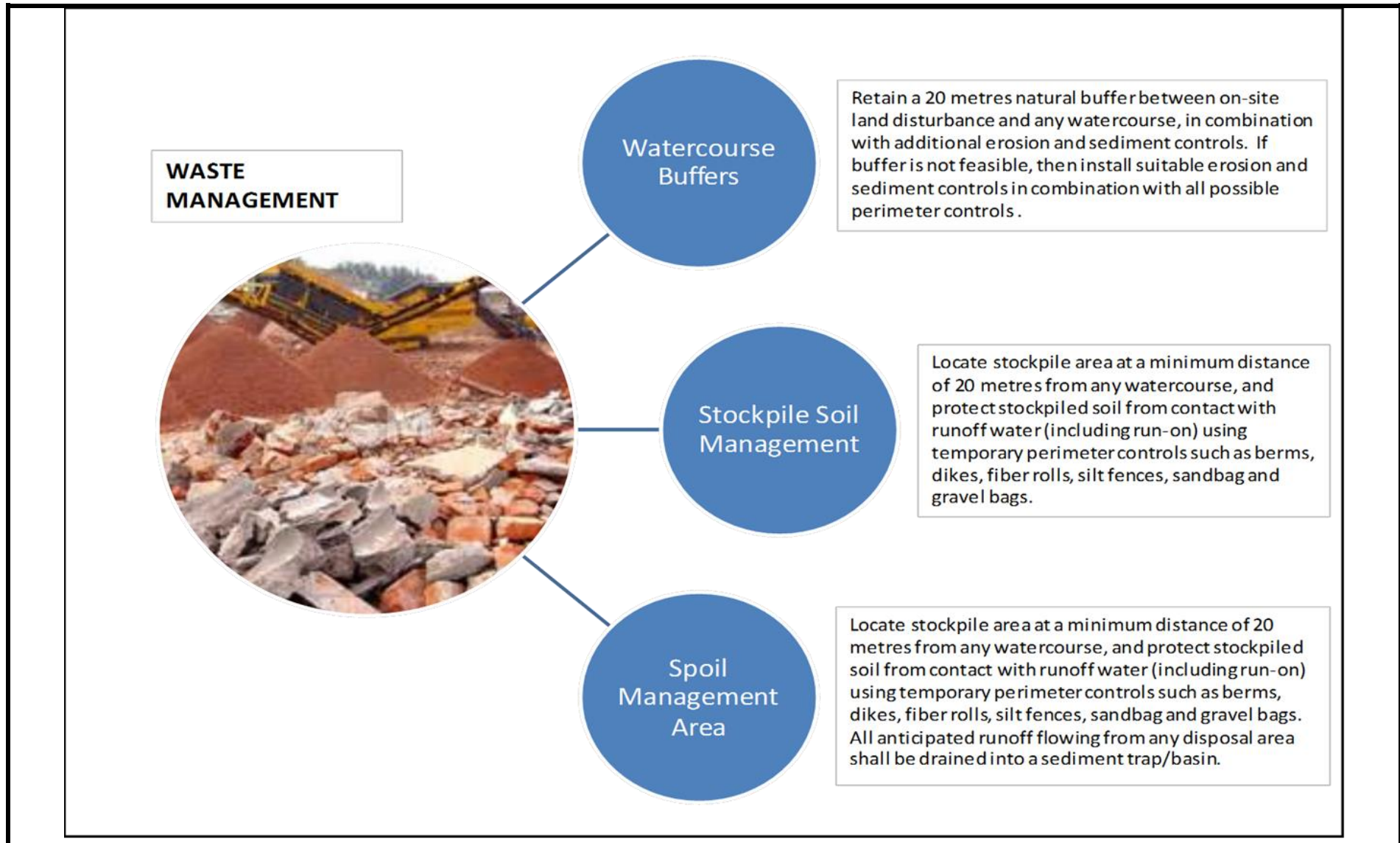


Figure 5.6: Soil Characteristics and Related P2M2s



**Figure 5.7: Erosion/Sedimentation Sensitive Receivers and Related P2M2s**



**Figure 5.8: Waste Management and Related P2M2s**

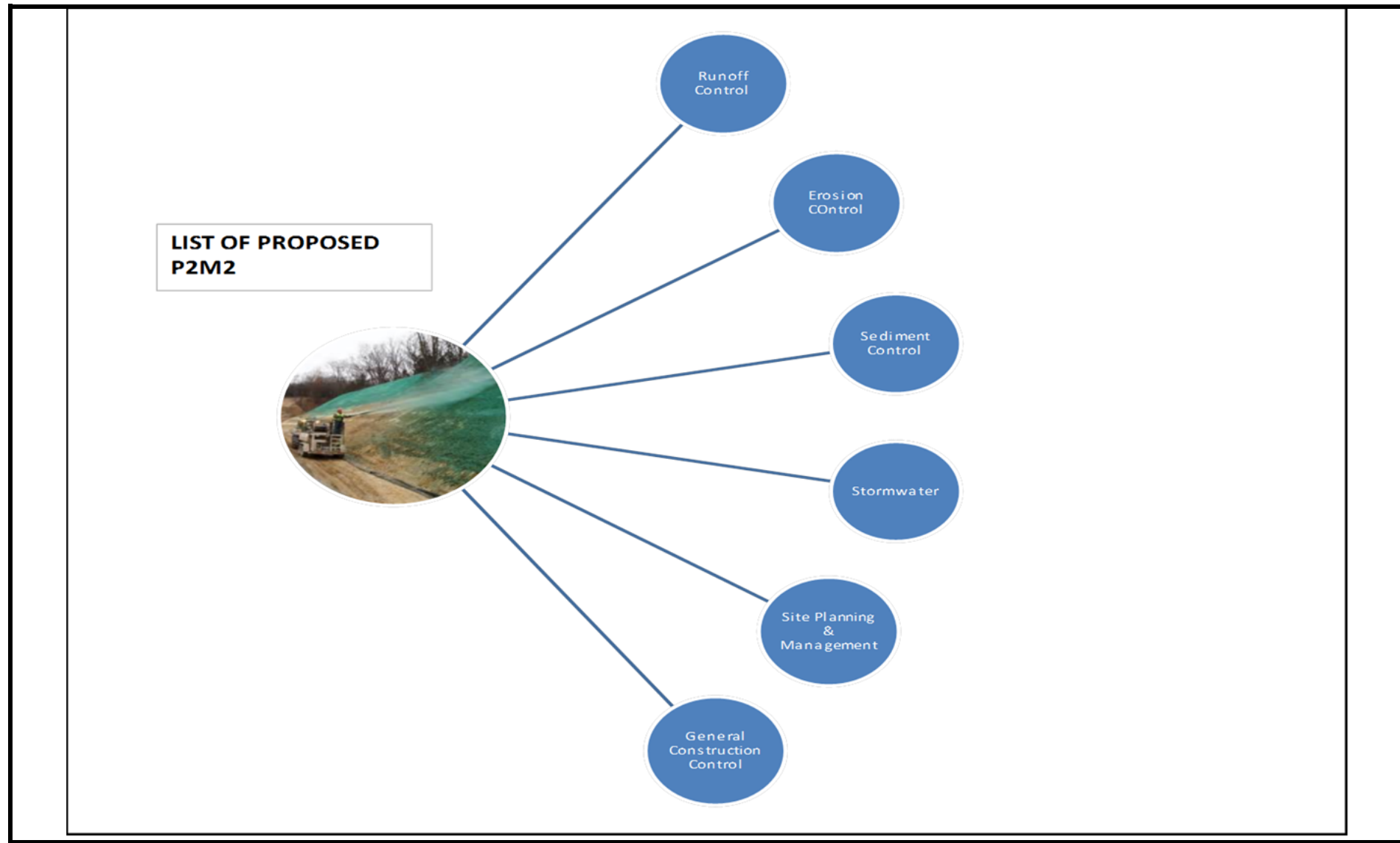


Figure 5.9: List of P2M2s

## 5.6.2 Applying LD-P2M2 Basic Principles

In this remaining section, each of the LD-P2M2 principles listed in above is elaborated to show how they can be applied on the field, i.e., at the project site. For ease of reference, these principles are reintroduced below:

- Principle 1: Integrate project design with site constraints.
- Principle 2: Preserve and stabilize drainage ways.
- Principle 3: Minimize the extent and duration of disturbance.
- Principle 4: Control runoff flows onto, through and from the site in stable drainage structures.
- Principle 5: Install perimeter controls.
- Principle 6: Stabilize disturbed areas promptly in a timely manner.
- Principle 7: Protect steep slopes.
- Principle 8: Use sediment controls to prevent off-site damage.
- Principle 9: Protect inlets, storm drain outfalls, and culverts.
- Principle 10: Provide access and general construction controls.
- Principle 11: Inspect and maintain best management practices and control measures
- Principle 12: Employ experienced and competent personnel and consistently conduct relevant training

This section will assist the relevant project parties in their planning of identifying risk analysis of potential erosion and sediment issues, and of identifying & selecting the P2M2s and BMPs that might be used to manage the risks. It should however be noted that such planning is subject to change once construction begins to suit the evolving site conditions. It should also be pointed out that the below discussion may not necessary follow the same order of the above principles, as some site conditions may warrant more than 1 principle to be incorporated.

### 5.6.2.1 Principles 1 & 5: Integrate project design with site constraints & Install perimeter controls

Before conducting land-clearing and soil-disturbing activities, mark all clearing limits on the plan sheets and in the field, so as to retain native topsoil, existing vegetation and buffer zones in an undisturbed state to the maximum extent practicable.

Use fences, signs, tapes, flags or other similar marking device to delineate project boundaries in non-sensitive areas, and use high-visibility fencing to delineate sensitive areas that are to be protected, such as wetlands, streams and their buffers, and vegetation to be

preserved. Only use high-visibility (orange) silt fence if it serves the dual purpose of delineation and sediment control.

The related minimum standards requirements associated with the above include: *Construction Markers; Stream/drainage way/waterway/watercourse buffers; Perimeter Control; Stockpile Soil Management; Spoil Management Area (Disposal Area).*

#### **5.6.2.2 Principles 2 & 9: Preserve and stabilize drainage ways & Protect inlets, storm drain outfalls, and culverts**

Protect all drain inlets from sediment with approved inlet BMPs. Inlet protection devices must be capable of being maintained without losing sediment or material into the catch basin and must be inspected weekly to ensure discharge treatment is occurring.

Use erosion control BMPs to prevent turbid water from being generated, and use diverting BMPs, like temporary curbs, to prevent turbid water from reaching inlets. Wherever feasible, use inlet covers or plugs to prevent turbid discharges, and implement a strategy to manage the resulting ponding water.

Design, construct, and stabilize all temporary conveyance channels to minimize erosion. Provide stabilization methods, including armoring material, adequate to minimize erosion at the outlets of all conveyance systems. Common outlet locations are areas where designed structures discharge, including ponds, culverts, or pipe slope drains discharge. Plastic covering increases flow rates, so stabilize outlet areas where water is running off plastic. Place check dams at regular intervals based on the grade of the conveyance.

The related minimum standards requirements associated with the above include: *Schedule of Phasing, Staging and Sequencing; Stream/drainage way/waterway/watercourse buffers; Sediment Basin/Trap; Runoff Management; Temporary or permanent watercourse diversion; Temporary or permanent watercourse crossing; Temporary Stabilization; Dewatering practices Active Treatment System (ATS); Discharge; Corrective Actions; Site Inspections; Maintenance.*

**5.6.2.3 Principles 3 & 4: Minimize the extent and duration of disturbance & Control runoff flows onto, through and from the site in stable drainage structures**

Before large grading or clearing activities occur, install detention facilities to use as containment, infiltration, or treatment.

Design drainages to account for both on- and off-site water sources (divert or tight-line off-site sources of water where feasible). Control discharges to protect downstream properties and waterways from erosion by preventing increases in the volume, velocity, and peak flow rate of stormwater leaving the site during construction. Control peak flow and discharge rates to minimize erosion at outlets and downstream channels or streambanks.

Minimize soil erosion by controlling stormwater volume and velocity within the site. Maintain or encourage sheet flow wherever feasible; use dispersion or energy dissipation BMPs to help prevent concentrated flows from developing. If concentrated flows cannot be prevented, such as in conveyance or outlet areas, ensure BMPs are designed to minimize erosion. Use upland vegetated areas to disperse and infiltrate stormwater wherever feasible.

The related minimum standards requirements associated with the above include: *Schedule of Phasing, Staging and Sequencing; Sediment Basin/Trap; Runoff Management; Discharge.*

**5.6.2.4 Principles 3 & 6: Minimize the extent and duration of disturbance & Stabilize disturbed areas promptly in a timely manner**

Stabilize all exposed and unworked soils by applying erosion control BMPs accordingly. Select erosion control BMPs based on site-specific factors and the estimated duration of the needed function (temporary stabilization until permanent stabilization will occur).

When selecting erosion control BMPs, consider factors such as the project location and time of year, and site conditions such as climate, slope length and gradient, and soil type.

Some erosion control products like biodegradable erosion control blankets and hydraulically-applied mulches come with a wide

variety of performance expectations, recommended uses, and installation requirements.

Stockpiles and cut and fill slopes are especially vulnerable to erosion when they become saturated. Locate stockpiles away from storm drain inlets, waterways, and drainage channels wherever feasible. Stabilize or protect all stockpiles and cut and fill slopes that are not actively being worked. Plastic covering can create erosion problems, the majority of which are related to installation errors. Plastic is the only BMP that can prevent soil saturation (it prevents infiltration). Preventing infiltration and soil saturation may be the goal in some cases; however, expect large volumes and velocities of clean water coming off the plastic. Unmanaged runoff from plastic covering can quickly create erosion issues. Seed laying on soil is not considered a soil stabilizing BMP; about a 70% vegetative cover must be evident before the soil is considered adequately stabilized. Consider using mulch with the seed to get the immediate soil coverage.

Control stormwater volumes and velocity within the site to minimize erosion. Whenever feasible, minimize the total amount of open and actively worked soil at one time and the disturbance of slopes during the wet season. Preserve topsoil whenever feasible, and minimize soil compaction in areas that will be permanently vegetated. Stabilize equipment staging, material storage, borrow areas, and construction haul roads.

If the contractor feels that the area limitation for land disturbing activities such as site clearance, grading and grubbing is too restrictive, he shall update the LD-P2M2 document to incorporate a larger area, as well as a plan and schedule for additional BMPs that are necessary to manage increased erosion-related risks.

The related minimum standards requirements associated with the above include: *Schedule of Phasing, Staging and Sequencing*; *Scheduled Site Meeting*; *Temporary Stabilization*; *Stockpile Soil Management*; *Spoil Management Area (Disposal Area)*; *Establishment of Environmental Performance Monitoring Committee (EPMC)* and *Performance Monitoring Documentation*.

### 5.6.2.5 Principle 7: Protect steep slopes

Design, construct, and manage cut and fill slopes to minimize erosion by the following:

- ✓ Select BMPs based on the soil type and potential for erosion.
- ✓ Reduce continuous length or gradient of slopes with terracing or diversions.
- ✓ Add surface texture to slope to slow, disperse, or dissipate flows (e.g., blanket, mulch, compost sock).
- ✓ Use top of slope BMPs to divert erosive flows away from the slope, such as interceptor dikes, swales, stabilized channels, or temporary pipe slope drains.

BMPs used to cover slopes, such as plastic covers, do not hold up to concentrated flows, which is why other BMPs must be used to prevent concentrated flows from developing or hitting slopes. Manage overland flow or off-site water run-on to minimize erosion on slopes. Ensure concentrated flows or drips coming off overhead structures do not create erosion on slopes.

Place excavated material on the uphill side of trenches, consistent with safety and space considerations.

The related minimum standards requirements associated with the above include: *Schedule of Phasing, Staging and Sequencing; Perimeter Control; Sediment Basin/Trap; Runoff Management; Temporary Stabilization; Stockpile Soil Management; Spoil Management Area (Disposal Area); Active Treatment System (ATS); Discharge.*

### 5.6.2.6 Principle 8: Use sediment controls to prevent off-site damage

Sediment control BMPs are required to be in place before construction starts in a contributing area, and maintained until construction is complete and the contributing runoff area is fully stabilized.

Use sediment control BMPs to detain, slow, or filter flows (provide treatment) prior to a discharge to minimize the release of sediment from project boundaries or to receiving surface waters.

Protect all potential discharge points with sediment control BMPs during construction activities, and maintain them based on changing

site conditions, site inspection findings, visual monitoring, or discharge sample quality.

For large land-disturbing projects with multiple discharge points, provide more sediment control BMPs and regular maintenance of those BMPs to ensure continued performance. Maintain sediment control BMPs (remove sediment, enhance, or replace) more often if erosion control BMPs are not installed or effective.

Silt fence can create erosion problems, the majority of which are related to installation errors. Do not install silt fence in areas that receive concentrated flows. Water filters through silt fence very slowly—too slowly to treat concentrated flow. Concentrated flows will overtop silt fence or collapse it altogether. Trench in silt fence and install it on the contour of the slope or it will create concentrated flow where there was none before.

