Appendix 12F

Emission Limit Value Calculation

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Derrygreenagh Power Project Appendix 12F - Emission Limit Value Calculation

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Quality information

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Revision History

Revision	Revision date	Details	Authorised	Name	Position
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1. Introduction

1.1 AECOM Limited (AECOM) has been commissioned by Bord na Móna Powergen Limited and Fichtner Consulting Engineers to undertake an Emission Limit Value (ELV) calculation in support of the planning application for the Derrygreenagh Power Project (the Proposed Development).

1.2 The Proposed Development consists of a c.170MW Open Cycle Gas Turbine (OCGT) a c.540MW Combined Cycle Gas Turbine (CCGT), a gas Above Ground Installation (AGI) and ancillary items hereafter referred to as the Power Plant Area, which will export power through an Electricity Grid Connection (via a 220kV tail substation, hybrid transmission of overhead line and 220kV underground cable to a proposed 400kV loop-in substation which seeks to connect into the existing Oldstreet-Woodland 400kV network).

1.3 The operational process water effluent generated at the Power Plant Area will be piped west of the R400 road before discharging into the Yellow River at approximately 3km southwest of the Power Plant Area (Easting 649758 Northing 736428). This discharge will comprise primarily of treated effluent from the water treatment plant which treats effluent from the water treatment plant and boiler blow-down. The proposed discharge will be operated under a new Industrial Emissions (IE) Licence and will have a requirement to comply with the relevant conditions of that licence, including ELVs.

1.4 This report sets out Environmental Limit Values (ELVs) and discharge flow rates for the Proposed Development which will achieve compliance with the aims of the Water Framework Directive (WFD, Directive 2000/60/EC) and relevant Irish enacting regulations set out below. These have been calculated based on upstream water quality and receiving river flow rate.

Background

1.5 ELVs are applied to industrial discharges to protect receiving water quality and are generally specified as maximum concentrations of limited substances by the Environmental Protection Agency (EPA) in Industrial Emissions (IE), Integrated Pollution Control (IPC) and Wastewater Discharge licences. This is in support of achieving 'good' WFD status under The Water Framework Directive (WFD, Directive 2000/60/EC).

1.6 The WFD Directive was enacted into Irish Law through S.I. No. 272/2009 - European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended by S.I. No. 386/2015 - European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2015 and S.I. No. 77/2019 - European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 (the Surface Water Regulations[1]). The 'Surface Waters Regulations' define Environmental Quality Standards (EQS) for achieving high, good, and moderate ecological status in waterbodies in Ireland. The aim of the Surface Waters Regulations is to achieve a minimum good status for all parameters in surface water and to avoid any deterioration.

1.7 Water quality in rivers is principally regulated with reference to nutrient concentrations (BOD, ammonia, and orthophosphate) and Table 1 outlines the EQS which apply to the Yellow River, the receiving watercourse. This technical note focuses on the calculation of indicative ELVs for these nutrients only. Other substances which can be present in industrial discharges in trace amounts are discussed briefly at the end of this note.

Table 1: EQS for Ammonia, BOD and Orthophosphate under the Surface Water Regulations

Parameter	High-Good boundary	Good-Moderate boundary
Ammonia	Mean = 0.040mg/l 95%ile = 0.09mg/l	Mean = 0.065mg/l 95%ile = 0.140mg/l
BOD	Mean = 1.30mg/l Or 95%ile = 2.20mg/l	Mean = 1.50mg/l Or 95%ile = 2.60mg/l
Molybdate Reactive Phosphorus (orthophosphate)	Mean = 0.025mg/l 95%ile = 0.045mg/l	Mean = 0.035mg/l Or 95%ile = 0.075mg/l

[1] Statutory Instruments SI No 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009 http://www.irishstatutebook.ie/eli/2009/si/272/made/en/pdf, updated 2015 and 2019.

1.8 The required ELVs for BOD, ammonia and orthophosphate which need to be applied to a discharge to achieve compliance with the aims of the Surface Waters Regulations can be calculated based on effluent flow rate, upstream water quality and river flow rate. Alternatively, an appropriate effluent flow rate can be calculated based on achievable ELVs. River flow and quality data are reviewed in Section 2.0 below and used to calculate indicative ELVs and an appropriate discharge flow rate for the Proposed Development in Section 3.0.