Locate BMPs intended to trap sediment on-site. Provide and maintain natural buffers around surface water and sensitive areas wherever feasible. Direct turbid stormwater to upland vegetated areas to maximize stormwater infiltration. Wherever feasible, design pond outlet structures that will withdraw or discharge stormwater from the surface of detained water, to avoid discharging sediment that is suspended lower in the detained water column.

The related minimum standards requirements associated with the above include: *Schedule of Phasing, Staging and Sequencing; Stream/drainage way/waterway/watercourse buffers; Perimeter Control; Sediment Basin/Trap; Runoff Management; Stockpile Soil Management; Spoil Management Area (Disposal Area); Dewatering practices; Active Treatment System (ATS); Discharge; Corrective Actions; Site Inspections; Maintenance, Standards and Specifications for P2M2s.*

#### **5.6.2.7 Principle 10: Provide access and general construction controls**

Install stabilized construction access points before major land clearing or grading operations take place. If a stabilized construction entrance fails to prevent sediment track-out, a tire wash may be necessary.

Wherever feasible:

- ✓ Limit access points to the fewest number possible, using only one wherever feasible (or one entrance and one exit);

- ✓ Slope entrances or haul roads toward the site to prevent discharges onto the roadway.

If sediment is tracked off-site, street sweeping is required at the end of each day at a minimum, and more frequently if necessary to prevent turbid discharges. However, sweeping does not remove fine sediment particles from the roadway (sweepers that use water to wash the roadway remove more sediment and prevent dust); therefore, a rain event can still cause a turbid discharge. Source control, preventing the track out in the first place, is always the goal. Street sweeping or cleaning is not a substitute for a stabilized construction entrance.

The related minimum standards requirements associated with the above include: *Stabilized Construction Entrance; Sediment Basin/Trap; Temporary or permanent roadways.*

#### **5.6.2.8 Principle 10: Provide general construction controls**

Use diversion, cover, containment, and other BMPs to minimize the contamination of stormwater. Handle and dispose of pollutants, including construction materials, waste materials, and demolition debris, in a manner that does not cause contamination of drainage or adjacent water bodies.

Concrete spillage and concrete wastewater are prohibited to discharge to outside drainage. Handle and dispose of concrete waste appropriately to prevent contamination. Collect concrete slurry generated from cutting or grinding operations from the roadway on a continual basis immediately behind the operations, and dispose of in accordance with waste management plan.

Discharge tire wash wastewater to a separate on-site treatment system that prevents discharge to surface waters, such as a closed-loop recirculation system or upland application. Do not use upland application if oil sheen or contaminated soils are present.

Outline methods for controlling nonhazardous sources of pollutants, such as loose soils or turbid stormwater/groundwater, and preventing high-pH discharges or other prohibited discharges. Planned work activity may trigger the development of additional plans to manage pollutant-generating work such as hydro-demolition or shaft drilling.

Outline methods that will be used for controlling potentially hazardous materials, such as cementitious materials, petroleum products, and chemicals. Include strategies for cover, containment, and protection from vandalism for all hazardous materials, as well as secondary containment for on-site fueling tanks.

The related minimum standards requirements associated with the above include: *Schedule of Phasing, Staging and Sequencing; Stream/drainage way/waterway/watercourse buffers; Sediment Basin/Trap; Runoff Management; Temporary or permanent watercourse diversion; Temporary or permanent watercourse crossing; Temporary Stabilization; Dewatering practices Active Treatment System (ATS); Discharge; Corrective Actions; Site Inspections; Maintenance.*

**5.6.2.9 Principles 11 & 12: Inspect and maintain best management practices and control measures, & Employ experienced and competent personnel and consistently conduct relevant training**

Engage suitably competent personnel (i.e. Environmental Officers) to perform periodic (weekly, monthly, audit) site inspections of the BMPs on-site, and maintain them based on site conditions, site inspection findings, and discharge sample values.

Maintain BMPs as needed to ensure functional performance in accordance with the LD-P2M2 Document. Keep records on-site to document BMP implementation and maintenance in the site log book.

The related minimum standards requirements associated with the above include: *Corrective Actions; Site Inspections; Maintenance; Standards and Specifications for P2M2s; Establishment of Environmental Performance Monitoring Committee (EPMC) and Performance Monitoring Documentation.*

**5.6.2.10 Principle 12: Employ experienced and competent personnel and consistently conduct relevant training**

Manage the contract and apply the following actions on all projects:

- Phase the work. If the contractor finds the exposure limitation too restrictive, they can submit a request to open a larger area, including a plan and schedule for any additional BMPs that may be necessary to manage the increased risks.
- Never allow the contractor to disturb more acreage than what was permitted.
- Ensure sediment control BMPs are installed before construction begins in an area, to provide treatment prior to discharge.
- Once construction begins, ensure the soil cover timelines are being followed.
- Ensure weekly (and other) site inspections are being performed.
- Conduct weekly discharge sampling in accordance with sampling plan and report data collected in the PMD.
- Maintain a site log book that contains records of the BMPs installation.
- Keep the updated LD-P2M2 Document and plans in the site log book or reasonably accessible to the site (an electronic copy is allowed as long as it can be accessed on-site).

The related minimum standards requirements associated with the above include: *Corrective Actions; Site Inspections; Maintenance; Standards and Specifications for P2M2s; Establishment of Environmental Performance Monitoring Committee (EPMC) and Performance Monitoring Documentation.*

## 5.7 PREPARING A LD-P2M2 DOCUMENT

### 5.7.1 General Guidelines for preparing a LD-P2M2 Document

**“Appendix 3 - Guidance Document For Addressing Soil Erosion And Sediment Control Aspects In The Environmental Impact Assessment” (from Environmental Impact Assessment Guidelines in Malaysia) 2016**

The requirements to address soil erosion and sediment control aspects are firstly stipulated in the *Environmental Impact Assessment Guidelines in Malaysia 2016* in “*Appendix 3 - Guidance Document For Addressing Soil Erosion And Sediment Control Aspects In The Environmental Impact Assessment*”, but also serve as useful reference for preparing a LD-P2M2 Document.

For easy reference, the requirements of “Appendix 3” are reproduced below.

### **“REQUIREMENT TO ADDRESS SOIL EROSION AND SEDIMENT CONTROL ASPECTS IN ALL EIA REPORTS**

1. All Environmental Impact Assessment (EIA) reports are required to address the aspects of soil erosion and sediment control.

### **PURPOSE OF THE GUIDELINES**

2. This Guideline is prepared to assist project proponents and environmental consultants in addressing the aspects of soil erosion and sediment control in the EIA reports. The information required as specified in this Guidelines is additional to that required by the EIA Guideline in Malaysia and EIA specific guidelines for different sectors.

### **CONTENT OF RELEVANT CHAPTERS ADDRESSING SOIL EROSION AND SEDIMENT CONTROL**

3. Soil erosion and sediment control shall be discussed in the following chapters in the EIA report.

#### **3.1 Project Description**

The project concept shall take into consideration the following aspects amongst others: terrain, geology, natural topography, hydrology and natural features. Specifically, the following principles shall be adopted:-

- a. Plan the development to fit the particular topography, soils, drainage patterns, natural features and vegetation of the sites, which is to be reflected in the layout plan.
- b. Method statement that describes how the major activities of the project that may cause erosion and sedimentation are going to be undertaken. Taking into consideration site conditions involved, the method statement shall also incorporate appropriate phasing (taking into account rainy seasons or monsoon period), preservation of green areas and buffer zones.

- 3.2 Project Options describe options for method statement and layout plans and the reasons why a specific method statement and layout plan has been chosen.
- 3.3 Description of the Existing Environment apart from the information required as described in the EIA Guideline in Malaysia, the following information shall be included:-
- a. Geological terrain mapping (for development on hills and highlands) in accordance with the requirements of the Department of Minerals and Geoscience (Manual Pemetaan Geologi Terrain, JMG 2006).
  - b. Erosion risk map.
  - c. Pre development conditions taking into consideration the following factors:-

rainfall-runoff erosivity factor (R), soil erodibility (K), topographic factor (LS), cover management factor (C), erosion control practice factor (P), volume of runoff (V) and peak flow (Q) for the storm event in order to determine soil loss and sediment yield using Universal Soil Loss Equation (USLE) and Modified Universal Soil Loss Equation (MUSLE).

All factors used in the USLE and MUSLE shall be taken from local conditions and results from studies conducted locally. R= rainfall erosivity data, must be obtained from rainfall station nearest to the project site based on average ten years records.

C = cover management factor must be taken from the published results of studies by the DID Malaysia or other researchers, if unavailable. K= soil erodibility data, must be obtained from results from tests done for the specific site. Tests must be conducted to obtain values for K (erodibility).

### 3.4 Potential Significant Impacts

Apart from the information required as described in the EIA Guideline, the information on R, K, LS, C, P, V, and Q for the storm event shall be provided and used to determine soil loss and sediment yield using Universal Soil Loss Equation (USLE) and Modified Universal Soil Loss Equation (MUSLE) for the following scenarios:

- a. During development/construction:
  - i. Without mitigating measures (worst case scenario).
  - ii. With mitigating measures.
  
- b. Post development conditions
 

The calculation to determine the soil loss (USLE) and sediment yield (MUSLE) must be performed according to the stages of construction and phases of development. Mitigation measures shall be instituted to ensure that the pre development's flow conditions at the site are maintained in the post development stage.

The details of USLE and MUSLE calculations in paragraphs 3.3c, 3.4a and 3.4b shall be included as an appendix to the EIA report.

## 4 Pollution Prevention and Mitigation Measures (P2M2)

### 4.1 Principles in Erosion and Sediment Control

To prevent erosion and control sediment, the following primary principles shall be adopted:-

- a. Integrate project design with site constraints.
- b. Preserve and stabilize drainageways.
- c. Minimize the extent and duration of disturbance.
- d. Control runoff flows onto, through, and from the site in stable drainage structures.
- e. Install perimeter controls.
- f. Stabilize disturbed areas promptly in a timely manner.

- g. Protect steep slopes.
- h. Use sediment controls to prevent off-site damage.
- i. Protect inlets, storm drain outfalls, and culverts.
- j. Provide access and general construction controls.
- k. Inspect and maintain control measures.
- l. Employ experienced and competent personnel.
- m. Conduct training on environmental requirements to relevant parties

In addition to the measures taken in conformity with the above principles, erosion and sediment loss from the site shall be effectively controlled by applying appropriate P2M2.

#### 4.2 Pollution Prevention and Mitigation Measures

The following information shall be provided:-

A site plan (which contains existing topographical and hydrological features, and land use) to be superimposed with site development plan (which illustrates the earthwork activities) which depicts pollution prevention and mitigating measures (P2M2) to be implemented on the site. The P2M2 shall include both temporary and permanent measures as described in paragraph 4.1. The drawings shall be drawn to scale and the scale clearly indicated. Drawings shall be legible with standard coding and submitted in A1 or A3 paper depending on the size of the project.

#### **PROFESSIONAL TO PREPARE WRITE-UP ON SOIL EROSION AND SEDIMENT CONTROL IN EIA REPORT**

- 5. The write-up on soil erosion and sediment control as required by this Guideline shall be undertaken by an environmental consultant who is knowledgeable and experienced in the subject matter and holds a certification as a professional in erosion and sediment control issued by the Department of Environment.

## PROVISION OF FUND FOR SOIL EROSION AND SEDIMENT CONTROL

6. Sufficient fund shall be made available for the implementation of P2M2 and their maintenance, including EMP preparation, auditing, monitoring and emergencies. The commitment of the project proponent on making the fund available for the above purposes shall be clearly stated in the EIA report.”

**“Appendix 4 - Guidance Document For Addressing Soil Erosion And Sediment Control Aspects In The Environmental Impact Assessment”**  
***(from Environmental Impact Assessment Guidelines in Malaysia)***

In Appendix 4, a comprehensive list of requirements of information to be furnished in a LD-P2M2 Document was provided in Chapter 8 of the appendix. For ease of reference, this submission checklist is reproduced below as extracted from Appendix 4:

### LD-P2M2 SUBMISSION CHECKLIST

#### Instructions

- (i) All relevant items cited in Section 8.1, 8.2, 8.3 and 8.4 checklist are required to be identified, addressed, discussed, assessed, evaluated and presented in the LD-P2M2 document according to appropriate chapters.
- (ii) All relevant items cited in Section 8.3 and 8.4 checklist are required to be illustrated or depicted in a minimum of three (3) sheets of plan or map or drawing to be referred to as LD-P2M2 Plan which contains the following:
  - (a) Map of site plan with the existing site conditions (pre-development),
  - (b) Map of site development plan (during development) and
  - (c) Overlaid map of (a) and (b).
- (iii) Maps shall be clear and legible where they may be provided with more than one sheet to commensurate with the size and complexity of the drainage areas as well as the terrain of the project site.
- (iv) The LD-P2M2 document shall include a legal pledge by the Project Proponent (PP) to comply with the Minimum Standards requirement of P2M2s as outlined in Section 7 of this Guidelines (PP).

ITEM	PAGE	MARK √ - Yes X - No NA - Non Applicable	REMARKS
<b>8.1 Project Activity and Implementation</b>			
(a) Phasing plan if relevant			
(b) Project implementation schedule			
(c) Description of the construction activity			
(d) Construction schedule for each major land disturbance complete with timeline or chart for the installations of P2M2s			
(e) Typical method statement for site clearing, cut and fill, excavation of foundation, drilling of borehole, in-stream works and construction of temporary / permanent stream / river crossing and diversion that incorporate the significance elements of pollution prevention and mitigation measures.			
(f) Estimated start date, completion date and stabilization schedule for each major land-disturbing activities or construction activities phases, stages and sequences.			
<b>8.2. Information and Analysis on Project Development</b>			
These information and analysis shall contain the following:			
(a) Weather and rainfall data.			
(b) Site runoff velocity and flow rate, both pre and during development			
(c) Description of site soil characteristics: i. Soil types ii. Soil test erodibility iii. Soil hydrologic group iv. Dispersible fine clay: Percentage of dispersible material v. Anticipated excavation depth for the proposed land disturbing activity			
ITEM	PAGE	MARK √ - Yes X - No NA - Non	REMARKS

		<b>Applicable</b>	
(e) List of streams and rivers identified on-site. (Use coding for unnamed streams and rivers).			
(f) List of receiving streams and rivers. (Use coding for unnamed streams and rivers).			
(g) List of existing drainage identified on-site.			
(h) List of P2M2s proposed. Please also make reference to P2M2s Description can be accessed through: <a href="https://enviro.doe.gov.my">https://enviro.doe.gov.my</a>			
(i) Identify access roads and other outsourced components (such as mobile batching or premix plant) that are located outside the proximity of the project boundary.			
(j) Earthworks cut and fill volume.			
(k) Availability of rocks material.			
(l) Biomass management.			
(m) Solid (construction waste) and domestic waste management.			
(n) Spill Prevention and Control from fuel and chemical use or storage.			
(o) Hazardous Waste Management.			
(p) Soil loss prediction using the Universal Soil Loss Equation (USLE), sediment yield calculation using Modified Universal Soil Loss Equation (MUSLE) and runoff estimation for pre, during and post development accounted for both with and without the implementation of LDP2M2s. All of the data and parameters used in the calculations shall be measured or rationally determined, and identified. If secondary sources are used, they shall be clearly identified.			
<b>ITEM</b>	<b>PAGE</b>	<b>MARK</b> √ - Yes X - No NA - Non Applicable	<b>REMARKS</b>
<b>8.3. Map of site plan with the existing site conditions (pre-development).</b>			

<b>(I) Site map which refers to:</b>			
(a) Topography survey map showing: i. Contours ii. Elevation iii. Slopes			
(b) Geological Terrain Mapping (if relevant).			
(c) Erosion risk map.			
(d) Drainage pattern showing: i. Delineation of watercourses. ii. Delineation of natural drainage depression. iii. Flow path and direction for the different drainage areas. iv. Marks and labels of drainage area(s) or drainage divides.			
<b>(II) Land use showing:</b>			
i. Trees. ii. Vegetation area. iii. Roads and infra-structures (inclusive of drainage system). iv. Buildings. v. Utilities.			
<b>(III) Adjacent within 150 metres from project site:</b>			
i. Watercourses (Flowing into or from site). ii. Roads and infra-structures (inclusive of drainage system). iii. Buildings and utilities. iv. Vegetation area.			
(IV) Use map scale and size of: i. 1:500 for area less than 20 hectares; ii. 1: 1000 for area more than 20 hectares iii. Size: A3 or A1.			
<b>ITEM</b>	<b>PAGE</b>	<b>MARK</b> √ - Yes X - No NA - Non Applicable	<b>REMARKS</b>
<b>8.4. Map of site development plan</b>			
(a) Depict the existing contour and proposed level.			
(b) Indicate the total site area.			
(c) Indicate the total disturbance area with			

line showing the area to be disturbed.			
(d) Show the cut and fill area.			
(e) Show the direction of the proposed earthwork movement.			
(f) Mark the limit of disturbance of each of the phase construction.			
(g) Identify and mark the temporary or permanent stream or river crossing.			
(h) Identify and mark the temporary or permanent stream or river diversion.			
(i) Identify and mark on-site temporary access or construction or haul road			
(j) Identify and mark site office area.			
(k) Identify and mark stockpile areas.			
(l) Identify and mark temporary preservation of existing vegetation.			
(m) Identify and mark permanent preservation of existing vegetation.			
(n) Identify and mark material staging area or equipment storage area.			
(o) Identify and mark workshop/maintenance or engineering work area.			
(p) Identify and mark generators set and/or motorized equipment area.			
(q) Identify and mark Vehicle and Equipment Washing Facility.			
(r) Identify and mark petroleum-based material/refueling, chemicals and skid tank area.			
(s) Identify and mark schedule waste storage area.			
<b>ITEM</b>	<b>PAGE</b>	<b>MARK</b> √ - Yes X - No NA - Non Applicable	<b>REMARKS</b>
(t) Identify and mark workers camp location.			
(u) Identify and mark sanitary facilities location.			
(v) Identify and mark batching plant location.			
(w) Identify and mark concrete wash P2M2 location.			

(x) Identify and mark spoil (unsuitable material) area or disposal area.			
(y) Identify and mark borrow area.			
(z) Identify and mark the location(s) of all proposed P2M2s application.			
(aa) Identify and mark all of the designated point(s) of water discharge and also any other potential point(s) of water discharge to off-site drainage ways.			
(bb) Provide the GPS location (WGS 84) of the construction ingress/egress and all designated point(s) of water discharge for the site.			
(cc)Use map scale and size of: 1:500 for area less than 20 hectares; 1: 1000 for area more than 20 hectares Size: A3 or A1.			

**5.7.2 Writing a LD-P2M2 Report**

Using the above guidelines as a whole, an example for preparing a LD-P2M2 Document is presented below, and where information is not available, it will be shown how this can be addressed in the Document.

## **SAMPLE LD-P2M2 DOCUMENT OUTLINE FOR A SEWAGE TREATMENT WORKS EXTENSION**

### **1 PROJECT DESCRIPTION**

#### **1.1 Background of Project**

This project involves the development of an unused land adjacent to an existing sewage treatment works (STW) named STW OLD located at 25 km north of Township A, approximately 120 km southwest of Seremban, Negeri Sembilan. The existing plant STW OLD was previously constructed in the late 1970s and at that time, designed for a population equivalent (PE) of 45,000. Due to the rapid expansion in the surrounding areas of Township A due to numerous out-of-state investments into the electronic manufacturing industry, the capacity of STW OLD has been surpassed for the last 2 years, resulting in some untreated effluents being discharged from the treatment works. In this regard, the government of Negeri Sembilan is anxious to expand the existing capacity of STW OLD by doubling the design capacity from 45,000 PE to 90,000 PE. After a feasibility study was undertaken in early 2016, it was concluded that this expansion is feasible by building another sewage treatment works adjacent to STW OLD with its own capacity of 45,000 PE. The proposed layout of the new STW is shown in Plate 1.

#### **1.2 Scope of Project**

The scope of this project is for the construction, testing and commissioning of the following sewage treatment works elements:

- Screening chamber;
- Grit chamber;
- Distribution tank;
- Oxidation ditches;
- Blower house and control rooms;
- Clarifiers;
- Sludge pump houses;
- Sludge treatment building;
- Sludge thickening building;
- Administration building;
- Workshop;
- Electrical building;
- Disinfection building;
- Power receiving station/TNB substation; and
- Ancillary facilities such as roads, drainage, utilities, etc.

## 2 PROJECT ACTIVITY AND IMPLEMENTATION

### 2.1 Project Work Breakdown Structure

Based on the works to be provided by the scope of this project, the proposed WBS of the project can be formulated as shown in **Figure 1**. In this figure, the proposed project components, project activities, scope of work, and environmental method statements are included.

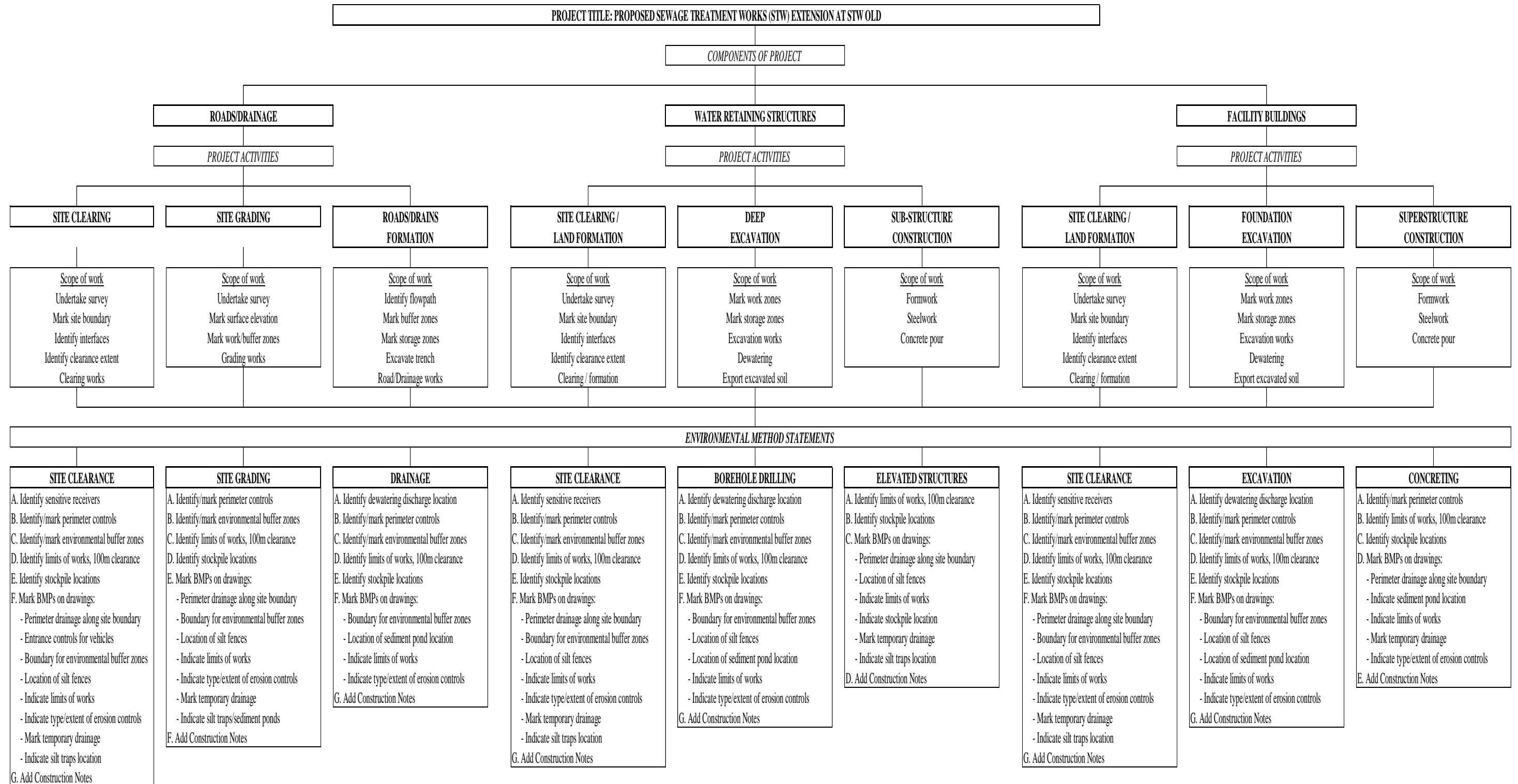
For this STW example, the information adopted to respond to the factors of consideration for the purposes of phasing the project is shown below:

**Table 1 Consideration Factors for Phasing STW Project**

<b>Factors</b>	<b>Description</b>
Size of site	<ul style="list-style-type: none"> <li>• Overall project size: About 2 ha</li> </ul>
Existing land use	<ul style="list-style-type: none"> <li>• Majority of site area covered by degraded/disturbed forest</li> <li>• Land for the extension project adjacent to an existing STW</li> <li>• Site is also close by to an existing railway line and Petronas reserve</li> <li>• On the south side of the plot, there is an existing swamp area.</li> <li>• No river or watercourse is found in the vicinity of the site</li> <li>• No villages or commercial activities in the vicinity of the site</li> </ul>
Types of land disturbance activities	<ul style="list-style-type: none"> <li>• Site clearance for temporary/permanent roads &amp; drainage, treatment facilities and various buildings</li> <li>• Site grading for temporary/permanent roads &amp; drainage, treatment facilities and various buildings</li> <li>• Excavation for roads &amp; drainage, treatment facilities and various buildings foundations</li> <li>• Dewatering</li> <li>• Stockpile management</li> <li>• Disposal area management</li> </ul>
Topography	<ul style="list-style-type: none"> <li>• Generally uneven ground with the southeast portion of the site on higher elevation.</li> <li>• A section of the southwest part of the site is occupied by swampy area.</li> </ul>
Weather	<ul style="list-style-type: none"> <li>• Subject to the Southwest monsoon</li> </ul>
Type of soil	<ul style="list-style-type: none"> <li>• Not known</li> </ul>
Environmental Sensitive areas	<ul style="list-style-type: none"> <li>• Existing site currently consists of degraded / disturbed forested areas.</li> <li>• The areas to the north and northwest outside of the site comprise more dense forests.</li> </ul>
Practicality of	<ul style="list-style-type: none"> <li>• Temporary roads need to be created across the site area to</li> </ul>

GUIDELINES ON LD-P2M2

BMP installation	install BMPs along the perimeter of the site.
Rate of production	<ul style="list-style-type: none"><li>• Not known</li></ul>



**Figure 1: WBS for STW Extension**

In view of the above consideration and considering the site is relatively small and manageable, it can be proposed for the STW Extension project to be broken down into the following phases, namely:

- *Pre-development Phase:* To provide and install all the necessary protection and mitigation measures prior to commencement of Phase 1;
- *Phase 1:* To commence earthworks from the southeast portion of the site where most of the work will involve cut the hilly side to resource fill materials for forming the remaining of the lower grounds. Phase 1 will cover almost half of the plot size;
- *Phase 2:* To construct the remaining half of the site which will involve mostly fill work to form the final platform of the STW; and
- *Phase 3:* To construct the individual sewage treatment facility components.

**2.2 Description of the construction activity**

Based on the above project phasing, the potential land disturbing activities that can be identified for the individual phases are shown in **Table 2**.

**Table 2: Identified Land Disturbing Activities**

Land Activities	Disturbing	Description
<b><i>Pre-Development Prior to Phase 1 commencement</i></b>		
Minor site clearing		Initial site clearance works but of lesser extent to be provided to establish site entry point, as well as to form temporary construction road accesses and drainage
Minor site grading		Minor site grading to prepare works area for the temporary construction roadworks
Minor excavation		Localised excavation for installing hoarding
<b><i>Phase 1</i></b>		
Site clearing		Site clearance works to be provided to remove existing trees and vegetation from the project site.
Site grading		Site grading to prepare works area for roadworks, drainage, land formation
Excavation		Excavation for permanent drainage and road foundation
Dewatering & stabilization of swamp		Filling up of swamp areas within site boundary.
Earthworks		Cut and fill of area within Phase 1
Stockpile & solid waste management		Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road &

	drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials
<b>Phase 2</b>	
Site clearing	Site clearance works to be provided to remove existing trees and vegetation from the project site.
Site grading	Site grading to prepare works area for roadworks, drainage, land formation
Excavation	Excavation for permanent drainage and road foundation
Earthworks	Cut and fill of area within Phase 2
Stockpile & solid waste management	Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials
Disposal area management	Disposal sites for excavated soil materials
<b>Phase 3</b>	
Deep excavation	Excavation of foundations, subsurface voids for water-retaining structures, building basements, utility trenches
Dewatering	Dewatering to excavated areas for subsurface works
Stockpile management	Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials

**2.3 Description of the construction sequences**

Based on the site conditions and on the requirements to control erosion and sediment issues for this project, the proposed construction sequences of works are listed below. The typical method statements for site clearing, cut and fill, excavation of foundation, drilling of borehole, in-stream works and construction of temporary / permanent stream / river crossing and diversion that incorporate the significance elements of pollution prevention and mitigation measures are also found in the appendix.

Construction Sequencing for Pre-Development Phase, i.e., before commencement of Phase 1 works:

1. Survey and identify project boundary and site limits.
2. Establish construction entrance control plus construction vehicles parking area.
3. Install hoarding around site boundary.
4. Survey and identify environmental sensitive receivers.
5. Mark environmental buffer zones.
6. Install sediment pond and/or traps, and silt fence.
7. Site clearing and grading for temporary roads and drainage.
8. Form temporary road and drainage.
9. Stabilize exposed roads with gravel.

10. Install check dam for earth drains.
11. Construct interceptor/perimeter drains along site boundary.
12. Construct sandbag barriers.

To describe the sequence for the Phase 1 works, it will be useful to first prepare another WBS, dedicated for the Phase 1 works only, noting that a WBS has been done previously but for the entire project. The breakdown of the various project components, project activities, scope of work and environmental method statements is shown in **Figure 2**. With the key components identified, 3 distinct sets of project sequence of works can now be prepared as below:

Construction Sequencing for Phase 1 works – Activity 1: Backfill Swamp:

1. Survey to mark area to be backfilled.
2. Survey and mark areas for isolation.
3. Prepare dry area adjacent to swamp to facilitate parking of heavy equipment near to water area. This is usually done by constructing a concrete platform to support the equipment and machineries.
4. Survey and identify environmental sensitive receivers.
5. Protect water quality outside of hoarding area; install silt curtains and sediment ponds.
6. Install sediment traps and silt fence if required.
7. Install sheet piles or similar structures for isolation of swamp area purposes.
8. Take water sampling upstream and downstream of sheet piles to establish control water quality.
9. Backfill layer by layer of isolated area; DO NOT dump backfill materials all at one go! Lay 300mm of material first; wait 1 hour, then lay the 2<sup>nd</sup> 300mm layer, and so on until reach final platform level.
10. Continue to monitor quality of water on the outside of sheet pile area.
11. When backfilling operation completed, sheet piles can be extracted out for other uses.

Construction Sequencing for Phase 1 works – Activity 2: Cut/Fill Operations:

1. Survey and identify low point for areas to be cut, by predicting how runoff will occur once cutting operations start.
2. Construct runoff conveyance systems to capture findings of item 1 above, provided with check dams or rocklined or other measures to minimize erosion and to reduce runoff velocities.
3. Install silt fences.
4. Install sediment ponds and/or traps.
5. Identify and protect environmental sensitive receivers, including marking environmental buffer zones.
6. Identify and mark temporary stockpile areas.
7. Commence cut operation.
8. Stockpile cut materials at designated locations.

9. Fill up and grade areas to be raised.
10. Stabilize exposed areas with erosion protection materials.
11. Repeat items 2,3,4,5 and 6 as the cutting works progress to upgrade or revise or replace BMPs accordingly.
12. Once Phase 1 earthworks completed, remove those BMPs that are not needed any longer.

Construction Sequencing for Phase 1 works – Activity 3: Road & Drainage:

1. Upon completion of earthworks activities and land formation is completed, survey and mark roadwork and drainage works limits.
2. Identify and mark temporary stockpile areas.
3. Identify and mark temporary dewatering discharge areas.
4. Construct runoff conveyance systems to capture potential runoff from road and drainage works.
5. Install silt fences, sediment ponds and/or traps.
6. Commence excavation for drainage and road.
7. Stockpile excavated materials at designated locations.
8. Stabilize exposed areas with erosion protection materials.
9. Lay road and drainage works.
10. Once road and drainage works completed, remove those BMPs that are not needed any longer.

To describe the sequence for the Phase 2 works, another WBS will prepared namely for the Phase 2 works only, and based on the various project components, project activities, scope of work and environmental method statements as shown in **Figure 3**, the sequence of works can then be prepared. This is similar also to the last phase, Phase 3 of the project.

Construction Sequencing for Phase 2 works – Activity 1: Cut/Fill Operations:

1. Survey and identify low point for areas to be cut, by predicting how runoff will occur once cutting operations start.
2. Construct runoff conveyance systems to capture findings of item 1 above, provided with check dams or rocklined or other measures to minimize erosion and to reduce runoff velocities.
3. Install silt fences.
4. Install sediment ponds and/or traps.
5. Identify and protect environmental sensitive receivers, including marking environmental buffer zones.
6. Identify and mark temporary stockpile areas.
7. Commence cut operation.
8. Stockpile cut materials at designated locations.
9. Fill up and grade areas to be raised.
10. Stabilize exposed areas with erosion protection materials.