1.9 The wastewater treatment plant proposed at the site will serve less than 60 population equivalent (PE). This is less than the 2,000 PE used as a minimum agglomeration size in S.I. No. 254/2001 - Urban Wastewater Treatment Regulations (2001) so compliance with these Regulations has not been considered further in this document. ELVs have not been calculated for surface water discharges because these do not normally contain significant quantities of limited pollutants. Compliance with the relevant Industrial Emissions (IE) Regulations will be demonstrated through a separate permitting application and will not form part of the ELV calculation and ELVs will not be calculated for other pollutants (e.g., priority hazardous substances, specific pollutants or watch list substances) because the use of these substances on the site has not been identified at this stage.

2. Data Inputs

Discharge Flow Rates

2.1 The Proposed Development indicates[2] a final discharge flow rate of 14.3m^3/hr under normal operating conditions, based on a treated foul water effluent flow rate of 0.4m^3/hr and a process water effluent flow rate of 13.9m^3/hr. This flow rate has not been used in the ELV calculation because the calculation has been based on achievable ELVs and the required flow rates calculated based on best available treatment (BAT) technology.

River Flow

2.2 The Yellow River is gauged at the Environmental Protection Agency (EPA) gauging station at Derryiron (station no. 07108), which is located at approximately 3km downstream of the proposed discharge point at INGR 252556 236000. River flows were continuously monitored at Derryiron between March 2009 and October 2021. Most of the gauge record is marked as good quality, with extrapolation at extreme flows above Q_1 and below Q_{99} and no suspect, erroneous, unchecked, or provisional data. The record length is 13 hydrological years, which is sufficient to enable a robust calculation of Q_{95}. The record is 92% complete and river flows are not impacted by reservoirs, pumping, abstraction, or large wastewater discharges. The gauge record from the Derryiron gauge (Figure 2) give the flow duration curve shown in Figure 3 and a Q_{95} of 0.17m^3/s.

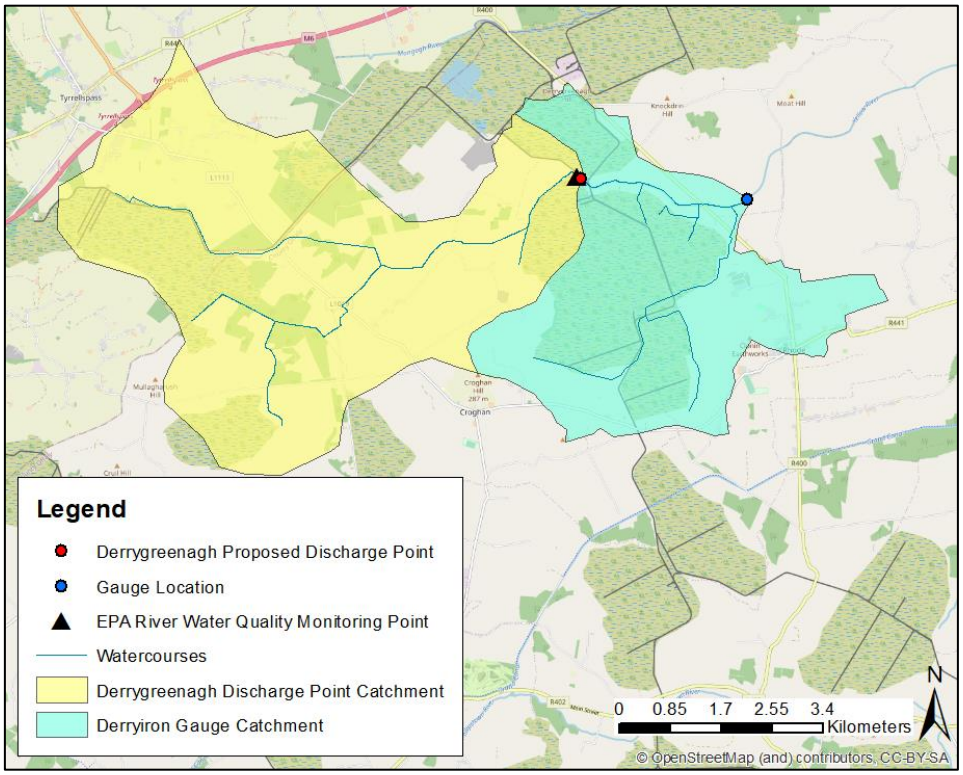

Figure 1: River Flow and Quality Monitoring Locations

[2] Drawing number S7060-8400-001 revision 4.0, Title "Water Balance for CCGT" Derrygreenagh Thermal Power Plant, Derrygreenagh

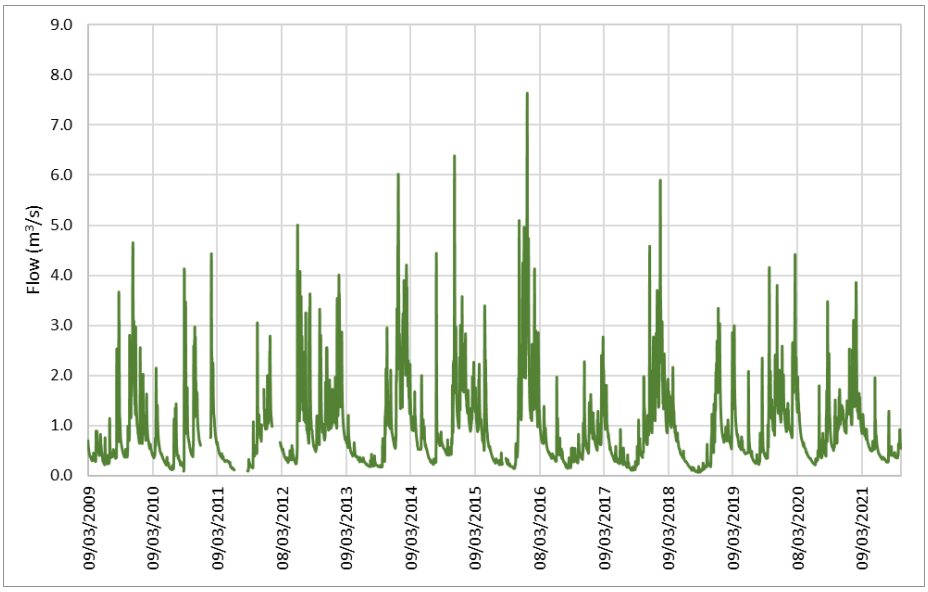

Figure 2: Daily Mean River Flow Monitoring Timeseries

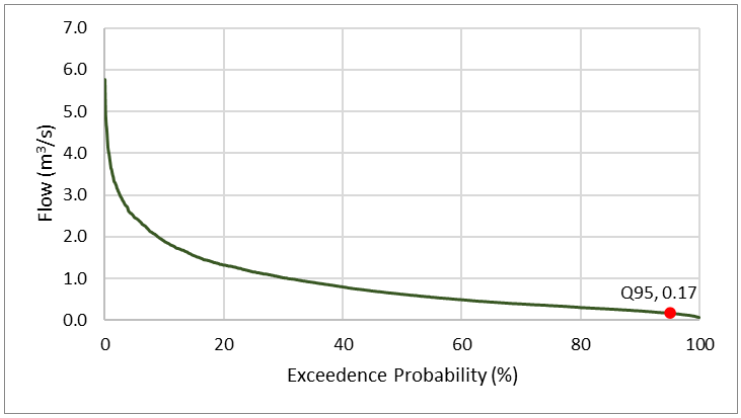

Figure 3: Daily Mean Flow Duration Curve for the Yellow River at Derryiron

2.3 The catchment area at the Derryiron gauge is 37% larger than at the proposed discharge point, mainly due to addition of flows from a single tributary (Figure 1). There is no significant change in catchment hydrology at the gauge because the Yellow River and its tributary both drain low gradient, peat-dominated catchment areas. The flows from the gauge can be scaled to give a Q_{95} estimate at the proposed discharge point of 0.11m^3/s and an average (Q_{30}) flow of 0.64m^3/s.

River Quality

2.4 River water quality is monitored on the Yellow River at EPA National Water Monitoring Station RS07Y020070 (Br d/s Big R Confl, see Figure 1). The water quality timeseries data for BOD, ammonia and orthophosphate are shown in Figures 4, 5 and 6 and the water quality statistics are shown in Table 2.