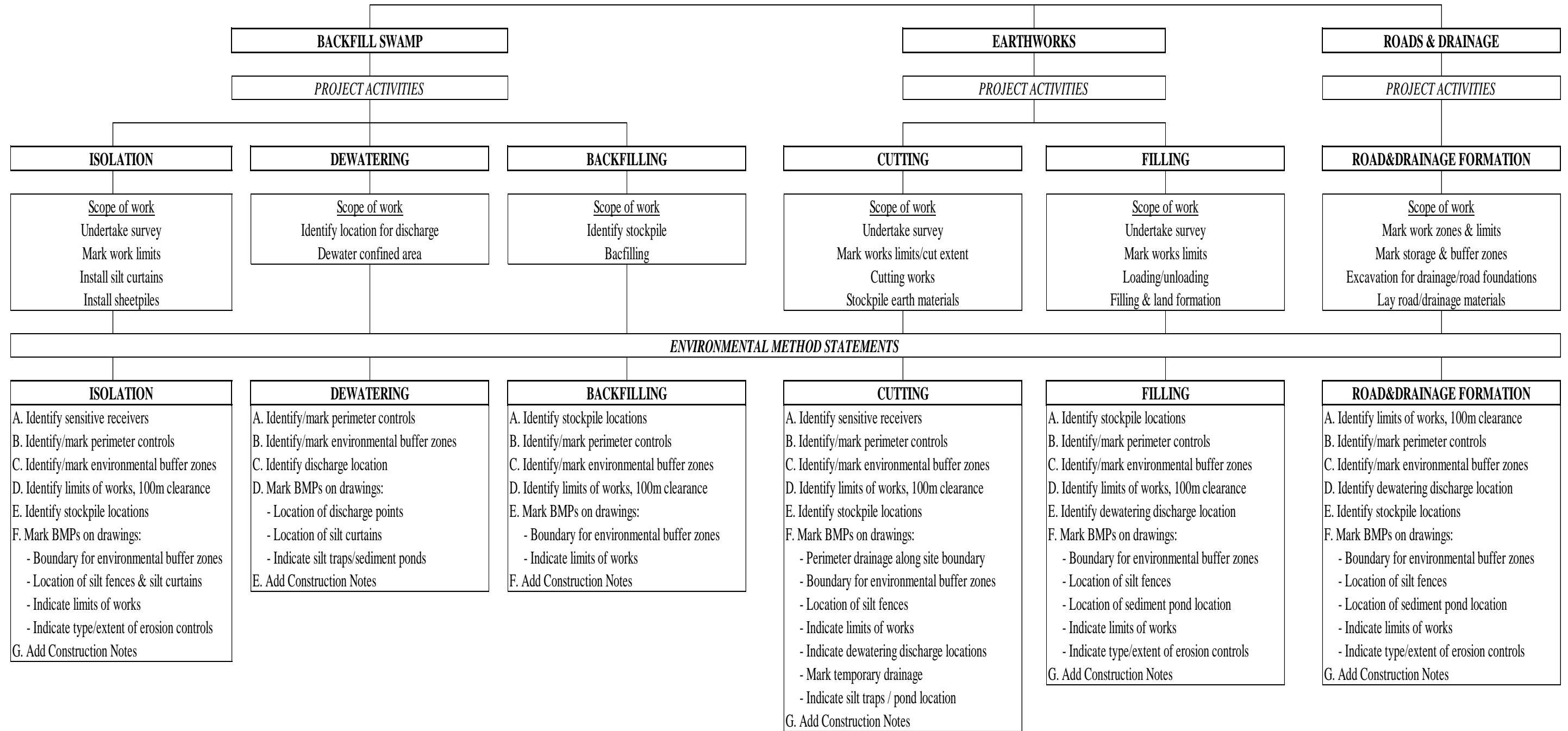
11. Repeat items 2,3,4,5 and 6 as the cutting works progress to upgrade or revise or replace BMPs accordingly.
12. Once Phase 1 earthworks completed, remove those BMPs that are not needed any longer.

Construction Sequencing for Phase 2 works – Activity 2: Road & Drainage:

1. Upon completion of earthworks activities and land formation is completed, survey and mark roadwork and drainage works limits.
2. Identify and mark temporary stockpile areas.
3. Identify and mark temporary dewatering discharge areas.
4. Construct runoff conveyance systems to capture potential runoff from road and drainage works.
5. Install silt fences, sediment ponds and/or traps.
6. Commence excavation for drainage and road.
7. Stockpile excavated materials at designated locations.
8. Stabilize exposed areas with erosion protection materials.
9. Lay road and drainage works.
10. Once road and drainage works completed, remove those BMPs that are not needed any longer.

**PROJECT TITLE: PROPOSED SEWAGE TREATMENT WORKS (STW) EXTENSION AT STW OLD**

*COMPONENTS OF PHASE 1*



**Figure 2: WBS for STW Extension – Phase 1 Works**

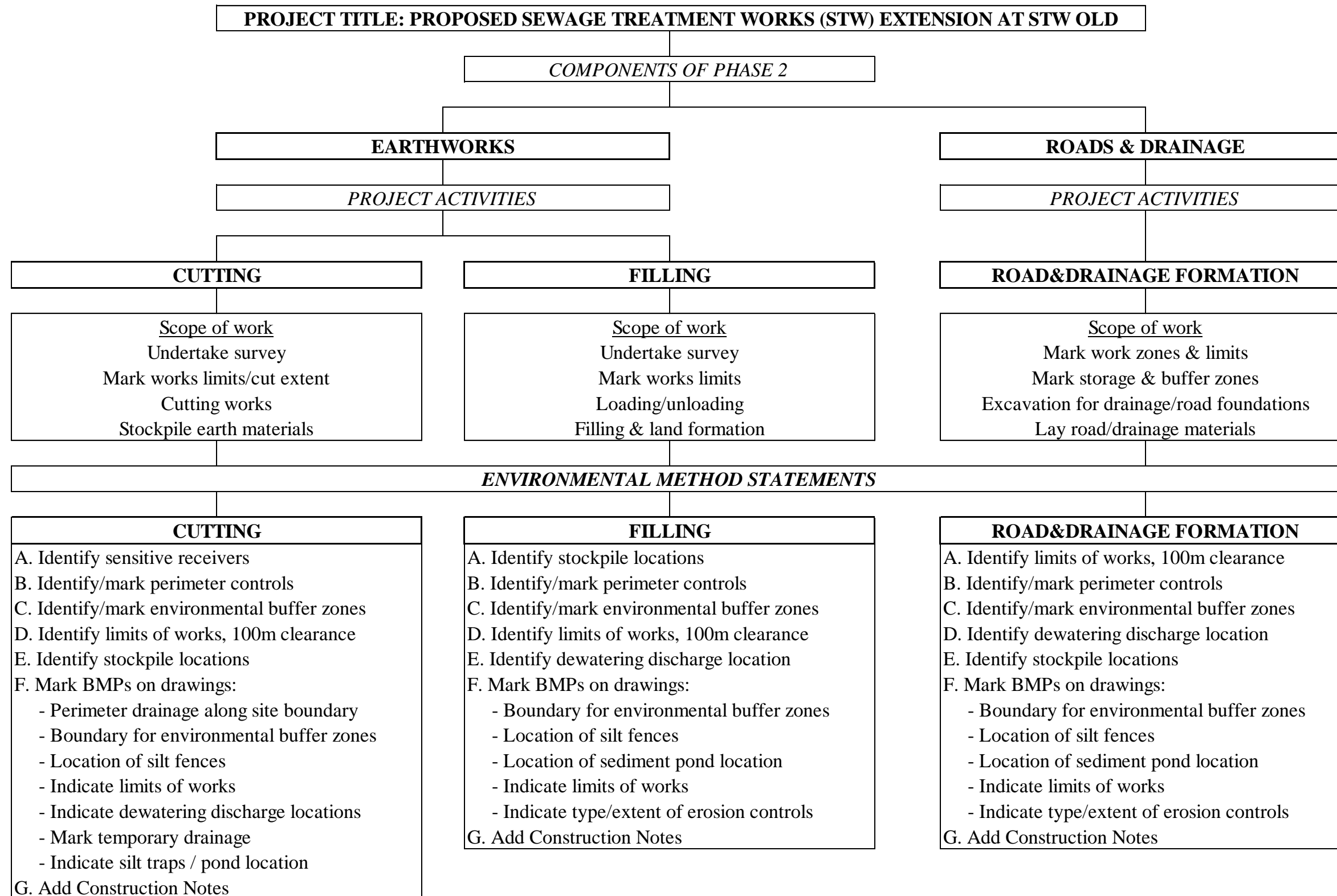


Figure 3: WBS for STW Extension – Phase 2 Works

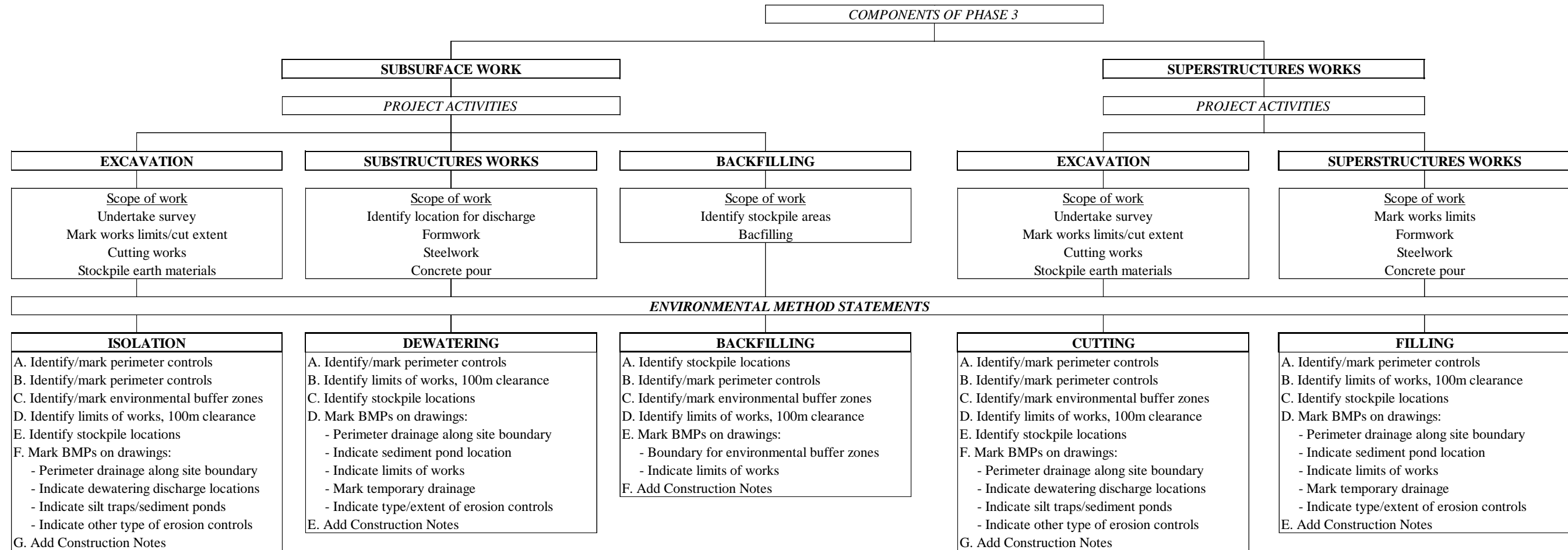


Figure 4: WBS for STW Extension – Phase 3 Works

### 3 INFORMATION AND ANALYSIS ON PROJECT DEVELOPMENT

#### 3.1 Available Data for Analysis

**Table 3** below summarizes the key information needed for the analysis of LD-P2M2, whilst the detailed information is included in Appendix A.

**Table 3: Summary of Key Information**

<b>Information Criteria</b>	<b>Description</b>
(a) Weather and rainfall data.	See Appendix G
(b) Site runoff velocity and flow rate, both pre and during development	See Appendix G
(c) Description of site soil characteristics: i. Soil types ii. Soil test erodibility iii. Soil hydrologic group iv. Dispersible fine clay: Percentage of dispersible material v. Anticipated excavation depth for the proposed land disturbing activity	See Appendix G
(d) Description of adjacent areas, such as streams, lakes, residential areas, and roads that might be affected by the land disturbance.	<ul style="list-style-type: none"> <li>- The site currently sits on a portion of a swamp at the southwest portion of the project site.</li> <li>- The allocated site is immediately adjacent to the existing sewage treatment works, called STW OLD.</li> <li>- Areas to the north and west of the project site are largely undisturbed forest.</li> <li>- To the south of the project site is a Petronas' reserve and also a railway track.</li> </ul>
(e) List of streams and rivers identified on-site. (Use coding for unnamed streams and rivers).	No streams or rivers are found to be sited within or near the project site.
(f) List of receiving streams and rivers. (Use coding for unnamed streams and rivers).	No streams or rivers are found to be sited within or near the project site.
(g) List of existing drainage identified on-site.	No existing drainage is found to be on the project site.

<p>(h) List of P2M2s proposed. Please also make reference to P2M2s Description can be accessed through: <a href="https://enviro.doe.gov.my">https://enviro.doe.gov.my</a></p>	<p>P2M2s related to the principles in erosion and sediment control have been proposed for this STW Extension project, with brief descriptions provided below:</p> <p><i>a. Integrate project design with site constraints:</i> Project phasing has been planned based on the topography of the project site, and the need to achieve equal cut and fill volumes. Based on various considerations, the works will be phased into Phase 1 and Phase 2, as shown in the attached Drawings.</p> <p><i>b. Preserve and stabilize drainageways:</i> Drainage within the project site will be lined to minimize erosion of their banks.</p> <p><i>c. Minimize the extent and duration of disturbance:</i> Exposed ground surfaces will be covered by stabilization materials such as by hydroseeding or gravel if surfaces will be left open for more than 14 days.</p> <p><i>d. Control runoff flows onto, through, and from the site in stable drainage structures:</i> Various drainage structures are being proposed to convey potential runoffs.</p> <p><i>e. Install perimeter control:</i> Perimeter controls are provided to control both surface runoff from outside the site to enter the project site, and prevent runoff from project site to discharge to outside the site.</p> <p><i>f. Stabilize disturbed areas promptly in a timely manner:</i> Stabilization provided to areas being disturbed to minimize erosion potentials.</p> <p><i>g. Protect steep slopes:</i> Runoff and sediment controls provided to cater for construction runoffs.</p> <p><i>h. Use sediment controls to prevent off-site damage:</i> Sediment ponds, silt traps and silt fences provided to control sediment.</p> <p><i>i. Protect inlets, storm drain outfalls, and culverts:</i> Provided.</p> <p><i>j. Provide access and general construction controls:</i> One of the first controls that shall be provided.</p>
<p>(i) Identify access roads and other outsourced components (such as mobile batching or premix plant) that are located</p>	<p>There is currently an access road that ends at the boundary of the project site, previously constructed as part of the asset of the existing STW OLD.</p> <p>No other outsourced components such as mobile batching or premix plant will be used.</p>

outside the proximity of the project boundary.	
(j) Earthworks cut and fill volume.	Estimated cut volume = 70653.95000 m <sup>3</sup> Estimated fill volume = 70653.95000 m <sup>3</sup>
(k) Availability of rocks material.	Limited to none.
(l) Biomass management.	Vegetation and trees covering about 1.5ha of the project site will be cleared and felled. Stockpiling areas will be provided, sited strategically throughout the site. Some of the biomass will be used as BMPs such as brush barriers, or as other erosion controls. Those that are not useful will be disposed off site.
(m) Solid (construction waste) and domestic waste management.	Dedicated stockpile areas and solid wastes management areas will be provided on the east portion of the site, with satellite secondary containment systems near to work areas.
(n) Spill Prevention and Control from fuel and chemical use or storage.	A dedicated central liquid waste and scheduled waste storage area will be provided at the east portion of the project site, with satellite secondary containment systems near to work areas.
(o) Hazardous Waste Management.	No hazardous waste materials will be used.
(p) Soil loss prediction using the Universal Soil Loss Equation (USLE), sediment yield calculation using Modified Universal Soil Loss Equation (MUSLE) and runoff estimation for pre, during and post development accounted for both with and without the implementation of LDP2M2s. All of the data and parameters used in the calculations shall be measured or rationally determined, and identified. If secondary sources are	See Appendix G

used, they shall be clearly identified.	
(q) Calculation of proposed sediment trap/basin based on drainage area disturbed and projected runoff flow direction from each disturbed land segment that will drain into the proposed sediment trap/basin.	See Appendix G

#### 4 MAPS AND DRAWINGS

##### 4.1 Maps and Drawings

Appropriately scaled drawings to indicate the proposed BMPs works are attached herein.