Table 2: Ambient Water Quality Monitoring Statistics and EQS for the Yellow River

Substance	Mean	95%ile	High-Good boundary	Good-Moderate boundary
BOD (mg/l)	1.32	2.19	Mean = 1.30mg/l Or 95%ile = 2.20mg/l	Mean = 1.50mg/l Or 95%ile = 2.60mg/l
Ammonia (mg/l)	0.097	0.216	Mean = 0.040mg/l And 95%ile = 0.09mg/l	Mean = 0.065mg/l And 95%ile = 0.140mg/l
Orthophosphate (mg/l)	0.009	0.036	Mean = 0.025mg/l And 95%ile = 0.045mg/l	Mean = 0.035mg/l And Or 95%ile = 0.075mg/l

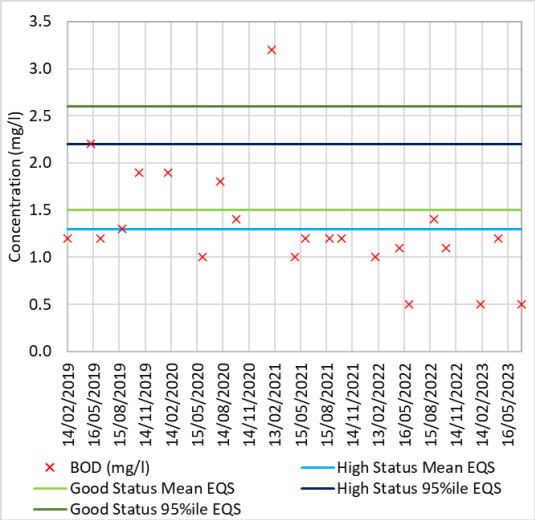

Figure 4: BOD Monitoring Data Timeseries

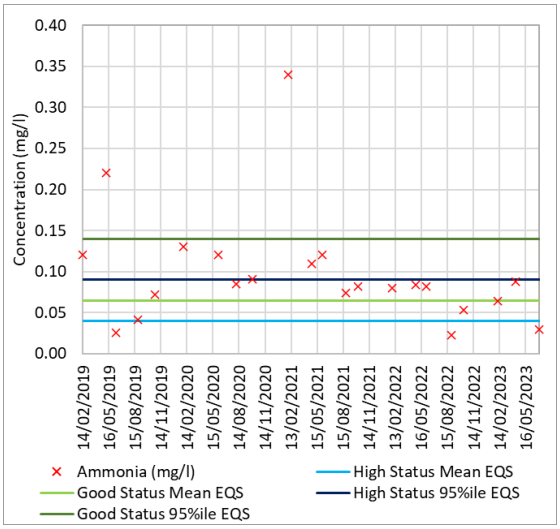

Figure 5: Ammonia Monitoring Data Timeseries

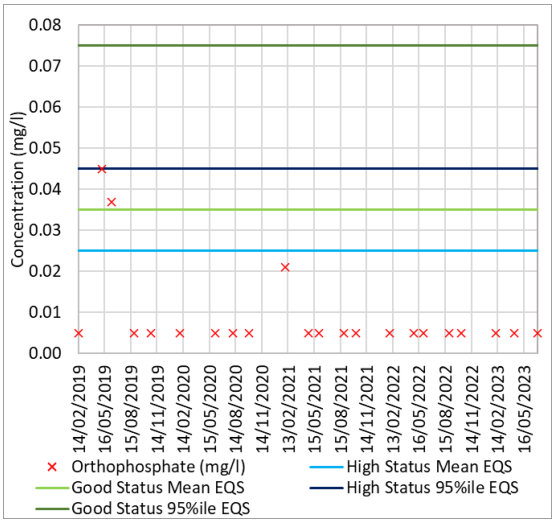

Figure 6: Orthophosphate Monitoring Data Timeseries

2.5 The mean BOD concentration of 1.32mg/l (Table 2) slightly exceeds the high status EQS for mean concentrations of 1.30mg/l. The 95%ile BOD concentration of 2.19mg/l is slightly less than the high status EQS for the 95%ile of 2.20mg/l. The mean and 95%ile orthophosphate concentrations are both well below the respective high status EQS but mean and 95%ile ammonia concentrations in the Yellow River both exceed the good status EQS. There are therefore pressures on upstream water quality which preclude the application of ELVs for ammonia in the proposed discharge at Derrygreenagh which will deliver good status in the Yellow River.

2.6 On this basis:

- The ELV for orthophosphate in the effluent discharged from the Proposed Development will need to be set to comply with the high status EQS values in the Yellow River. This is in line with the "no deterioration" principle in the Surface Waters Regulations.
- The ELV for BOD will need to be set with reference to the EQS for good status because the current mean concentration in the Yellow River exceeds the high status EQS and the 95%ile concentration is extremely close to the High-Good boundary. It is therefore not possible to assign an ELV to the Derrygreenagh discharge which will deliver high status downstream due to other upstream pressures on water quality.
- The ELV for ammonia will need to be calculated using notionally clean upstream conditions in place of observed ambient data. This aims to take account of upstream pressures on water quality and allows for delivery of good status in the Yellow River once upstream pollution sources are addressed. The notionally clean water quality statistics are calculated as 20% of the high status EQS, giving an upstream mean concentration of 0.008mg/l for ammonia.

3. ELV Calculation

BOD, Ammonia and Total Phosphorus

3.1 The ELV calculation is carried out based on a simple mass balance approach in which the concentrations of limited substances in the receiving watercourse and proposed process water effluent are combined, taking account of the relevant river and effluent flow rates.

3.2 An ELV is calculated which will protect mean river water quality using mean upstream quality, design effluent flow rates and an average river flow rate. An ELV is calculated which will protect 95%ile water quality by using average upstream river quality, design effluent flow rates and low Q_{95} river flows. The final ELV is selected as the minimum of the two conditions. The equation can be re-arranged, if necessary, to allow for calculation of an effluent flow rate which will protect water quality given minimum ELVs which are considered achievable using the appropriate treatment technology.

3.3 Table 3 sets out ELVs which are considered to be achievable using Best Available Technology (BAT) for the treatment of process water effluent from thermal power plants. These ELVs will be used to calculate appropriate discharge rates from the Proposed Development.

Table 3: Typical Best Available Technology Concentrations for Thermal Power Plant Effluent [3]

Parameter	ELV
pH	6-9
Toxicity	5-10 Toxicity Units
BOD	20mg/l
COD	30-250mg/l
Suspended solids	10-35mg/l
Ammonia	3mg/l
Total Nitrogen	5-25mg/l
Total Phosphorus	0.1mg/l
Oils, fats and greases	10mg/l
Mineral Oil (from interceptor)	20mg/l
Mineral Oil (from biological treatment)	1.0mg/l

3.4 The ELV calculations are set out in Appendix A and the final recommended ELVs are set out in Table 4 below. The effluent flow rate required to ensure compliance with downstream water quality targets, given upstream water quality and BAT ELV limits, is 18.0m^3/hr (5l/s). The limiting factor determining the discharge rate is the BAT concentration for ammonia of 3mg/l. Discharge rates of 5l/s are required to allow this concentration of ammonia to be diluted to the good status EQS under Q_{95} river flows using notionally clean upstream conditions. The flow rate is lower than the flow rate required to diluted BAT concentrations of BOD and orthophosphate to the respective EQS levels so the allowable concentration of BOD and orthophosphate in the effluent can be increased above BAT.

Table 4: Recommended ELVs for Process Water Discharges to the Yellow River

Substance	ELV
Effluent Flow Rate (m^3/hr)	18.0
BOD (mg/l)	24.0
Ammonia (mg/l)	3.0
Orthophosphate (mg/l)	0.8

[3] ELVs for ammonia and total phosphorus based on Huntstown Thermal Power Plant (IPPC Licence No. P0483-04)

3.5 The ELV for phosphates is given with reference to orthophosphate only because this is the form of phosphate which is limited in surface waters under the Surface Water Regulations. The BAT ELV is given in terms of total phosphorus; however, since orthophosphate is a component of total phosphorus, and since the BAT ELV for total phosphorus is less than the proposed ELV for orthophosphate, the ELV calculated for orthophosphate alone is considered to be compatible with the use of BAT.

Summary

3.6 The purpose of this report is to provide ELVs and effluent discharge flow rates for the Proposed Development which will achieve compliance with the aims of the WFD (2000/60/EC) given upstream water quality and receiving river flow rates.. These ELVs are summarised below, as well as the effluent flow rate required to ensure compliance with downstream water quality targets, given upstream water quality and BAT ELV limits.