**Identified Land Disturbing Activities**

Land Disturbing Activities	Description
<b>Pre-Development Prior to Phase 1 commencement</b>	
Minor site clearing	Initial site clearance works but of lesser extent to be provided to establish site entry point, as well as to form temporary construction road accesses and drainage
Minor site grading	Minor site grading to prepare works area for the temporary construction roadworks
Minor excavation	Localised excavation for installing hoarding
<b>Phase 1</b>	
Site clearing	Site clearance works to be provided to remove existing trees and vegetation from the project site.
Site grading	Site grading to prepare works area for roadworks, drainage, land formation
Excavation Dewatering & stabilization of swamp	Excavation for permanent drainage and road foundation Filling up of swamp areas within site boundary.
Earthworks Stockpile & solid waste management	Cut and fill of area within Phase 1 Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials
<b>Phase 2</b>	
Site clearing	Site clearance works to be provided to remove existing trees and vegetation from the project site.
Site grading	Site grading to prepare works area for roadworks, drainage, land formation
Excavation	Excavation for permanent drainage and road foundation
Earthworks	Cut and fill of area within Phase 2
Stockpile & solid waste management	Stockpiling of biomass from forest clearing works; Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials
Disposal area management	Disposal sites for excavated soil materials
<b>Phase 3</b>	
Deep excavation	Excavation of foundations, subsurface voids for water-retaining structures, building basements, utility trenches
Dewatering	Dewatering to excavated areas for subsurface works
Stockpile management	Stockpiling of excavated soil materials; Stockpiling of construction materials for the road & drainage works
Disposal area management	Disposal sites for the biomass and excavated soil materials

Construction Sequencing for Phase 1 works – Activity 1: Backfill Swamp:

1. Survey to mark area to be backfilled.
2. Survey and mark areas for isolation.
3. Prepare dry area adjacent to swamp to facilitate parking of heavy equipment near to water area. This is usually done by constructing a concrete platform to support the equipment and machineries.
4. Survey and identify environmental sensitive receivers.
5. Protect water quality outside of hoarding area; install silt curtains and sediment ponds.
6. Install sediment traps and silt fence if required.
7. Install sheet piles or similar structures for isolation of swamp area purposes.
8. Take water sampling upstream and downstream of sheet piles to establish control water quality.
9. Backfill layer by layer of isolated area; DO NOT dump backfill materials all at one go! Lay 300mm of material first; wait 1 hour, then lay the 2<sup>nd</sup> 300mm layer, and so on until reach final platform level.
10. Continue to monitor quality of water on the outside of sheet pile area.
11. When backfilling operation completed, sheet piles can be extracted out for other uses.

Construction Sequencing for Phase 1 works – Activity 2: Cut/Fill Operations:

1. Survey and identify low point for areas to be cut, by predicting how runoff will occur once cutting operations start.
2. Construct runoff conveyance systems to capture findings of item 1 above, provided with check dams or rocklined or other measures to minimize erosion and to reduce runoff velocities..
3. Install silt fences.
4. Install sediment ponds and/or traps.
5. Identify and protect environmental sensitive receivers, including marking environmental buffer zones.
6. Identify and mark temporary stockpile areas.
7. Commence cut operation.
8. Stockpile cut materials at designated locations.
9. Fill up and grade areas to be raised.
10. Stabilize exposed areas with erosion protection materials.
11. Repeat items 2,3,4,5 and 6 as the cutting works progress to upgrade or revise or replace BMPs accordingly.
12. Once Phase 1 earthworks completed, remove those BMPs that are not needed any longer.

Construction Sequencing for Phase 1 works – Activity 3: Road & Drainage:

1. Upon completion of earthworks activities and land formation is completed, survey and mark roadwork and drainage works limits.
2. Identify and mark temporary stockpile areas.
3. Identify and mark temporary dewatering discharge areas.
4. Construct runoff conveyance systems to capture potential runoff from road and drainage works.
5. Install silt fences, sediment ponds and/or traps.
6. Commence excavation for drainage and road.
7. Stockpile excavated materials at designated locations.
8. Stabilize exposed areas with erosion protection materials.
9. Lay road and drainage works.
10. Once road and drainage works completed, remove those BMPs that are not needed any longer.

Construction Sequencing for Phase 2 works – Activity 1: Cut/Fill Operations:

1. Survey and identify low point for areas to be cut, by predicting how runoff will occur once cutting operations start.
2. Construct runoff conveyance systems to capture findings of item 1 above, provided with check dams or rocklined or other measures to minimize erosion and to reduce runoff velocities..
3. Install silt fences.
4. Install sediment ponds and/or traps.
5. Identify and protect environmental sensitive receivers, including marking environmental buffer zones.
6. Identify and mark temporary stockpile areas.
7. Commence cut operation.
8. Stockpile cut materials at designated locations.
9. Fill up and grade areas to be raised.
10. Stabilize exposed areas with erosion protection materials.
11. Repeat items 2,3,4,5 and 6 as the cutting works progress to upgrade or revise or replace BMPs accordingly.
12. Once Phase 1 earthworks completed, remove those BMPs that are not needed any longer.

Construction Sequencing for Phase 2 works – Activity 2: Road & Drainage:

1. Upon completion of earthworks activities and land formation is completed, survey and mark roadwork and drainage works limits.
2. Identify and mark temporary stockpile areas.
3. Identify and mark temporary dewatering discharge areas.
4. Construct runoff conveyance systems to capture potential runoff from road and drainage works.
5. Install silt fences, sediment ponds and/or traps.
6. Commence excavation for drainage and road.
7. Stockpile excavated materials at designated locations.
8. Stabilize exposed areas with erosion protection materials.
9. Lay road and drainage works.
10. Once road and drainage works completed, remove those BMPs that are not needed any longer.

Construction Sequencing for Pre-Development Phase, i.e., before commencement of

Phase 1 works:

1. Survey and identify project boundary and site limits.
2. Establish construction entrance control plus construction vehicles parking area.
3. Install hoarding around site boundary.
4. Survey and identify environmental sensitive receivers.
5. Mark environmental buffer zones.
6. Install sediment pond and/or traps, and silt fence.
7. Site clearing and grading for temporary roads and drainage.
8. Form temporary road and drainage.
9. Stabilize exposed roads with gravel.
10. Install check dam for earth drains.
11. Construct interceptor/perimeter drains along site boundary.
12. Construct sandbag barriers.

OWNER SIGNATURE :

PROJECT TITLE :

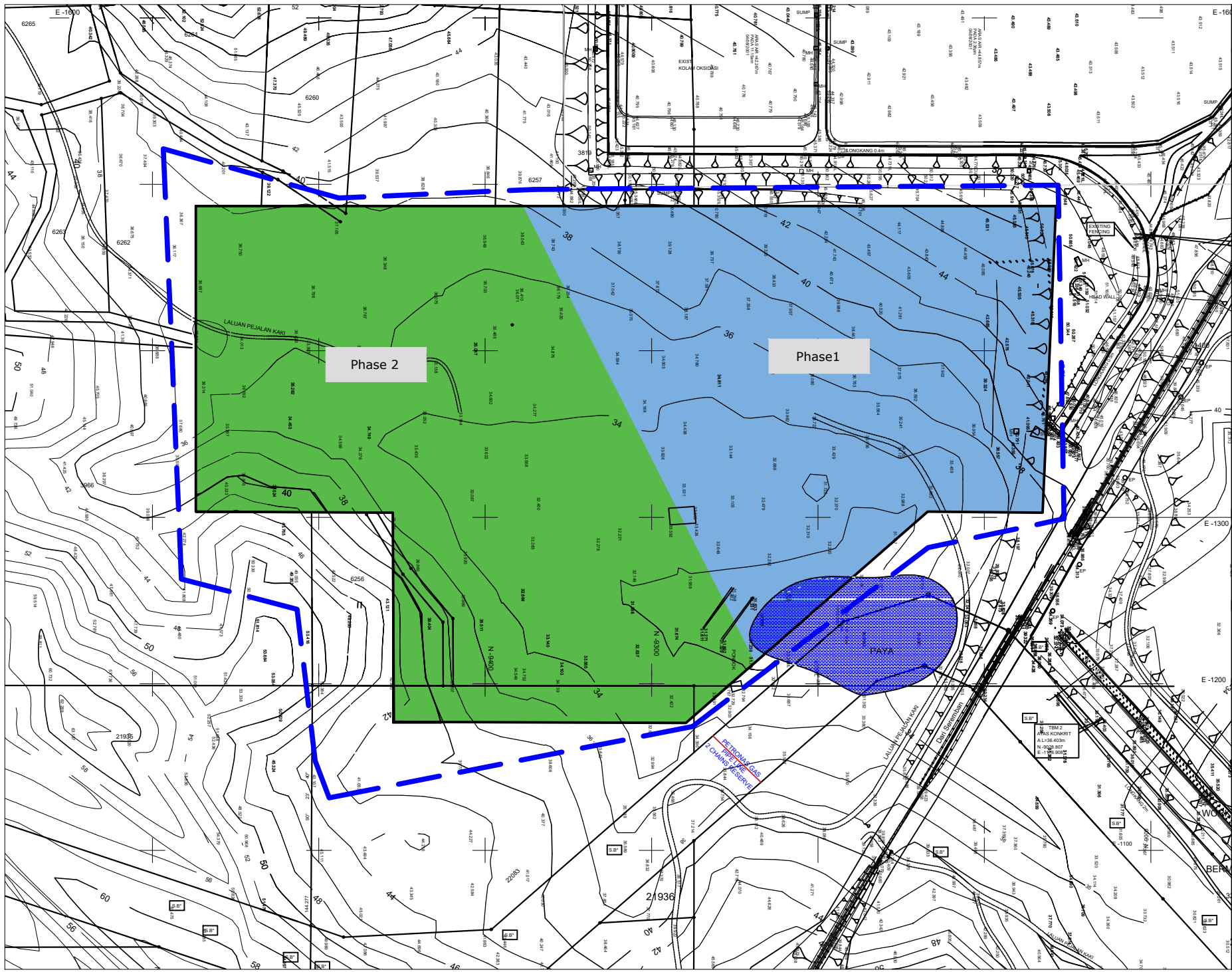
PROJECT SEWAGE TREATMENT WORK EXTENSION

SUB - TITLE :

**CONSTRUCTION SCHEDULE**

ENGINEER SIGNATURE :

LEGEND :



OWNER SIGNATURE

PROJECT TITLE  
PROJECT SEWAGE TREATMENT WORK EXTENSION

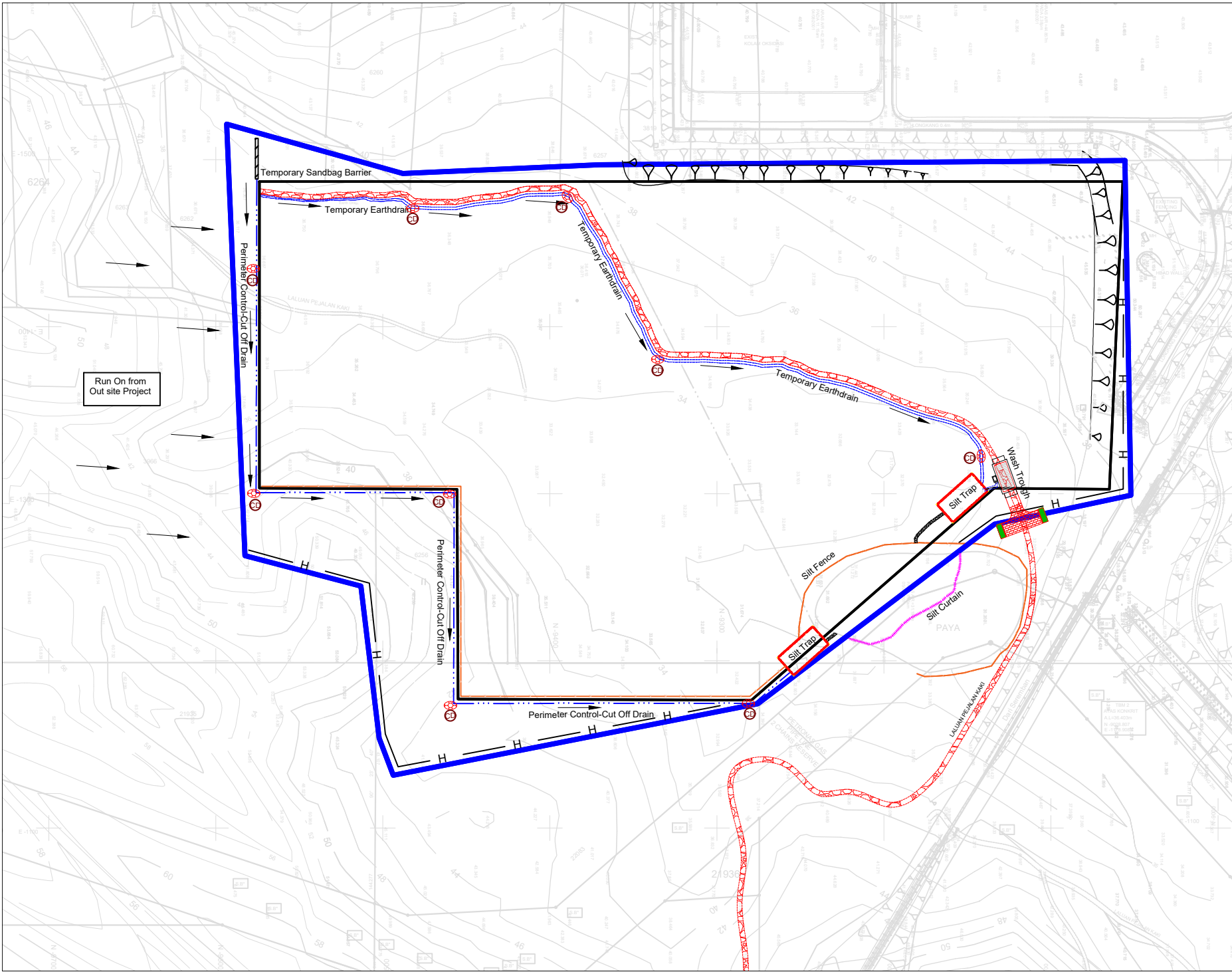
SUB-TITLE  
**PROPOSED PHASE OF CONSTRUCTION ACTIVITIES**

ENGINEER SIGNATURE

- LEGEND:
- Phase 1
  - Phase 2
  - FOREST
  - CONTOUR
  - PROJECT ROW
  - BOUNDARY
  - SWAMP
  - EXISTING
  - SPOT HEIGHT

NO.	REVISION	DATE	BY	CHECKED

The details of construction work for pre development phase can be refer to construction sequence notes.



OWNER SIGNATURE

PROJECT TITLE  
PROJECT SEWAGE TREATMENT WORK EXTENSION

SUB - TITLE

**PRE - CONSTRUCTION**

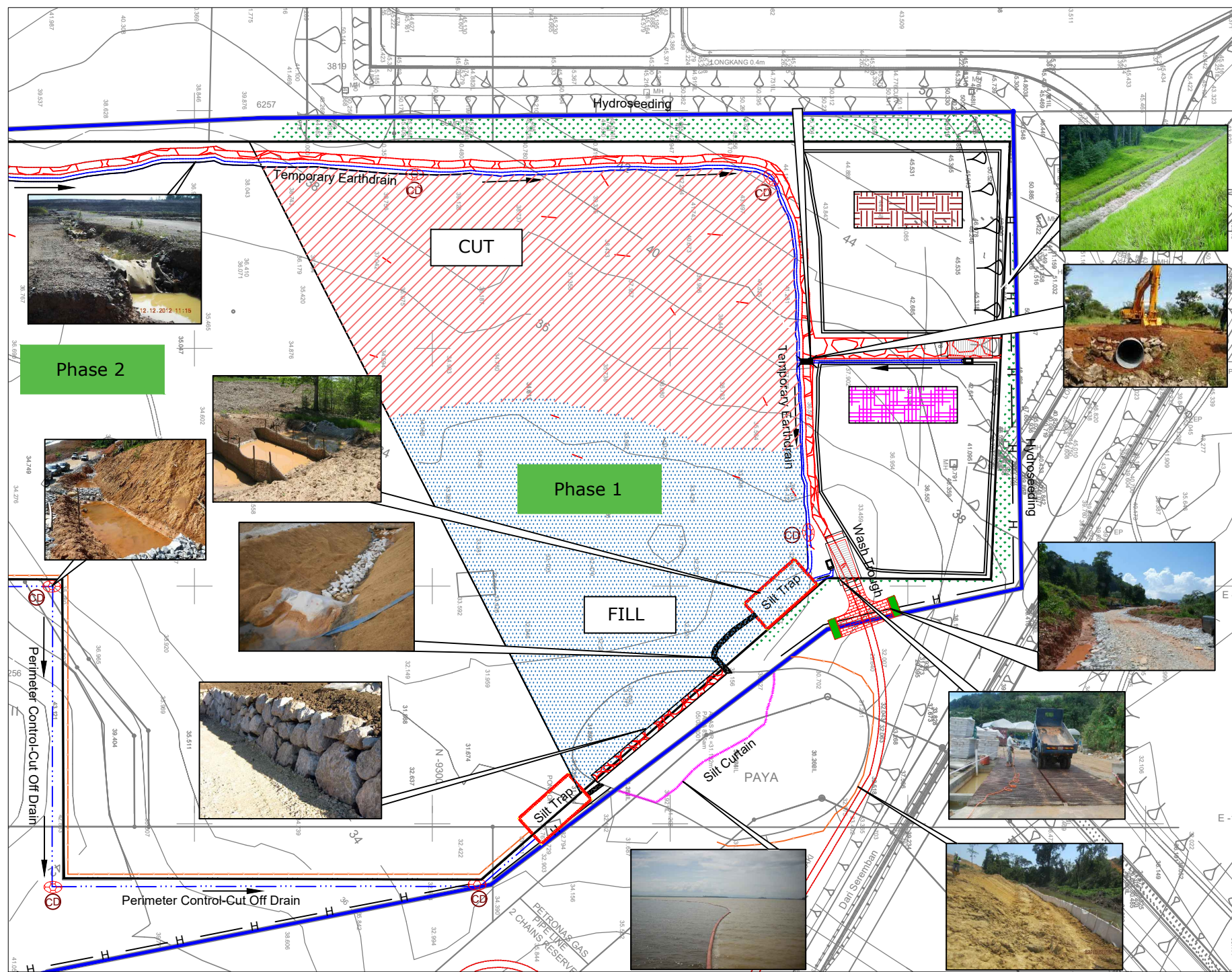
ENGINEER SIGNATURE

**LEGEND AND SEQUENCE CONSTRUCTION**

CONTOUR		TEMPERARY SAND BAG BARRIER
PROJECT BOUNDARY		SILT TRAP WITH BAFFLES
SWAMP		REP RAP
EXISTING BERM		ROCK OUTLET PROTECTION
SPOT HEIGHT		WASH TROUGH
PHASE 1 WORK		STABILISED ENTRANCE/EXIT
PHASE 2 WORK		CHECK DAM
HOARDING		TEMPERARY EARTHRAIN
PROJECT ROW		
WORK BOUNDARY		
SILT CURTAIN		
SILT FENCE		
CUT OFF DRAIN		

OWNER	SCALE	1:1000
D/LIST	D/REVISION	
NO	DATE	

The details of construction work for during development phase can be refer to construction sequence notes.



OWNER SIGNATURE

PROJECT TITLE  
PROJECT SEWAGE TREATMENT WORK EXTENSION

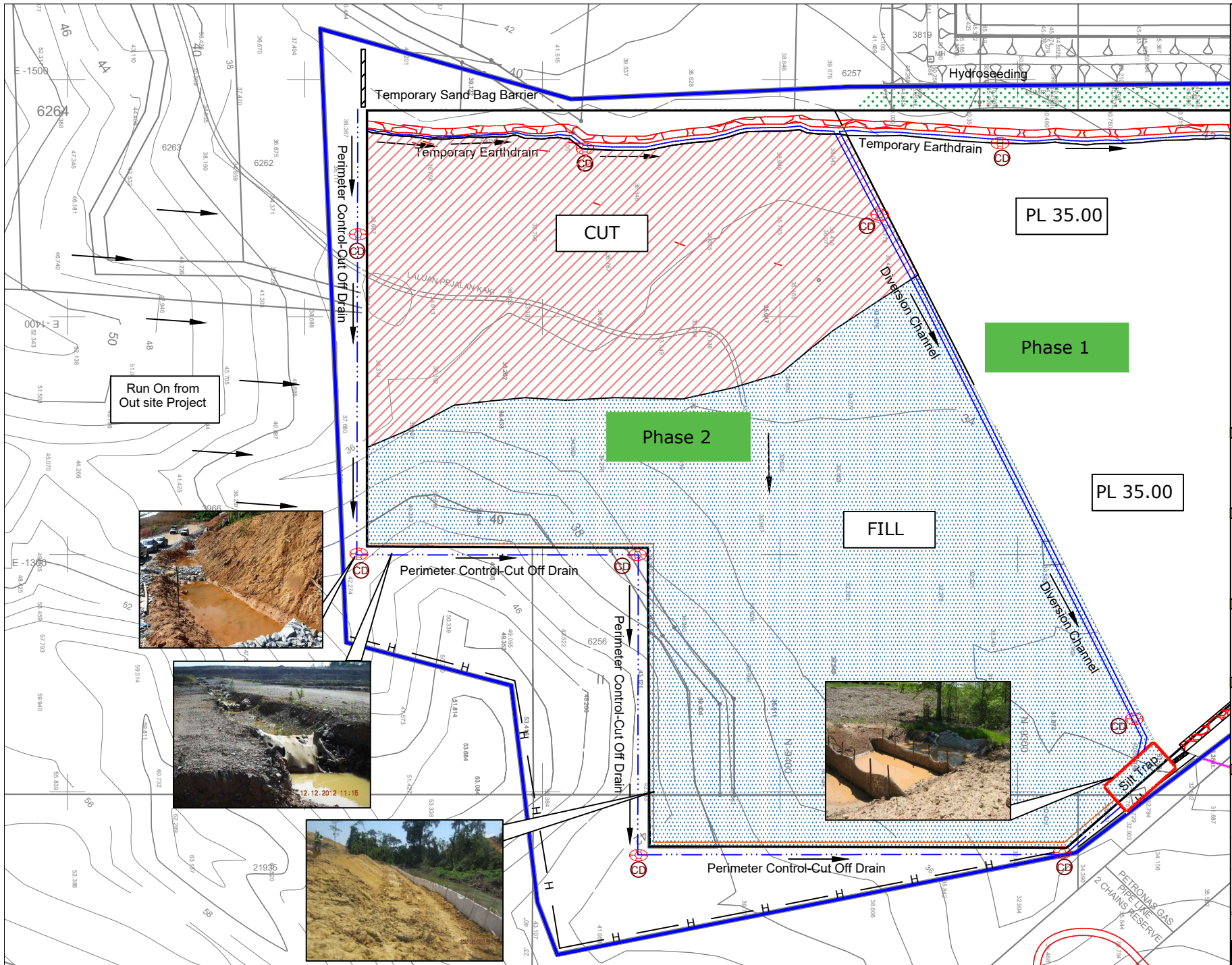
SUB-TITLE  
**DURING CONSTRUCTION (PHASE 1)**

ENGINEER SIGNATURE

LEGEND AND SEQUENCE CONSTRUCTION

CONTOUR	TEMPORARY SAND BAG BARRIER
PROJECT BOUNDARY	SILT TRAP WITH BAFFLES
SWAMP	RIP RAP
EXISTING BERM	ROCK OUTLET PROTECTION
SPOT HEIGHT	WASH TROUGH
PHASE 1 WORK	STABILISED ENTRANCE/EXIT
PHASE 2 WORK	CHECK DAM
HOARDING	SPOIL MANAGEMENT AREA (DISPOSAL A)
PROJECT ROW	STOOPPILE SOIL MANAGEMENT
WORK BOUNDARY	HYDROSEEDING
SILT CURTAIN	ROCK FILL
FENCE	TEMPORARY EARTHDRAIN
CUT OFF DRAIN	CULVERT
FILL	CULVERT
PLATFORM LEVEL	CUT

The details of construction work for during development phase can be refer to construction sequence notes.



OWNER SIGNATURE	
PROJECT TITLE PROJECT SEWAGE TREATMENT WORK EXTENSION	
SUB-TITLE <b>DURING CONSTRUCTION (PHASE 2)</b>	
ENGINEER SIGNATURE	
<b>LEGEND AND SEQUENCE CONSTRUCTION:</b>	
CONTOUR	TEMPORARY SAND BAG BARRIER
PROJECT BOUNDARY	SILT TRAP WITH BAFFLES
SWAMP	RIP RAP
EXISTING BERM	ROCK OUTLET PROTECTION
SPOT HEIGHT	WASH TROUGH
PHASE 1 WORK	STABILISED ENTRANCE/EXIT
PHASE 2 WORK	CHECK DAM
HOARDING	SOIL MANAGEMENT AREA (SPECIAL A)
PROJECT ROW	STOCKPILE SOIL MANAGEMENT
WORK BOUNDARY	HYDROSEEDING
BOUNDARY	ROCK FILL
CURTAIN	TEMPORARY EARTHRAIN
FENCE	CULVERT
CUT OFF DRAIN	CUT
FILL	
PLATFORM LEVEL	
DATE	SCALE
DRAWN	BY
CHECKED	BY
DATE	

## CHAPTER 6

### MONITORING, REPORTING & DOCUMENTATION

#### 6.1 IMPORTANCE OF IIM

The project implementation of the LD-P2M2 Document basically boils down to the notion of “IIM”, or the conducting the processes of “Install”, “Inspect” and “Maintain”. Different projects may adopt differing approaches to conduct IIM but the ultimate purposes of these varying approaches remains the same, and are likely include the following:

- To comply with the contractual and legal requirements pertaining of pollution prevention and mitigation control of environmental issues;
- To make sure the fit for purpose BMPs are constructed in accordance to the plans to pre-empt potential erosion and sediment issues;
- To make sure the installed BMPs are functioning accordingly and that their performance is up to the anticipated levels;
- To upkeep the installed BMPs so as to recharge their performance to the anticipated levels; and lastly,  
To ensure all parties are responsibly accountable in their roles in controlling erosion and sediment issues throughout the life of the intended BMPs.

In a nutshell, the objectives of IIM are graphically shown below:

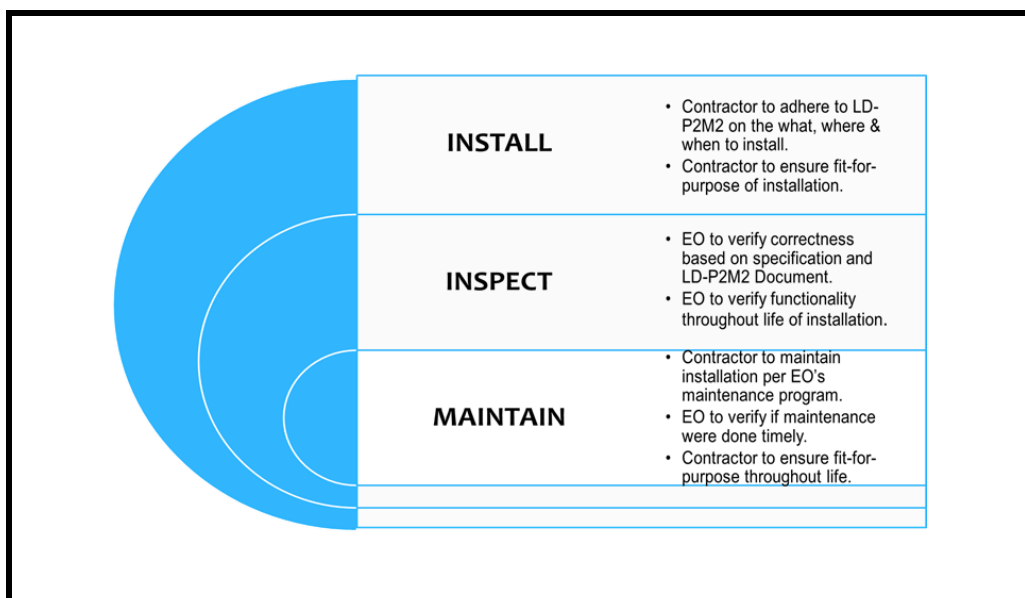


Figure 6.1: Objectives of IIM

### 6.1.1 Install

The installation of erosion and sediment P2M2s is undertaken primarily by the contractor of a project site, but other parties such as the EO plays a role too during this first part of the IIM. Essentially, the objectives of this part of the implementation are to:

- Install and construct the appropriate P2M2s including BMPs at the project site during the pre-construction and construction stages of the project, in accordance with the LD-P2M2 plans and other related plans;
- Execute timely the above P2M2s and BMPs in a systematic manner in accordance with the planned phasing and sequences, and taking into account the weather conditions and site development progress;
- Understand the reasons and purposes for the installation of dedicated P2M2s and BMPs for their specific goals in controlling erosion and sediment issues, or in other words, the cause and effect of such installation;
- Follow the recommendations for the locations of the installation of these P2M2s and BMPs as specified in the LD-P2M2 Document in relation to the evolving site conditions;
- Install the P2M2s and BMPs for land disturbing activities in accordance with the basic principles mentioned in the preceding chapters:
  - Integrate project design with site constraints.
  - Preserve and stabilize drainage ways.
  - Minimize the extent and duration of disturbance.
  - Control runoff flows onto, through and from the site in stable drainage structures.
  - Install perimeter controls.
  - Stabilize disturbed areas promptly in a timely manner.
  - Protect steep slopes.
  - Use sediment controls to prevent off-site damage.
  - Protect inlets, storm drain outfalls, and culverts.
  - Provide access and general construction controls.
  - Inspect and maintain best management practices and control measures.
  - Employ experienced and competent personnel and consistently conduct relevant training.

Moreover, all P2M2s shall be designed, constructed, installed, and maintained in accordance with good engineering practices and applicable design

specifications, and application of all of these P2M2s onsite shall be in accordance with standards and specifications indicated in:

- a. Department of Irrigation and Drainage – DID. 2010. Guideline for Erosion and Sediment Control in Malaysia
- b. Department of Irrigation and Drainage – DID. 2000. Urban Storm Water Management Manual for Malaysia
- c. Erosion and Sediment Control Planning and Design Manual issued by North Carolina Department of Environment and Natural Resources (Note: This manual can be accessed at <https://enviro.doe.gov.my/>)
- d. Best Management Practices for Construction and Maintenance Activities issued by North Carolina Department of Transportation (Note: This manual can be accessed at <https://enviro.doe.gov.my/>).

Following the installation of erosion and sediment control measures, a walkthrough or site inspection should be conducted to ascertain that all measures have been implemented in the field, that erosion is being controlled, and that sediment and other pollutants are not being transported off-site or into critical areas on-site. Any improper installation or any repairs necessary to complete the job should be noted at this time. These critical points must include:

- All disturbed areas of the site;
- Material storage areas;
- Locations where vehicles enter or exit the site;
- All erosion and sediment control BMPs;
- Discharge outfall visual monitoring points.

### 6.1.2 Inspect

Inspection is one of the most important elements of construction and contract administration, and this is also applicable to the implementation of LD-P2M2. Project inspection is provided to ensure that the Contractor's work complies with the contract requirements, and in the context of erosion and sediment control, with the LD-P2M2 Document.

Besides good engineering design and properly prepared plans and specifications, a detailed and sensible LD-P2M2 Document is also essential for quality implementation of the land disturbing P2M2s and BMPs. In this regard, ensuring that the requirements of LD-P2M2 are adhered to depend largely on

the Environmental Officers (EO), regardless of whether the EO is representing the Project Proponent or Contractor.

The minimum information encompassing the inspection activities from day one of the construction commencement through completion of the project includes: Inspector's Daily Logs; Project Log Book (Field Diaries); Photographs labeled and dated for record purposes, and Construction Progress. In addition, any inspectors of P2M2s for land disturbing activities have to be prepared and possess knowledge on the following elements:

- Basic understanding of erosion process;
- Principles of erosion and sediment controls;
- Type of pollution prevention and mitigation measures;
- RUSLE & MUSLE and runoff estimation;
- Major construction activities;
- Plan review including site base maps, topography map, soil map, site development plan, earthwork plan, road and drainage plan etc.;
- LD-P2M2 Document and associated plans and drawings;
- BMPs overview, standards & specifications;
- List of proposed BMPs application;
- Post construction or stormwater BMPs;
- Environmental construction method statements;
- Legislations;
- EIA Approval Conditions;
- Site Safety;
- Communication and Code of Ethic;
- Inspection and enforcement protocol as well as approach;
- Documentation of site activities, and
- Inspection and Enforcement Reporting including PMD (Performance Monitoring Document)

The Inspector must consider safety first during his line of inspection duties. When conducting site inspections, the EO should take due consideration of the following potential health and safety hazards on project sites:

- \* Insects
- \* Animals and Plants
- \* Exposure to the Elements
- \* Vehicle and Equipment
- \* Scrapes, Scratches and Cuts
- \* Slips, Trips and Fall Hazards
- \* Falling Objects
- \* Utilities
- \* Trenching

- \* Confined-Space Inspections
- \* Excessive Noise
- \* Dust and Airborne Particulates
- \* Traffic Safety (Driving, Stopping and Parking)
- \* Hazardous Material Areas
- \* Asbestos Exposure
- \* Pesticides Exposure
- \* Chemicals/Compounds
- \* Gas/Fuel
- \* Spill Prevention
- \* Blasting and Explosives
- \* Protective Clothing

Information from site observations and inspections is only useful if only such information can be effectively communicated to the responsible parties, and one of the most critical factors in ensuring the success of this communication is through the attitude and ethic of the EO. In this regard, the following guidelines should be adhered to during any site inspections:

- \* *Be professional - never lower the standards on how you present yourself.*
- \* *Be courteous, polite, respectful and considerate. Do not mistreat those with whom you come in contact.*
- \* *Be consistent in every situation. People should know what to expect in dealing with you.*
- \* *Be impartial - do not allow yourself to be influenced or coerced in your evaluation of site conditions.*
- \* *Be honest and conduct him/herself in a fair straightforward manner.*
- \* *When under stress, the inspector must still be able to maintain personal composure and make good decisions.*
- \* *Be frank and sincere in relationships with people, and be a skilled diplomat able to handle tough situations without arousing hostility.*
- \* *Be observant and be capable of keeping neat, concise accurate records.*

In addition to the above, the EO or inspectors should be prepared or knowledgeable in the following areas before engaging with site personnel during his inspections:

- \* Establishes communication and becomes acquainted with the contractor's key personnel, namely Environment Officer or Manager;
- \* Have you met with and talked with the responsible site personnel?
- \* Do you believe this person has adequate knowledge to perform this work?
- \* Does this person understand all the required duties in respect to LD-P2M2?