Table 5: Recommended ELVs for Process Water Discharges to the Yellow River from the Proposed Development

Substance	ELV
Effluent Flow Rate (m^3/hr)	18.0
BOD (mg/l)	24.0
Ammonia (mg/l)	3.0
Orthophosphate (mg/l)	0.8

Appendix A

DERRYGREENAGH WASTEWATER ASSIMILATIVE CAPACITY CALCULATION

Design Effluent Flow Rate	18.0	m^3/hr	0.005	m^3/s	
River Flow Rate					
Yellow River Q_{95} Flow	0.11	m^3/s	Dilutions at Q_{95}	22.00	Q_{95}/C_{eff}
Yellow River Q_{30} Flow	0.64	m^3/s	Dilutions at Q_{30}	128.00	Q_{30}/C_{eff}

Upstream Water Quality			Notionally Clean Proxy	
	Mean	95%ile	Mean	95%ile
BOD (mg/l)	1.32	2.19	0.26	0.44
Ammonia (mg/l)	0.097	0.216	0.008	0.018
Orthophosphate (mg/l)	0.009	0.036	0.005	0.009

Environmental Quality Standards

	High Status		Good Status	
	Mean	95%ile	Mean	95%ile
BOD (mg/l)	1.30	2.20	1.5	2.6
Ammonia (mg/l)	0.040	0.09	0.065	0.14
Orthophosphate (mg/l)	0.025	0.045	0.035	0.075

Notes:

Current ambient mean BOD concentrations slightly exceed the EQS for high status - target good status
Use ambient BOD concentrations when calculating ELVs
Current ambient ammonia concentrations exceed the EQS for good status - ELV cannot deliver good status
Use notionally clean proxy concentrations for ammonia ELV to account for upstream water quality pressures
Target good status EQS for ammonia
Current ambient orthophosphate concentrations are below the EQS for high status - target high status
Use ambient orthophosphate concentrations when calculating ELVs

Target Downstream Concentrations			River Concentrations Used in Calculations
	Mean	95%ile	Mean
BOD (mg/l)	1.5	2.6	1.32
Ammonia (mg/l)	0.065	0.14	0.008
Orthophosphate (mg/l)	0.025	0.045	0.009

Mass Balance Equation: $$C_{downstream} = \frac{(C_{eff}Q_{eff}) + (C_{river}Q_{river})}{Q_{eff} + Q_{river}}$$

$C_{downstream}$ = downstream substance concentration (target)
C_{eff} = substance concentration in effluent
C_{river} = ambient river concentration upstream of discharge point
Q_{eff} = effluent flow rate
Q_{river} = river flow rate at the discharge point

Equation for ELVs: $$C_{eff} = \frac{\left(C_{downstream}(Q_{eff} + Q_{river})\right) - (C_{river}Q_{river})}{Q_{eff}}$$

Equation for Effluent Flow Rate: $$Q_{eff} = \frac{\left(C_{downstream}(Q_{eff} + Q_{river})\right) - (C_{river}Q_{river})}{ELV_a}$$

ELV_a = minimum achievable concentration in the effluent

ELV Calculation: BOD

ELV (Mean)
$$C_{eff} = \frac{(1.5(0.005+0.64)) - (1.32\times0.64)}{0.005} = 24.54 mg/l$$

ELV (95%ile)
$$C_{eff} = \frac{(2.6(0.005+0.11)) - (1.32\times0.11)}{0.005} = 30.76 mg/l$$

ELV Calculation: Ammonia

ELV (Mean)
$$C_{eff} = \frac{(0.065(0.005+0.64)) - (0.008\times0.64)}{0.005} = 7.36 mg/l$$

ELV (95%ile)
$$C_{eff} = \frac{(0.14(0.005+0.11)) - (0.008\times0.11)}{0.005} = 3.04 mg/l$$

ELV Calculation: Orthophosphate

ELV (Mean)
$$C_{eff} = \frac{(0.025(0.005+0.64)) - (0.009\times0.64)}{0.005} = 2.07 mg/l$$

ELV (95%ile)
$$C_{eff} = \frac{(0.045(0.005+0.11)) - (0.009\times0.11)}{0.005} = 0.84 mg/l$$

Final Recommended ELV
BOD = 24mg/l
Ammonia = 3mg/l
Orthophosphate = 0.8 mg/l

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