- \* Does this person have the authority to direct resources and make changes in an emergency situation?
- \* Discuss the plans and specifications for the project, traffic control techniques, and define lines of authority;
- \* Be proactive by understanding the project from the contractor's point of view but does not permit reduced quality in order to increase the contractor's productivity;
- \* Influences the construction process to obtain the best possible results;
- \* Offer assistance while being careful not to supervise construction;
- \* To be prepared to respond to the following common claims or statements from Developers, Contractors and relevant parties in the context of erosion and sediment control:
  - It's normal to cause little pollution (sedimentation) during any land development.
  - Lack the knowledge in handling erosion and sediment control since we are not so called technical guys.
  - It's costly and expensive to implement ESC.

#### 6.1.2.1 Checklist

It is normally a good practice to conduct an inspection using tools such as a checklist to ensure the key areas for inspection are covered during the inspection and that important site observations are recorded accordingly on site. In this regard, a checklist for site inspection can be designed to be project specific but generally should cover the major aspects such as the following:

- Regulatory compliance
- Performance of P2M2
- P2M2 installations
- Performance monitoring
- P2M2 suitability
- Maintenance
- Documentation/reporting
- P2M2 closure

In view of the above, **Appendix H** presents checklists that can be made referenced to during inspection of BMPs on a project site.

#### 6.1.3 Maintain

After the installation, all the erosion and sediment controls must remain in effective operating condition during the construction period and be protected

from activities that would reduce their effectiveness. Maintenance differs from the other activities in that it must begin as soon as the first practice is installed and must continue through all the succeeding activities until the permanent erosion control measures are established and functioning.

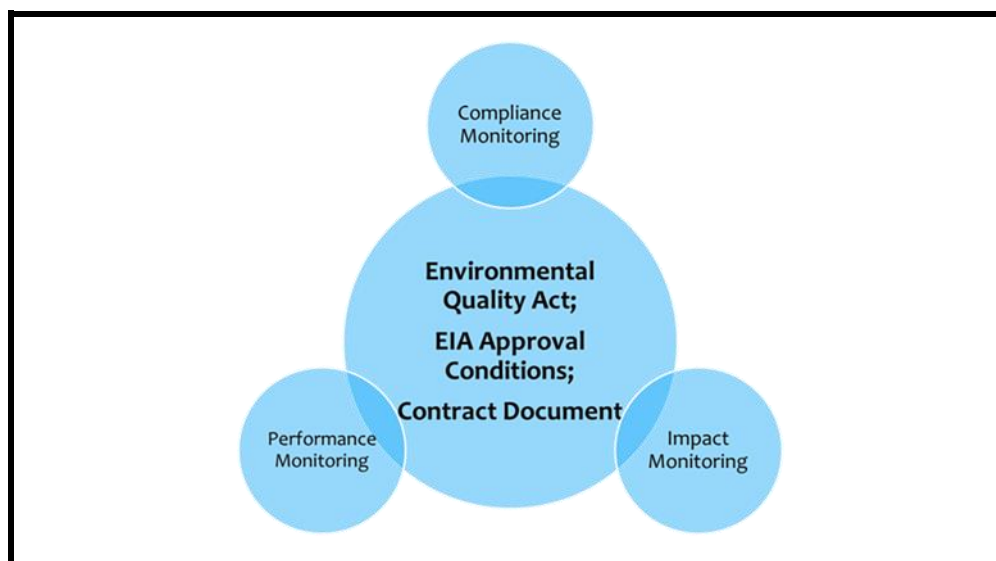
If during the routine or ad-hoc inspections a problem is observed, e.g., erosion and sediment controls need to be replaced, repaired, or maintained), the necessary repairs or modifications shall be carried out accordingly, as follows:

- i. Initiate work to fix the problem immediately after discovering the problem, and complete such work by the close of the next work day, if the problem does not require significant repair or replacement, or if the problem can be corrected through routine maintenance.
- ii. When installation of a new erosion or sediment control or a significant repair is needed, the new or modified control must be installed and made operational or repaired by no later than 72 hours from the time of discovery where feasible. If it is not feasible to complete the installation or repair within 72 hours, it must be documented in the log book why it is not feasible to complete the installation or repair within the 72-hour timeframe.
- iii. Document the schedule for installing the erosion or sediment control and making them operational as soon as practicable after the 72-hour timeframe. Where these actions result in changes to any of the erosion or sediment controls or procedures documented in the LD-P2M2 Document, this document must be modified accordingly within 7 calendar days of completing this work, and submitted to the relevant authorities.

## **6.2 TYPES OF MONITORING**

### **6.2.1 General**

The three (3) types of monitoring typically encompass a construction project, particularly an EIA project, are shown in the figure below.



**Figure 8.2: Types of Environmental Monitoring**

### **6.3 COMPLIANCE MONITORING (CM)**

#### **6.3.1 Definition**

A Compliance Monitoring (CM) program is typically employed in the Project site to assess the overall project compliance and opportunity for optimization and further improvement in environmental management of the Project. In this regard, compliance shall be in accordance with the limits stipulated in the Conditions of Approval of the approved EIA.

### **6.4 IMPACT MONITORING (IM)**

#### **6.4.1 Definition**

A new construction site, especially when established in a green field or near major sensitive receivers such as rivers or streams, may result in some impacts on the surrounding conditions of the area. Therefore, Impact Monitoring (IM) will be carried out to observe if there is any deterioration of the surrounding environment (outside of the project boundaries). Where applicable, this monitoring will be conducted to verify that the findings of the EIA study on the potential impacts are correct, and that the appropriate mitigation and prevention measures are effective in mitigating the adverse impacts to the environment.

## 6.5 PERFORMANCE MONITORING (PM)

### 6.5.1 Definition

Performance Monitoring in the context of erosion and sediment control is the ongoing, systematic process of collecting, analyzing and using performance information to assess and report on the Project Proponent and his Contractor's progress in meeting expected results in addressing erosion and sediment issues and, if necessary, make adjustments to ensure these results are achieved.

Performance monitoring is a similar concept to self-regulating. The Project Proponent is responsible to assign competent personnel (usually his EO) to establish the performance monitoring duty. A Performance Monitoring Document (PMD) and report may be used as a tracking mechanism of the performance based nature of the erosion and sediment control measures implemented on the project site. As soon as the performance monitoring program has been established, the inspection will be easier and smoother to conduct.

By inspecting the performance monitoring report conducted progressively throughout the project life, the inspector as well as the project proponent could back track whether the erosion and sediment control measures has been implemented or maintained correctly or not or even not been done at all.

The key processes involved in conducting PM include the following steps: Planning; Identification of performance questions; Data collection; Data analysis; and Communication.

“Planning” is the process of setting up project objectives to define a strategy needed on how to achieve these objectives, which include the following:

- To be certain that all erosion and sediment control measures in the approved plan have been properly installed and maintained;
- Erosion is being controlled;
- Off-site sedimentation is being prevented; and
- Compliance.

In outlining the strategy during the planning stage, the basic principles of LD-P2M2 as listed in Section 6.1.2 will need to be taken into consideration into the strategy. Additionally, the elements to be included in the Performance Monitoring will need to be briefly described, such as: Mark Clearing Limits; Establish Construction Access; Control Flow Rates; Install Sediment Controls; Stabilize Soils; Protect Slopes; Protect Drain Inlets; Stabilize Channels and Outlets, Control Pollutants; Control Dewatering; Maintain BMPs; Manage the

Project; and Training, CPESC AND CESSWI certified. Alongside these will be to list all of the suggested / proposed BMPs as per the LD-P2M2 Document.

Another important element in the “Planning” stage is to designate the responsible person and to set job descriptions for the following tasks:

- To supervise erosion and sediment control work on-site as specified in the LD-P2M2 Document and EMP of the said project.
- To keep and update Site Diary Log Book.
- To keep and update Rainfall Log Book.
- To keep and record Rain Gauge Log Book.
- To conduct daily inspection on pollution control measures and structural erosion and sediment control BMPs of the project inclusive perimeter drain, check dam, silt trap, wash trough, slope protection and others.
- To inspect all erosion and sediment controls once every 7 days and within 24 hours after each rainfall of 25mm (0.5 inch) or greater.
- To conduct necessary repairs within 72 hours or otherwise required by authority.
- To hold site meeting every two (2) weeks with the project developer and contractor.
- To conduct in-situ measurement for the turbidity parameter of the final discharge within 30 minutes after every storm event. In the case of storm event that continuing exceeding 24 hours, the measurement shall be taken once a day.
- To maintain a record of all of these inspections and maintenance for the duration of the project. These records must be made available to the enforcing official upon request.

In “Identification of performance questions”, what information should be collected in order to respond to the knowledge demand expressed by project stakeholders shall be specified. This implies specifying the information that has to be collected, when, for what reason, and how this is expected to be used.

“Data collection” relates to the collection of data needed to respond to the performance questions formulated by project stakeholders. Data should then be stored and processed in order to be used for analysis.

During “Data analysis (Interpretation)”, the collected information is analyzed, clarified and organized in order to assess whether results have been achieved,

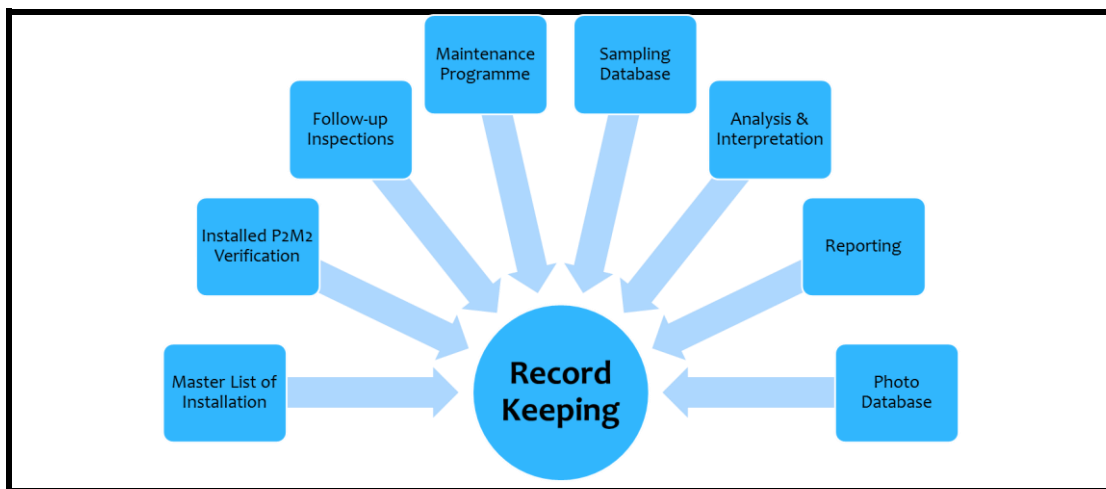
identifying best and worst practices while pointing out correlations and changes that have occurred throughout the project implementation.

Lastly, the results of the analysis are communicated to stakeholders concerned in this last step “Communication (Reporting)”.

## 6.6 REPORTING & DOCUMENTATION

### 6.6.1 General

The reporting and documentation of site observations as well as results of site inspections of land disturbing P2M2s is probably one of the most critical aspects of the implementation of LD-P2M2. Without such data, audit trails cannot be performed, effectiveness of the P2M2s’ performance cannot be measured, erosion and sediment issues cannot be prevented, and accountability cannot be pinned onto the negligent parties. The types of information that shall be diligently collected and recorded in the implementation of LD-P2M2 are shown in **Figure 6.3**.



**Figure 6.3: Critical Record Types**

### 6.6.2 Master List of Installation

Whether we are talking about a small project with a footprint of 10ha or another large project commanding a footprint of 10,000ha, the first and foremost record that the EO should create in the process of LD-P2M2 implementation is a “Master List of Installation”. This list aims to provide a master record for future easy reference on the status of all the installed P2M2s for any single project component. As anticipated, the list of P2M2 and BMP installation will become longer and harder to manage as the project progresses, if such a list is not available.

The objective of a “Master List of Installation” is to consolidate all the installed P2M2’s for any single project component at the project site into one single location where details of all the installations can be readily reviewed and retrieved. The Master List documents the following information:

- \* Identification of project component and respective location
- \* Types of pollution and associated mitigation measures
- \* Coding or labeling of each installation and associated location
- \* Date of actual installation (passed verification)
- \* Date of closure
- \* Photo references

A sample of a Master List is shown in **Figure 6.4:**

**Master List And Installation Of P2M2 (Water, Air & Waste Pollution Control) Components for:  
AR 1 - Access Road from Kg Cheros to M.A.T CH 0+000 - CH 7+150**

Category of Pollution Control	Items	Label	(Reference) Location Chainage GPS	Installation date	Closed / demolished date	Reference Photograph	Remark
Water	Wash trough	WT 1	Ch 0+020	28/11/2010			
	Silt trap	ST 1	CH 0+750	1/1/2011			
		ST 2	CH 1+120	1/1/2011			
		ST 2a	CH 3+080	8/1/2011			
		ST 3	CH 3+200	12/1/2011			
		ST 4	CH 3+600	12/1/2011			
		ST 5	CH 4+500	3/2/2012			
	Silt fence	SF 1	CH 0+000 to CH 0+750 LHS/RHS				
	Check dam	CD					
	Settling Basin	SB					
	Concrete washout area	CW					
	Presevation Of Existing Vegetation	PEV					
	Hydroseeding	HDY					
	Hydroseeding with RECP	HDY					
	Closed turfing	CT					
Temporary earth drain	TED						
Pipe slope drain	PED						
Temporary stream crossing	TSC						
Air/Noise							

**Figure 6.4: Sample Master List of Installation Record**

### 6.6.3 Installed P2M2 Verification

When a P2M2 or BMP is first installed on site, it is important to check and verify that it has been correctly installed. In this regard, this “Installed P2M2 Verification” record provides the evidence to confirm that all the P2M2s were checked to be correctly built prior to being used.

The objective of this record is to maintain a status of all the P2M2’s during their first installation, by documenting the following information:

- ❖ Identification of the types of installation
- ❖ Coding or labeling of each installation and associated location
- ❖ Date(s) of installation
- ❖ Date(s) of inspection and names of parties involved
- ❖ Description of parameters for checking
- ❖ Status of checking
- ❖ Sign off by Inspector and parties involved
- ❖ Photo references

A sample of an “Installed P2M2 Verification” record is shown in **Figure 6.5:**

**Record of 1st Installation Inspection**

Component: Silt Trap  
 Label: ST1  
 Installed Date: 1.1.2011

**Findings from 1st Inspection**

1st Inspection Date & Time: 5.1.2011, 9.00am EO/EO Rep: \_\_\_\_\_ Production Team Rep: \_\_\_\_\_

Parameters for checking	Details	Comply with Std / Dwg / Spec?	If does not comply, describe discrepancies	Suggested Corrective Actions	Production Team Informed Date	Proposed Rectification Date	Status	Reference Photos	Remarks / Instructions
Drawing reference	Dwg ABCD, Rev 1	No	Length specified 40m but actual built 20m	See below	5.1.2011	See below	F	1,2	
Standard & Specification	NA	NA	-	-	-	-	-	-	-
Location	Ch 0+750, adjacent Sg AAA	Yes	-	-	-	-	P	10	-
Size	All ok except for length	No	Length is short by 20m	See below	5.1.2011	See below	P/F	1,2,3,4	
Materials of construction	Concrete	Yes	-	-	-	-	P	-	-
Physical condition	Incorrect length	No	Length is short by 20m	Rectify to comply to approved drawings	5.1.2011	19.1.2011	F	1,2	Upstream activities to ST1 cannot commence
Clear of construction waste/debris	Yes	NA	-	-	-	-	P	5	
Inlet point protected?	Yes	NA	-	-	-	-	P	6	
Discharge point protected?	Yes	NA	-	-	-	-	P	7	
Discharge lower than inlet	Yes	Yes	-	-	-	-	P	8	
Accessories provided	Water/Depth measuring poles	Yes	-	-	-	-	P	9	

**Findings from following Inspection**

2nd Inspection Date & Time: 22.1.2011; 2.00pm EO/EO Rep: \_\_\_\_\_ Production Team Rep: \_\_\_\_\_

Parameters for checking	Details	Comply with Std / Dwg / Spec?	If does not comply, describe discrepancies	Suggested Corrective Actions	Production Team Informed Date	Proposed Rectification Date	Status	Reference Photos	Remarks / Instructions
Drawing reference				Ok as per 1st inspection					
Standard & Specification				Ok as per 1st inspection					
Location				Ok as per 1st inspection					
Size	Ok	Yes	Actual length = 40m	-	-	-	P	12,13	
Materials of construction				Ok as per 1st inspection					
Physical condition	Length rectified	Yes	-	-	-	-	P	12,13	
Clear of construction waste/debris	Yes	NA	-	-	-	-	P	11	
Inlet point protected?	No	NA	New concrete waste plugging inlet	Remove plugged waste	22.1.2011	22.1.2011	F	14,15	Upstream activities to ST1 cannot commence
Discharge point protected?	Yes	NA	-	-	-	-	P	16	
Discharge lower than inlet				Ok as per 1st inspection					
Accessories provided				Ok as per 1st inspection					

3rd Inspection Date & Time: 24.1.2011; 10.00am EO/EO Rep: \_\_\_\_\_ Production Team Rep: \_\_\_\_\_

Parameters for checking	Details	Comply with Std / Dwg / Spec?	If does not comply, describe discrepancies	Suggested Corrective Actions	Production Team Informed Date	Proposed Rectification Date	Status	Reference Photos	Remarks / Instructions
Drawing reference				Ok as per 1st inspection					
Standard & Specification				Ok as per 1st inspection					
Location				Ok as per 1st inspection					
Size				Ok as per 2nd inspection					
Materials of construction				Ok as per 1st inspection					
Physical condition				Ok as per 2nd inspection					
Clear of construction waste/debris	Yes	NA	-	-	-	-	P	20	
Inlet point protected?	Yes	NA	-	-	-	-	P	20,21	
Discharge point protected?	Yes	NA	-	-	-	-	P	22	
Discharge lower than inlet				Ok as per 1st inspection					
Accessories provided				Ok as per 1st inspection					

**Final Inspection Summary**

Final Inspection Date & Time: 24.1.2011  
 Examined to be Satisfactory: Yes  
 Upstream activities can commence: Yes

EO (Name): \_\_\_\_\_  
 Date: \_\_\_\_\_

Production Team Rep (Name): \_\_\_\_\_  
 Date: \_\_\_\_\_

Figure 6.5: Sample of Installed P2M2 Verification Record

#### 6.6.4 Follow-up Inspections

Following the successful installation of the specific P2M2 or BMP, i.e., the installation has passed the inspection of the EO to be in compliance with the specifications or drawings, periodic inspections of the said installation will be undertaken. The “Follow-up Inspections” record will thus provide the evidence on the functionality and effectiveness of these installed P2M2s during their operation and throughout their life.

The “Follow-up Inspections” record aims to provide a snapshot record on the inspection history of installed P2M2s, by documenting the following information:

- ❖ Identification of the types of installation
- ❖ Coding or labeling of each installation and associated location
- ❖ Basic dimensional information of installation
- ❖ Dates of inspection and weather conditions
- ❖ General observations in the vicinity of installation
- ❖ Specific observations of installation on its performance
- ❖ Status of inspection and corrective actions needed
- ❖ Photo references

A sample of a “Follow-up Inspections” record is shown in **Figure 6.6:**

## Inspection Record

Component: Silt Trap      Base Elev:      510.0m      Inlet Inv Level:      512.5m      Sediment Depth Trigger E:      511.05m  
 Label:      ST1      Bank Elev:      512.5m      Outlet Inv Level      511.7m      Water Depth Trigger Elev:      512.40m  
 Installed  
 Date:      1.1.2011      Freeboard:      0.3m

Inspection Date	Weather Conditions	General Observations				Specific Observations									Remarks
		Overall House keeping	Congested Site Conditions	Indiscriminate Upstream works	Photo Reference	Uncontrolled Flow Entry?	Designated Inflow protected?	Structural Integrity?	Outlet Free Flowing?	Evidence of Shortcircuit?	Sediment Depth, m	Water Depth, m	Maintenance Trigger Depth reached?	Photo Reference	
22.1.2011	Sunny	Good	No	None	1,2	No	Yes	No physical damage	Yes	No	510.0	510.2	No		ST1 started to receive flows. Foreman not aware ST1 not ready to be used.
25.1.2011	Sunny	Good	No	None	6,7,8	No	Yes	No physical damage	Yes	No	510.0	510.3	No		
26.1.2011	Heavy rain	Good	No	None	11,12	No	Yes	No physical damage	Yes	No	510.2	510.5	No		
30.1.2011	Drizzle	Fair	Yes - 50% working area used up	None	20,21,22,23	No	Yes	No physical damage	Yes	No	510.3	511.0	No		Big increase in water depth from heavy rain the night before
31.1.2011	Heavy rain	Fair	Yes - 50% working area used up	None	28,29	No	Yes	No physical damage	Yes	No	510.6	511.7	No		
7.2.2011	Sunny	Fair	Yes - 60% working area used up	None	35,36	No	No	No physical damage	Yes	No	510.8	511.7	No		Some construction waste dumped near inflow
10.2.2011	Sunny	Fair	Yes - 60% working area used up	None	38,39,40	No	No	No physical damage	Yes	No	510.8	512.2	No		
14.2.2011	Sunny	Fair	Yes - 75% working area used up	Yes, discharge from adjacent roadworks	43,44	Yes	No	No physical damage	Yes	No	511.0	512.4	Yes		Inflows from bank of ST1
18.2.2011	Sunny	Fair	Yes - 75% working area used up	Yes, discharge from adjacent roadworks	49,50	Yes	No	No physical damage	Yes	No	511.5	512.4	Yes		
26.2.2011	Heavy rain	Poor	Yes - 90% working area used up	Yes, discharge from adjacent roadworks	55-62	Yes	No	No physical damage	Yes	No	511.7	512.4	Yes		
27.2.2011	Heavy rain	Poor	Yes - 90% working area used up	Yes, discharge from adjacent roadworks	70-76	Yes	No	No physical damage	Yes	Yes	511.7	512.4	Yes		
28.2.2011	Heavy rain	Poor	Yes - 90% working area used up	Yes, discharge from adjacent roadworks	80-83	Yes	Yes	No physical damage	Yes	Yes	510.1	512.2	No		Inflow cleared; surrounding areas levelled
7.3.2011	Sunny	Fair	Yes - 70% working area used up	Yes, discharge from adjacent roadworks	90-94	No	Yes	No physical damage	Yes	No	510.2	512.2	No		

Figure 6.6: Sample Inspection Record

### 6.6.5 Maintenance Programme

A “Maintenance Programme” record provides a snapshot record on the maintenance history of installed P2M2s, by documenting the following information:

- ❖ Identification of the types of installation
- ❖ Coding or labeling of each installation and associated location
- ❖ Basic dimensional information of installation
- ❖ Dates of maintenance requests
- ❖ Types of maintenance requested and reasons for maintenance
- ❖ Types of suggested corrective actions
- ❖ Status of maintenance work

A sample of a “Maintenance Programme” record is shown in **Figure 6.7:**

## Maintenance Record

Component: Silt Trap      Base El: 510.0m    Inlet IL: 512.5m    Sediment Depth Trigger Ele    511.05m  
 Label: ST1                Bank El: 512.5m    Outlet IL 511.7m    Water Depth Trigger Elev: 512.40m  
 Installed Date: 1.1.2011      Freeboard: 0.3m

Maintenance Order No	Order Date	Types of Maintenance				Related Inspection Date	Maintenance Arising from General Observations			Maintenance Arising From Specific Observations							Proposed Maintenance / Corrective Actions	Maintenance / Corrective Actions Done?	Maintenance / Corrective Actions Date	Remarks			
		Regular (Planned)	From General Obsv	From Specific Obsv	Others		Overall Housekeep	Congested Site Conditions	Indiscriminate Upstream works	Uncontrolled Flow Entry?	Designated Inflow protected?	Structural Integrity?	Outlet Free Flowing?	Evidence of Shortcircuit?	Sediment Depth	Water Depth					Maintenance Trigger Depth reached?		
ST1-001	18.2.2011			✓		18.2.2011	NA	NA	NA	✓	✓	NA	NA	NA	✓	✓	Yes	1. Excavate and dispose sediment; 2. Clear inflow of debris and protect	No	-	Upon checking on 26.2.2011, conditions of silt trap remained the same. Foreman advised equipment tied up for other works.		
ST1-002	24.2.2011	✓				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1. General cleanup; 2. Excavate and dispose sediment; 3.	No	-	Upon checking on 26.2.2011, conditions of silt trap remained the same. Foreman advised equipment tied up for other works.		
ST1-003	26.2.2011		✓	✓		26.2.2011	✓	✓	✓	✓	✓	NA	NA	NA	✓	✓	Yes	1. Excavate and dispose sediment; 2. Clear inflow of debris and protect	Yes, as requested	28.2.2011			
ST1-004	24.3.2011	✓				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1. General cleanup; 2. Excavate and dispose sediment; 3. Clear inflow	Yes	24.3.2011			
ST1-005																							
ST1-006																							
ST1-007																							
ST1-008																							
ST1-009																							
ST1-010																							
ST1-011																							
ST1-012																							
ST1-013																							

Figure 6.7: Sample Maintenance Programme record

### 6.6.6 Sampling Database

A proper accounting of all the sampling results based on the dedicated monitoring points as stipulated in the EMP shall be maintained. Such database will provide the record on the planned and ad-hoc sampling events undertaken, to verify the effectiveness of the installed P2M2s. The database should include the following information:

- ❖ Dates of sampling and testing
- ❖ Nos. and types of sample taken
- ❖ Location of sampling point
- ❖ Types of laboratory tests
- ❖ Results of tests
- ❖ Conclusion of sampling exercise

### 6.6.7 Analysis & Interpretation

Based on the sampling results and field observations, a simple analysis of the collected data shall be undertaken to provide the project stakeholders with some information on the performance of the P2M2s, such as the trending record on the performance of the installed P2M2's, by documenting the following information:

- ❖ Analytical period for the installation
- ❖ Qualitative analysis on the performance based on visual observation on the P2M2's physical conditions and surrounding site
- ❖ Quantitative analysis on the performance based on measured data of the conditions of the installed P2M2
- ❖ Interpretation of analysis from perspectives of administrative and technical findings

A sample of a simple analysis record is shown in **Figure 6.8:**

Analysis Record of ST1 Inspection and Maintenance Record

Component:	Silt Trap	Base Elevation:	510.0m	Inlet IL:	512.5m	Sediment Depth Trigg	511.05m
Label:	ST1	Bank Elevation:	512.5m	Outlet IL:	511.7m	Water Depth Trigger El	512.40m
Installed Date:	1.1.2011	Freeboard:	0.3m				

Analysis of ST1 for the Period 1.1.2011 - 31.1.2011

<b>Qualitative Analysis</b>	No of Inspections conducted:	5
	Overall weather condition:	Generally sunny with occasional heavy rain
	Overall housekeeping of the work areas:	Generally good for the 1st 3 weeks, but quickly degraded after working area began to be consumed
	Interface with other work packages:	No conflict
	Functionality of ST1:	
	- Compliance with EIA	ST1 begun to receive flows on 22.1.2011, even though approved to be used only on 24.1.2011. Workers not aware not ready to be used.
	- Surrounding areas well maintained	Yes. No evidence of overflows breaching over the bank of the silt trap
	- Condition of inflow	Good - clear of obstruction
	- Condition of outflow	Good - clear of obstruction
	- Condition of sediment/water measuring scale	Good - depth indicators can be clearly read
	- overall structural integrity of ST1	Good - no physical damages observed
	- flow conditions inside silt trap	Normal - no observed shortcircuiting

Date	Sediment Depth, m	Water Depth, m	Sediment Trigger	Water Trigger	Bank EL	Discharge IL
22.1.2011	510.0	510.2	511.05	512.4	512.5	511.7
25.1.2011	510.0	510.3	511.05	512.4	512.5	511.7
26.1.2011	510.2	510.5	511.05	512.4	512.5	511.7
30.1.2011	510.3	511.0	511.05	512.4	512.5	511.7
31.1.2011	510.6	511.7	511.05	512.4	512.5	511.7

Date	Gauge No.	Location	Rainfall, mm
22.1.2011	4a	Hill near Ch 0+300	0
23.1.2011	4a		0.2
24.1.2011	4a		0
25.1.2011	4a		8
26.1.2011	4a		11
27.1.2011	4a		5
28.1.2011	4a		8
29.1.2011	4a		8
30.1.2011	4a		13
31.1.2011	4a		15

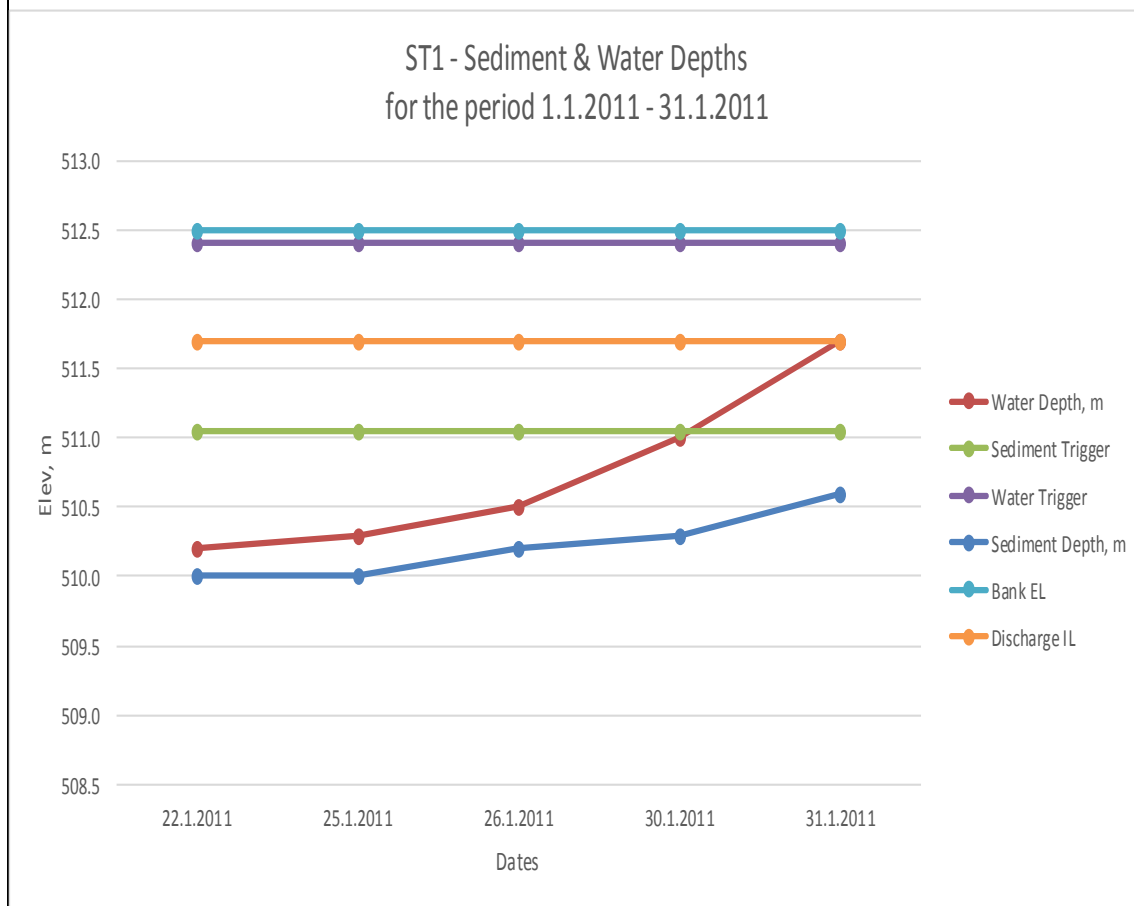


Figure 6.8: Sample Analysis

### **6.6.8 Reporting**

Thereafter, a simple shall be prepared to provide a summary of the above analysis and interpretation, and decision making based on administrative and technical findings.

### **6.6.9 Photo Database**

A comprehensive database shall be maintained to compile a chronological record of all photographic evidence captured during the following events:

- ❖ Installed P2M2 Verification
- ❖ Follow-up Inspections
- ❖ Sampling

## **6.7 ENVIRONMENTAL AUDITING**

### **6.7.1 Environmental Audit Program**

An audit programme represents the Project Proponent's efforts to monitor the implementation and effectiveness of the environmental pollution prevention protection measures by the contractor as specified in the construction specifications and contract documents. An audit checklist shall be developed and distributed and briefed to contractors and all personnel responsible for environmental protection activities. Independent specialist groups should be engaged to closely monitor the project development and to carry out the audits.

This program is proposed to track and ensure the enforcement of specified environmental protection and pollution control measures, including for erosion and sediment control. The audit should be undertaken routinely by the audit team to ensure that the appropriate land disturbing protection and pollution control mitigation measures are properly implemented.

The main coverage of the audit program are to include:

- ❖ General environmental conditions in the vicinity of the site;
- ❖ Pollution control and mitigation measures within the sites;
- ❖ Environmental condition outside the site area which is likely to be affected, directly or indirectly by site activities.

The audit team shall make reference to the following information in conducting the audit:

- The EIA Conditions of Approval from DOE
- The EIA recommendations on environmental protection and mitigation measures
- All the record as discussed in Section 8.6 above

The audit findings and their associated recommendations on improvements to the environmental including land-disturbing protection and mitigation measures shall be submitted to the Project Proponent for immediate action. The contractor shall follow the procedures and time frames stipulated in the environmental audit for the implementation of the mitigation proposal. An action reporting system shall be implemented to report on any remedial measures implemented subsequent to the environmental audit.

All auditors must be registered with DOE. Auditor for the development stage should also possess the CESSWI Certificate (competency to inspect the LD-P2M2 and erosion and sedimentation control plans).

ISBN 978-983-3885-58-8



**Department of Environment**

Ministry of Natural Resources and Environment Malaysia

Level 1 - 4, Podium 2 & 4, Wisma Sumber Asli No. 25, Persiaran Perdana, Precinct 4  
Federal Government Administrative Centre 62574 Putrajaya, Malaysia.

Tel : 03 8871 2000 / 2200

Fax : 03 8889 1971/75

[www.doe.gov.my](http://www.doe.gov.my)